MANUFACTURING FUNCTIONAL BAKERY PRODUCTS

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MANUFACTURING FUNCTIONAL BAKERY PRODUCTS

Handbook addressed to the technological specialists in the bakery industry and nutritionists

Material edited within the project

„Let's produce new functional bakery products for people with digestive disorders“

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SUMMARY

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Chapter 3. Newly developed functional bakery products depending on the digestive disorders 3.1. Functional bakery products with digestive disorders: Gastroesophageal reflux Celiac disease Ulcerative colitis Indigestion Ulcers Irritable bowel syndrome 3.2. Newly developed functional bakery products produced in present depending on the digestive disorders	6	4 hours theoretical part 2 hours practical part
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Assessment methods for competencies certification:		
The assessment for competencies certification will be done through tools and tests developed in accordance with the provisions on cognitive and professional skills, taking into account the performance criteria and the conditions of its applicability. Assessment tools will be able to take into account the integrated assessment of the multiple competencies acquired in the course. At the end of the training, the evaluation of the participants will be done through a test, and the graduates will receive diplomas. The assessment highlights the extent to which key competencies, general technical skills and specialized technical skills are modeled.		
List of teaching materials: The theoretical and practical parts will be exemplified by texts, images and videos, and the final teaching method will take into account the level of the target group to which it is addressed.		

CHAPTER 1.

THE IMPORTANCE OF FUNCTIONAL BAKERY PRODUCTS CONSUMPTION

1.1. Functional food and its role in human health

Balanced diet adapted to the body's needs should be accomplished in order to maintain body development, growth and maintenance, to improve the state of well-being and health and to reduce the risk of diseases.
Functional foods are natural or processed foods that contain biologically active compounds, proven to have a specific health benefit (Bultosa, 2016; Ashwell, 2002).
The concept of „functional food" is originated in the early 1980s in Japan and further being developed in the United States and Europe (Siro, 2008).
There are several categories of functional foods:

- natural foods in which one of the components has been naturally enhanced through special growing conditions;
- foods to which a component has been added to provide benefits (e.g.: the addition of selected probiotic bacteria with proven health benefit characteristics to improve gut health);
- foods from which a component has been removed so that the food has less adverse health effects (e.g.: the reduction of saturated fatty acids, reduction of sugars);
- foods in which the nature of one or more components has been chemically modified to improve health (e.g.: the hydrolysed protein in infant formulas to reduce the likelihood of allergenicity);
- foods in which the bioavailability of one or more components has been increased to provide greater absorption of a beneficial component;
- and any combination of the above possibilities.
- Several important functions of human physiology are influenced by functional foods (Ashwell, 2002; Wu et al., 2017; Green et al., 2020):
- Early development and growth;
- Regulation of basic metabolic processes (energy balance and obesity, diabetes, insulin resistance syndrome);
- Defence against oxidative stress;
- Cardiovascular physiology (lowering the blood pressure, blood lipids, homocysteine levels);
- Gastrointestinal physiology (promoting gut health);
- Cognitive and mental performance, including mood and alertness;

• Physical performance and fitness.

Functional foods are composed of natural ingredients that provide functional substances or additional ingredients are added to them to achieve beneficial health effects. Plant-based foods such as fruits, vegetables, herbs, cereals, nuts and beans contain vitamins, minerals, dietary fiber, omega-3 fatty acids, antioxidants and phenolic compounds that play a functional role in the human body against chronic diseases, including cancer, cardiovascular or gastrointestinal tract disease (Arshad et al., 2021; Banwo et al., 2021; Lau et al., 2022). Also, food of animal origin, seafood and other marine products are rich in biologically active compounds such as polyunsaturated fatty acids, bioactive peptides, antioxidants, which can be used as functional ingredients in bakery products (Kadam and Prabhasankar, 2010).

One way to obtain functional foods is to add fiber-rich concentrates, obtained by squeezing fruits or vegetables. Thus, apple pomace, which has been dehydrated and ground into a powder rich in soluble and insoluble dietary fibers and phenolic compounds, has been used to partially replace wheat flour in biscuits. Consumption of these apple biscuit has led to a significant reduction in glycemic index when choosing these products. The conventional biscuit had a glycemic index of 70 and was thus classified as a food with a high glycemic index. Replacing wheat flour with 10 and 20% apple pomace, respectively, reduced the glycemic index of biscuits to 65 and 60, respectively, ranking the product in foods with an intermediate glycemic index (Alongi, M. et al, 2019). Plant-based dietary fibers have also other proven roles: reducing intestinal transit time and increasing bowel volume, reducing plasma cholesterol and / or LDL cholesterol levels, and lowering postprandial blood glucose and / or insulin levels (Kendall et al., 2010).

Conventional foods that contain natural bioactive substances (for example, oat beta-glucan) are also foods with beneficial effects on the body. Thus, studies have shown that beta-glucan reduces inflammation, activates the immune response, or helps maintain normal blood cholesterol and glucose levels (No, H. et al., 2021; Raghavan, K. et. Al., 2022, Tiwari and Cummins, 2011).

Supplementing foods with probiotics reduces the incidence of intestinal inflammation. Probiotics are contained, among others, in whipped milk, yogurt, kefir, fermented oats, olives, cabbage. Prebiotics are non-digestible food ingredients that stimulate the activity of bacteria, giving them the substrate. Milk oligosaccharides, vegetable fibers, some meat peptides stimulate their fermentation by *Bifidobacteria* with the synthesis of short-chain fatty acids and the formation of lactic acid. They have an intestinal trophic role, increase blood flow to the colon, stimulate the synthesis of entero-hormones, the development of the intestinal nervous system and gastrointestinal motility. Lactic acid lowers

the pH, inhibits the proliferation of enteropathogenic flora, promotes the absorption of calcium, magnesium and iron from the colon (Nitescu et al., 2019; Anton et al. 2011).
Another category of functional foods are those from which certain components are removed, such as gluten-free products. The raw materials used for the production of gluten-free products are mainly cereals such as corn, rice, sorghum, millet and pseudocereals (e.g., amaranth, buckwheat, quinoa). (Koehler, P. et. al., 2014).
All these functional products and ingredients have the potential to improve human health by regulating biological processes at the cellular level and are considered value-added food ingredients, which are constantly evolving in terms of the variety of products and their properties.

1.2. Cereals and cereal derivatives - nutritional value, consumption recommendations

1.2.1. Nutritional value of cereals and cereal derivatives

Cereals are herbaceous plants of the Gramineae family, cultivated since ancient times for their seeds and are basic foods for the population around the world. Through the increased content of carbohydrates and proteins they cover up to 60% of the daily caloric requirement globally (Tullio, V et al, 2021), and in the traditional Mediterranean diet, cereals and cereal derivatives (bread, pasta, rice) bring up to 55-60% of the caloric intake (Brites, C, 2015).
Pseudocereals (buckwheat, quinoa, sesame, amaranth), along with cereals, with a similar structure of seeds, have an important contribution in the diet through the intake of macronutrients, dietary fiber, mineral elements, vitamins and phytochemicals.
The main types of cereals in the human diet are represented by wheat, corn, rice, oats, rye, millet, sorghum, triticale and of these, rice, corn and wheat are the most cultivated globally, with a production of 2646 million tons in 2018-2019 (Nugent, A.P et al, 2019).
In the category of cereals and cereal derivatives, several categories are distinguished based on the type of grain they contain:

- cereals and refined cereal derivatives (white flour, white rice, white bread, white flour pasta, bakery/ pastry products prepared with white flour, refined breakfast cereals, etc.);
- cereals and whole cereal derivatives (whole grain flour, whole rice, whole grain bread, whole grain pasta, whole cereals for breakfast, etc.);

• enriched cereal derivatives in which nutrients are added that have been eliminated during processing (e.g. vitamins, fiber added to white bread);
• cereal derivatives fortified with nutrients/micronutrients that are not naturally found in their composition (e.g. iron-fortified breakfast cereals).

In order to understand the difference between whole and refined cereals, it is important to know the structure of the grain because in the technological process, by eliminating the outer layer and the germ, an important part of the nutrients contained is eliminated, which lowers the health benefit of refined (ultra-processed) products.

In 2010, HEALTHGRAIN European Consortium developed the new definition of whole cereals in line with that given by the American Association of Cereals Chemists (AACC): "whole cereals must contain the grain intact, ground or cracked or in the form of flakes, after removing inedible parts such as coating and peel. The main anatomical components - endosperm, germ and bran - must be found in the same proportions as in cereal seeds. Small losses of the components (10% of the bran and < 2% of the seed) that occur by processing methods, according to safety and quality are accepted" (Jan Willem van der Kamp et al, 2014).

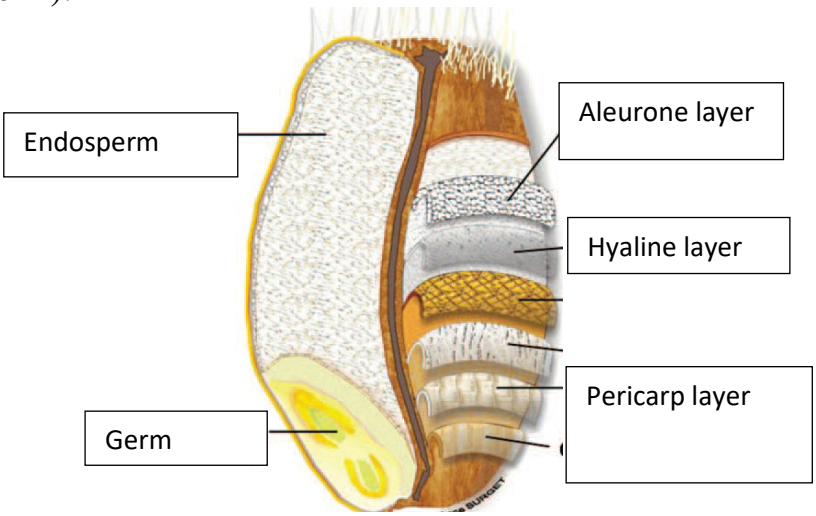

Figure 1.1. *Histological structure of wheat grain, Adapted from Surget and Barron* (2005); (Fred Brouns et al, 2012)

From a nutritional point of view cereals and cereal derivatives are distinguished by: important content of carbohydrates and proteins, dietary fiber, vitamins and mineral elements (Poole N. et al, 2020).

a) **Important carbohydrate content**

Digestible carbohydrates range from 40 to 78% (40% in brown bread, 50% in intermediate bread, 75-78% in wheat flour and cornmeal, 77% in rice). Of these carbohydrates, the best representation is made by starch, which is found in a

percentage of 95-98%, the rest being small molecule carbohydrates (mono and disaccharides) with an important role in alcoholic fermentation.

Indigestible carbohydrates are represented especially by cellulose, pentozani, lignin. They are stored in the shell of the berries. Therefore, if the product is too refined (husked or with few bran), most of the fibers disappear. In white bread the ammount of fibers can be 2-6 times lower than in whole grain bread. In oats and barley there are important amounts of soluble fibers called beta-glucans. These fibers are recognized for their antiatherogenic effect having the role of reducing the absorption of cholesterol.

b) **Protein source**

Proteins in cereal derivatives have a lower nutritional value than proteins of animal origin because they contain limiting essential amininoacids (lysine) or do not contain all the essential aminoacids, as is the case with corn (zein, the main protein in corn is poor in tryptophan, isoleucine, lysine and valine) (Li et al., 2016). In the grain of cereals, proteins are found mainly in the aleuronic layer and in the germ, for this reason, refining will also cause a reduction in the amount of protein (in white flour we find a percentage of 10.33% protein compared to 13.7% as we find in wholemeal flour) (USDA Food Composition Data).

c) **Lipids** in cereals are concentrated in the germ (so they are found in small quantities) and are represented by unsaturated fatty acids (oleic, linoleic and linolenic) with antiatherogenic effect. A greater amount of lipids is found in corn germs. In the germ oil are also found large amounts of vitamin E.

d) **Mineral elements** are concentrated in the shell and are represented by potassium and phosphorus. Phosphorus is found in a percentage of about 70% (in the whole grain). Calcium is almost absent. Sodium is found in small quantities. Cereals also contain some oligoelements such as Cu, Zn, Mn etc. These foods can make a substantial contribution to ensuring the mineral balance.

Table 1.1 *Wheat minerals (whole grain, bran and germ), (Anthony Fardet, 2010)*

Mineral content (mg/100g)	Content in whole grain (per 100 g)	Content in bran (per 100 g)	Content in germ (per 100 g)
Fe	1,0-14,2	2,5-19,0	3,9-10,3
Mg	17-191	390-640	200-290
Zn	0,8-8,9	2,5-14,1	10-18
Mn	0,9-7,8	4-14	9-18
Cu	0,09-1,21	0,84-2,20	0,7-1,42
Se	0,0003-3	0,002-0,078	0,001-0,079

P	218-792	900-1500	770-1337
Ca	7-70	24-150	36-84
Na	2-16	2-41	2-37
K	209-635	1182-1900	788-1300

Phosphorus is present in cereal derivatives, especially in wheat, as the salt of phytic acid (myoinositol-hexaphosphate); the phytic acid reacts with bivalent cations (calcium, zinc, iron) to form insoluble salts, thus reducing their absorption (Couzy F et al., 1998).
Most of the phytic acid is found in bran and germs, so the higher the percentage of bran in flour, the richer it will be in phytates.

Table 1.2 *Mineral content (dry basis) of wheat flour of different extraction rates (Joanne L. Slavin, 2000)*

Mineral content	**Extraction rates**						
	100%	95%	91%	87%	80%	75%	66%
Calcium, mg/g	0,44	0,43	0,38	0,33	0,27	0,25	0,23
Phosphorus, mg/g	3,8	3,3	2,8	2,1	1,5	1,3	1,2
Zinc, ppm	29	25	21	18	12	8	8
Copper, ppm	4,0	3,7	3,4	2,8	2,4	1,6	1,3
Iron, ppm	35	33	28	23	15	13	10

In the bakery process, the phytates content decreases due to the action of the phytase in the flour, which becomes active under the influence of heat and moisture.
Cereal products are acidic foods.

d) Vitamins

Cereals are a good source of vitamin A (in the form of provitamins A), vitamins of the B complex (except vitamin B12), vitamin E and reduced amounts of vitamin K. They do not contain vitamins C and D.
Vitamin A is found in the form of carotene and carotenoids, with ß carotene, ß-cryptoxanthine, lutein and zeaxanthin in cereals (Trono D. et al, 2019). Carotenoids are found mainly in endosperm, grinding and degermination do not greatly influence the content in carotenoids,

B-complex vitamins

Cereals are a good source of B-complex vitamins with the exception of vitamin B 12.

These vitamins are found especially in the shell and in the germ, so whole grains have a higher content of B vitamins compared to refined ones. 100 g of whole grain bread can provide between 10 and 24% of the daily requirement of B vitamins, while the same amount of white bread can only provide between 1 and 10% of this requirement.
In case of rice, 100g of cooked whole rice provides between 1 and 10% of the daily requirement of B vitamins, while the cooked white rice provides between 0 and 7% of this need.

Vitamin E

Cereals contain tocopherol and tocotrienol. These compounds are found mainly in the high in fat layer of the germ, so degermination and grinding determinates the loss of 90-95% of the content of vitamin E.
Fortification of cereal products with vitamins from B group (B2, B9,B12) and vitamin K with the help of bacteria and yeasts, as well as direct fortification with vitamins A, B1, B2, B3, B6, B9, B12, D and E are a method of preventing micronutrient deficiency (Garg M. et al., 2021). Biofortification is a long-term solution to improve the nutritional quality of cereals and can be achieved through agricultural practices, genetic engineering and biotechnologies. This method allows direct biofortification of cereal crops with vitamins A, B1, B2, B3, B6, B9, B12, C and E (Garg M. et al, 2018).

1.2.2. Consumption recommendations for cereals and cereal derivates

For over 10,000 years cereals have been a staple food worldwide, providing between 30 and 50% of the daily caloric requirement. In addition, for the poor population it is also the main source of protein, along with seeds and legumes. In 2003, the World Health Organisation for Europe published its first report on the existence of national nutrition guidelines for the population at the level of countries in the region.
The report stressed that there are important discrepancies between sub-regions and from country to country, and that efforts are needed to develop guidelines (where they do not exist) and implement national nutrition policies (Food based dietary guidelines in the WHO European Region, 2003).
Regarding the consumption of cereals and cereal derivatives, the report showed the existence of large differences from one country to another, from 2-4 servings/day to 8-10 servings/day (for countries that had recommendations on the consumption of cereals and their derivatives), while other countries had no provision (see Table 1.3).

Table 1.3 *Recommendations on the daily consumption of bread, cereals, rice, potatoes and/or pasta (World Health Organization, 2003, https://apps.who.int/iris/handle/10665/107490)*

Country by sub-region	Recommendation on bread, grains, rice, potatoes and/or pasta
Nordic countries	
Denmark	Yes, but not specified
Finland	Included, but not quantified (food circle, pyramid and plate model)
Sweden	Included, but not quantified
Iceland	8-10 servings/d (1 serving=1slice of bread; 1.5dl cereals; 1dl cooked rice or pasta; 2small potatoes)
Norway	Included, but not quantified (more whole grain products)
Western Europe	
Austria	5 – 7 slices/d of bread (250 – 350 g), 1 portion/d of rice or pasta (50 – 70 g raw, 220 – 250 g cooked) or 4 – 5 medium sized potatoes (250 – 300 g). 1 – 2 slices of bread could also be replaced through cereals.
Belgium	*No reply*
France	*No FBDG*
Germany	5-7 slices/d of bread (250-350g) of which 2 slices should be whole grain; 1 portion/d of rice or pasta (50-70g / cooked 220-270g); 1 portion/d of potatoes (4-5 middle sized /250-300g)
Ireland	6 servings/d or more of food rich in fiber and starch like bread, cereals or potatoes (1serving = 1 bowl breakfast cereal; 1 slice bread; 2 tablespoons cooked pasta or rice; 1 medium potato boiled or baked). Choose high fiber bread and cereals.
Luxemburg	4-5 portions/d (1 serving at each main meal)
Netherlands	Not included

Switzerland	Not included
UK	"Eat lots" recommended for bread, other cereals and potatoes
Southern Europe	
Andorra	*No reply*
Greece	8 servings/d of non-refined cereals and products: whole grain bread, whole grain pasta, brown rice etc, not including potatoes on daily basis. One serving = one slice of bread (25g) = half a cup (i.e. 50-60 g) of cooked rice or pasta
Country by sub-region	**Recommendation on bread, grains, rice, potatoes and/or pasta**
	= approximately ½ portion as defined in Greek market regulations (in case of mixed dishes)
Israel	Being updated
Italy	2-4 portions/d (*FBDG in preparation or waiting for official endorsement)*
Malta	Complex carbohydrates > 45% total energy intake; dietary fiber > 30 g/day
Portugal	Increase intake of cereals, potatoes and pulses but not quantified
Spain	6-10 portions/d (1 portion=40-50g rolls; 40-60g bread; 30-40g cereals; 100-150g rice; 100-150 g legumes; 100-150g pasta)
Turkey	4-6 portions/d breads and grains (1 portion=25g bread; 120-150g rice;100-120g legumes)
Central and Eastern Europe	
Czech Rep	3-6 servings/d; 1 serving = 1 slice of bread (60g), 1 cup boiled pasta, rice, cereals (120g)
Hungary	5-9 unit/day of cereals (mostly whole grains)
Poland	5-6 portions/d of cereals and potatoes
Romania	Not included

Slovak Republic	Increase intake of cereals and cereal products (mainly whole grain products), potatoes, quantified in kg/year
Southeast Europe	
Albania	*No FBDG*
Bosnia & Herzegovina	*No FBDG*
Croatia	Bread, grains and preferably whole grain products, rice and potatoes. Constitute the base of the dietary pyramid.
Slovenia	Eat bread, grains, pasta, rice or potatoes several times per day. *FBDG in preparation*
Former Yugoslav Republic of Macedonia	About 450g/d
Baltic countries	
Estonia	Eat mostly rye-bread and cereals: Cereals - 6-8 portions daily, one portion 1 slice of bread, 1 dl porridge, pasta, rice, 3 tablespoon of müesli or flakes; Potato – 3-5 portions daily, one portion 1 big boiled potato or 1 dl mashed potato etc.
Latvia	About 500g/d for adults (*FBDG in preparation or waiting for official endorsement)*
Lithuania	5-11 portions of bread, grains and potatoes
Commonwealth of Independent States	
Azerbaijan	*No reply*
Armenia	250g/d of bread, 20g/d of grains, 50g/d of rice, 250g/d of potatoes, 15g/d of pasta
Belarus	*No reply*
Georgia	360 g/d bread, 24.6 g/d flour, 41.1 g/d wheat, 11-13.7 g/d rice, 137 g/d potato
Republic of Moldova	*No reply*

Russian Federation	*No FBDG*
Ukraine	290g bread; 13.6g grains; 7g rice; 11g pasta; 260g potatoes
Central Asian republics	
Kazakhstan	*No reply*
Country by sub-region	**Recommendation on bread, grains, rice, potatoes and/or pasta**
Kyrgyz Republic	Quantified in g/d, kg/month or kg/year
Tajikistan	*No reply*
Turkmenistan	*No reply*
Uzbekistan	*No reply*

Since 2003, national nutritional guidelines have been developed in many countries or have been revised once or several times.
Official data on nutritional recommendations at national level, including recommendations for the consumption of cereals and cereal derivatives, can be found on the website of the Food and Agriculture Organization of the United Nations (https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries), as well as on the website of the European Commission (https://knowledge4policy.ec.europa.eu/health-promotion-knowledge-gateway/food-based-dietary-guidelines-europe-table-1_en).

We note that although there are consistent observational studies on the beneficial effects of the consumption of whole grains, not all countries have included in the national guidelines specific recommendations from a quantitative point of view for this group of foods (quantities by type of products).
For example, we will present the existing recommendations in several nutritional guidelines from European countries and North America.
The American Nutritional Guide 2020-2025 developed by the Department of Agriculture provides quantitative recommendations for cereals and derivatives according to daily energy intake, while also having recommendations for the consumption of whole grains and derivatives.

Symbolically, a healthy diet is represented by the pattern of the plate, a simple tool for the education of the population, through which one can easily remember which are the foods that contribute to the maintenance of health.
Cereals and their derivatives occupy a quarter of a plate, and there are recommendations that at least half of them should be whole (American Nutritional Guide 2020-2025, USDA My Plate, US Department of Agriculture https://www.myplate.gov/)

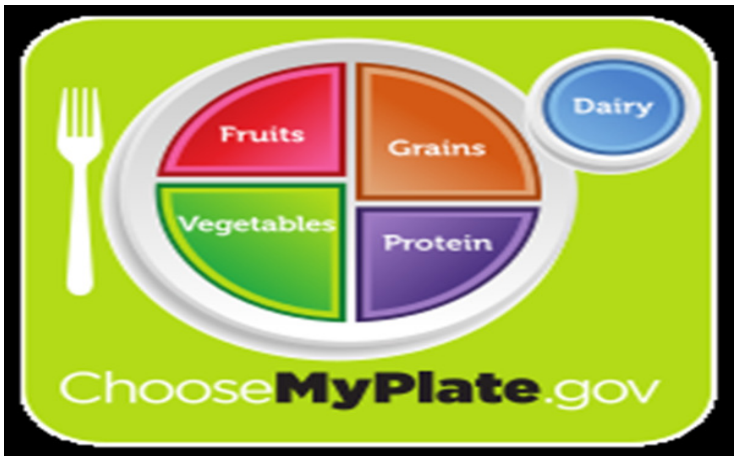

Figure 1.2 *The pattern of the plate*
(https://www.myplate.gov/resources/graphics/myplate-graphics)

Table 1.4. *Recommendations for cereal intake - American Nutritional Guide 2020 – 2025 ((*https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf)

Daily caloric intake (Kcal)	**1600**	**1800**	**2000**	**2200**	**2400**	**2600**	**2800**	**3000**
Cereals-ounce/ day equivalent; (1 ounce-approx.30g)	5	6	6	7	8	9	10	10
Whole grains	3	3	3	$3^{1/2}$	4	$4^{1/2}$	5	5
Refined cereals	2	3	3	$3^{1/2}$	4	$4^{1/2}$	5	5

Table 1.5 *Daily cereal recommendations by age groups* (https://www.myplate.gov/eat-healthy/grains)

Age groups		Total Grains in ounce-equivalents	Whole Grains in ounce-equivalents
Toddlers	12 to 23 months	1¾ to 3 oz-equiv	1½ to 2 oz-equi
Children	2-4 yrs 5-8 yrs	3 to 5 oz-equiv 4 to 6 oz-equiv	1½ to 3 oz-equiv 2 to 3 oz-equiv
Girls	9-13 yrs 14-18 yrs	5 to 7 oz-equiv 6 to 8 oz-equiv	2½ to 3½ oz-equiv 3 to 4 oz-equiv
Boys	9-13 yrs 14-18 yrs	5 to 9 oz-equiv 6 to 10 oz-equiv	3 to 4½ oz-equiv 3 to 5 oz-equiv
Women	19-30 yrs 31-59 yrs 60+ yrs	6 to 8 oz-equiv 5 to 7 oz-equiv 5 to 7 oz-equiv	3 to 4 oz-equiv 3 to 3½ oz-equiv 3 to 3½ oz-equiv
Men	19-30 yrs 31-59 yrs 60+ yrs	8 to 10 oz-equiv 7 to 10 oz-equiv 6 to 9 oz-equiv	4 to 5 oz-equiv 3½ to 5 oz-equiv 3 to 4½ oz-equiv

Age groups		Total Grains in ounce-equivalents	Whole Grains in ounce-equivalents
Toddlers	12 to 23 months	1¾ - 3 x30 g/day	1½ - 2 x 30 g/day
Children	2-4 yrs 5-8 yrs	3 – 5 x 30 g/day 4 – 6 x 30g/day	1½- 3 x 30g/day 2 – 3 x 30g/day
Girls	9-13 yrs 14-18 yrs	5 – 7 x 30g/day 6 – 8 x 30g/day	2½ - 3½ x 30g/day 3 – 4 x 30g/day
Boys	9-13 yrs 14-18 yrs	5 – 9 x 30g/day 6 – 10 x 30g/day	3 - 4½ x 30g/day 3 – 5 x 30g/day

Age groups		Total Grains in ounce-equivalents	Whole Grains in ounce-equivalents
Women	19-30 yrs 31-59 yrs 60+ yrs	6 – 8 x 30g/day 5 – 7 x 30g/day 5 – 7 x 30g/day	3 – 4 x 30g/day 3 - 3½ x 30g/day 3 - 3½ x 30g/day
Men	19-30 yrs 31-59 yrs 60+ yrs	8 – 10 x 30g/day 7 – 10 x 30g/day 6 – 9 x 30g/day	4 – 5 x 30g/day 3½ - 5 x 30g/day 3 - 4½ x 30g/day

2. Canada, 2019

Figure 1.3 *The pattern of the plate – Canada 2019* (Canada's Dietary Guidelines: https://food-guide.canada.ca/en/guidelines/)

3. Italy, 2018

This nutritional guide of Italy was updated in 2018 (CREA, 2018) (https://www.crea.gov.it/web/alimenti-e-nutrizione/-/linee-guida-per-una-sana-alimentazione-2018).

Regarding the consumption of cereals and cereal derivatives, it provides recommendations according to the daily caloric necessary intake (1500-2500 Kcal/day), the recommended quantities ranging from 125-225 g/day for bread, 80-120g/day for pasta, 15-90 g/week for breakfast cereals and 200g potatoes/week (potatoes together with cereals are included in the same group of carbohydrate-rich foods). No quantities of whole grains are mentioned, but only the recommendation to increase the consumption of foods rich in fiber, namely vegetables, fruits, whole grains and legumes.

4. Greece, 2014

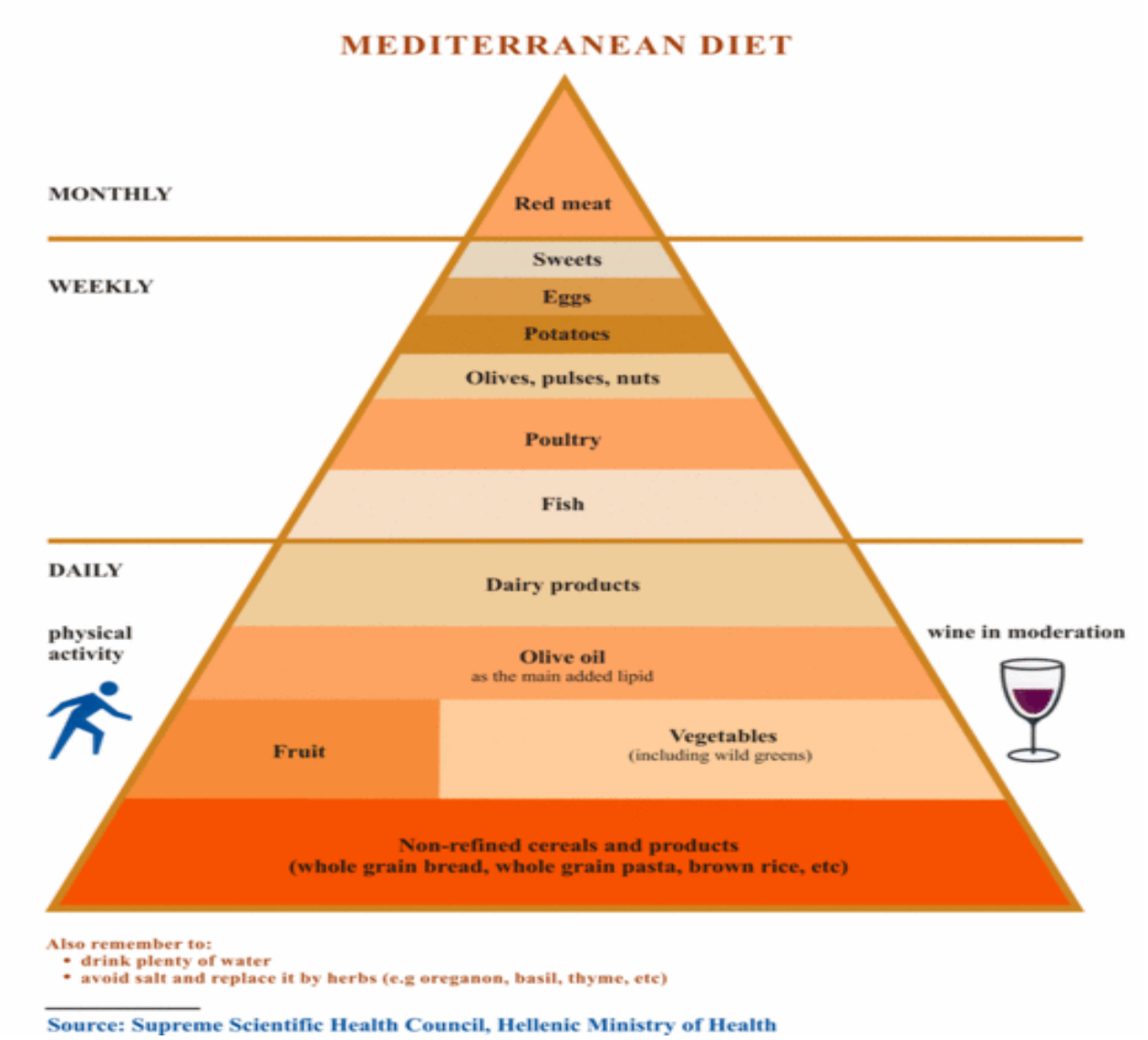

Figure 1.4 *Mediterranean diet* (https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/greece/en/)

5. **Hungary, 2004**

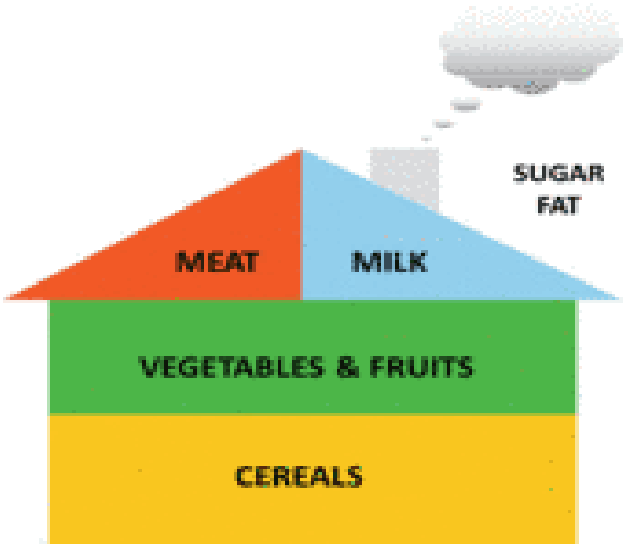

Figure 1.5 *The house of healthy diet*

(https://www.fao.org/nutrition/education/food-based-dietary-guidelines/regions/countries/hungary/en/)

6. Ireland, 2017

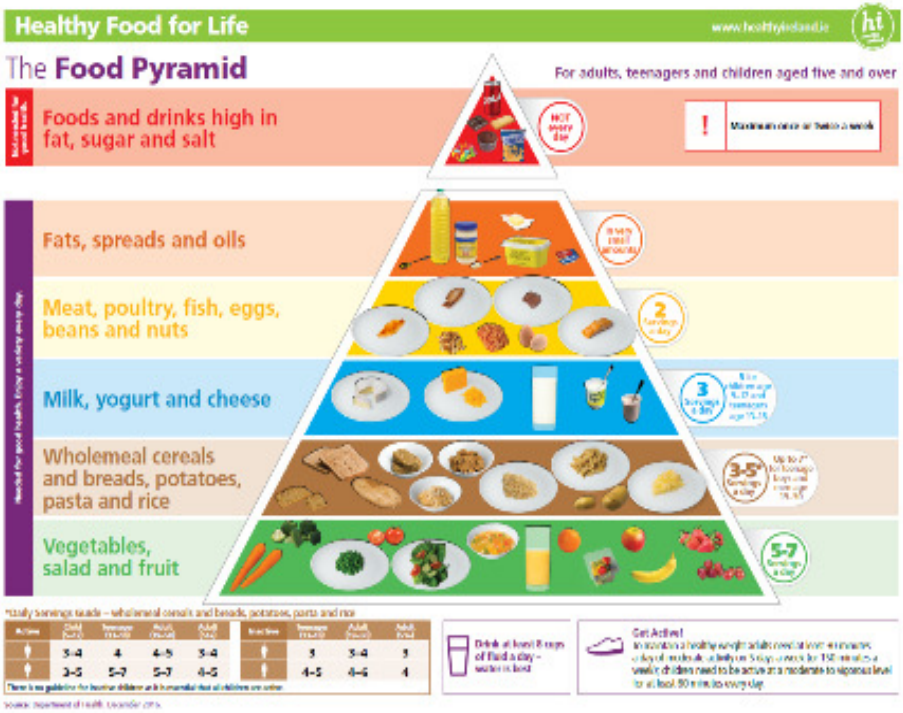

Figure 1.6 *Ireland, 2017* **-** *The food pyramid*

(https://www.fsai.ie/science_and_health/healthy_eating.html)

7. **Romania, 2006**

Figure 1.7 *The food pyramid – Romania, 2006* (https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/romania/en/)

8. **Germany, 2017**

Figure 1.8 (https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/germany/en/)

As we mentioned earlier, a summary of recommendations for starchy foods (including cereals and their derivatives) can also be found on the Europen Commission's website (see table 1.6). This summary may differ from the original nationale guidelines, but keep it unchanged the number and size of portions.

Table 1.6 *Summary of FBDG* recommendations for starchy foods for the EU, Iceland, Norway, Switzerland and the United Kingdom*

(https://knowledge4policy.ec.europa.eu/health-promotion-knowledge-gateway/food-based-dietary-guidelines-europe-table-1_en)

Country	Quantitative recommendations	Qualitative recommendations	Portion size
Belgium - Flanders	-	Eat cereals at every main meal and in bigger quantities if you are sporty or have a hard physical job. Choose little- or non-processed and prefer wholegrain over white flour products.	-
	Notes: Bread, biscuits, and cereals - Dark green zone (=preferred choice): whole wheat or brown with at least 50% wholegrain Grey zone (=no preference): white or brown with less than 50% wholegrain Red zone (=as little as possible): e.g.: croissant, coffee cakes, all kinds of cakes and pastries, breakfast cereals with less than 50% wholegrain and with additives NB: Breakfast cereals and muesli may belong to different zones depending on their composition. Check amount of added sugars and fats on the package. Grain products (pasta, rice) - Dark green zone (=preferred choice): whole wheat or brown with at least 50% wholegrain - Grey zone (=no preference): white or brown with less than 50% wholegrain (white pasta, white rice, couscous) -Red zone (=as little as possible): -		

Belgium - Wallonia	-	-Include grain foods in every meal. -Prefer wholegrain products. -Favour: wholegrain cereals with low SFA content and lightly salted. -Tolerated: refined cereals with intermediate SFA, added sugars, or salt content. -Occasionally: foods richer in SFA, added sugars, or salt, and fried foods	-
	Notes: To belong to this food group: made of at least 50% cereal(s) or potatoes. Excluded from the group if >10% saturated fat (SFA) or >30% added sugars or >1,500 mg/100 g sodium. Favour whole grains (at least 50% unrefined cereals), max 20% added sugars, max 1.5% SFA, max 600 mg sodium/100 g, i.e. wholegrain cereals with low SFA content and lightly salted. Tolerated: 1.5-5% SFA and/or 20-25% added sugar and/or 600-1,000 mg sodium/100 g, i.e. refined cereals with intermediate SFA, added sugars, or salt content. Occasionally: 5-10% SFA and/or 25-50% added sugars and/or 1,000-1,500 mg sodium/100 g and/or fried, i.e. foods richer in SFA, added sugars, or salt, and fried foods.		
Bulgaria	Eat bread daily, other cereals and/or potatoes - 300-500 g/d (the amount depends on gender and physical activity)	- Replace at least half of the white bread with wholegrain bread. - Include more wholegrain pasta, brown rice, prefer boiled or baked potatoes, avoid consuming fried potatoes and chips. - Limit the	-

		consumption of bakery products rich in fats.	
Czechia	Max. 4 times/d	- Prefer wholegrain products. - Prefer to eat food with lower glycemic index (less than 70) - legumes, whole grains, pasta, etc.	-
Denmark	Eat at least 75 g whole grains per day.	- At least 2/5 of the meal should be wholegrain cereals or potatoes. - Choose whole grains.	75 g of whole grains corresponds to 2 dl oatmeal and one slice of whole grain bread.
Germany	Eat every day: 4-6 slices (200-300 g) of bread or 3-5 slices (150-250 g) of bread + 50-60 g of cereal flakes and 1 serving (200-250 g) potatoes (cooked) or 1 serving (200-250 g) of pasta (cooked) or 1 serving (150-180 g) rice (cooked)	Eat plenty of cereals, preferably wholegrain, and potatoes.	200-250 g potatoes or pasta (cooked), 150-180 g rice (cooked), 50 g slice of bread.
Estonia	7-9 portions cereal products & potatoes (bread, wholemeal bread:	-Prefer whole grains. -Prefer breakfast cereals with the least sugar. -Avoid over-baking and	-Cereal products: 30 g rye-, whole grains-, seed breads, 30 g barley bread,

	3-4; porridge, rice, pasta, other: 2-4; potatoes: 1-2).	excessive crispness (acrylamide).	wholemeal pastry, scones, 30 g white ryebread, 30 g pastry. -Porridge, rice, pasta 100 g cereal grains or cooked cereals as side dishes, 75 g of maize-based products, 70 g cooked: rice, pasta products, quinoa, 50 g cooked couscous. -Other cereal products: 25 g cooking flour, 20 g corn flakes, muesli (excl. muesli cereal bars).
	Notes: Potatoes included		
Ireland	3-5 servings/d of wholemeal cereals and breads, potatoes, pasta and rice.	-Wholemeal and wholegrain cereals are best (be aware of the calorie difference - some types contain more calories than others). -Enjoy at each meal. -The number of	2 thin slices wholemeal bread, 1.5 slices wholemeal soda bread or 1 pitta pocket, 1/3 cup dry porridge oats or 1/2 cup unsweetened muesli,

		servings depends on age, size, gender, activity levels.	1 cup flaked type breakfast cereal, 1 cup cooked rice, pasta, noodles or couscous, 2 medium or 4 small potatoes, 1 cup yam or plantain.
	Notes: Potatoes included		
Greece	5-8 servings/d of cereals (bread, pasta, rice, potatoes, etc.). Consumption of potatoes should be limited to approximately 3 servings/week.	- Consume a variety of cereals everyday. - Prefer wholegrain products.	1 slice of bread, half a cup (120 ml) cooked pasta or rice. 1 medium potato (120-150 g cooked).
	Notes: Potatoes included		
Spain	Fiber: 25 g/d.	Healthy diet must include carbohydrates with a predominance of complex carbohydrates (rice, bread, pasta, potatoes, legumes). Fiber is necessary in the diet and it is found in whole grains, legumes, vegetables, salads, fruits, nuts.	-
	Notes: In the NAOS Pyramid: Food group to be consumed at every meal, in amounts commensurate with level of physical activity. Starchy foods are the basis of the diet and should be consumed daily.		

France	-	Eat every day and give preference to whole grain and minimally processed products. Favour cereal products grown according to production methods that reduce pesticide exposure (precautionary principle). Only whole grain breakfast cereals without added sugar may be included in this group.	-
Croatia	-	This food group should be a part of almost every meal. Eat plenty of wholegrain cereals.	-
	Notes: Potatoes included		
Italy	3-5 portions/d of bread, 1-2 times/d 2-4 biscuits / 2.5 crackers of bakery products 1-2 portions/d of pasta or rice* + 1-2 portions of fresh pasta*. *if in soup, it is half a portion	Regularly consume bread, pasta, rice, and other grains (preferably wholegrain), avoiding too much fat condiments. When you can, choose products made from wholegrain flours and not simply with added bran or other fibers (read labels).	1 small bun ("rosetta") 1 medium slice of bread (50 g) 2-4 biscuits 2,5 crackers of bakery products (20 g) 1 average portion of pasta or rice* (80 g)

			1 small portion of fresh pasta* (made with eggs) (120 g). *if in soup, it is half a portion
	Notes: Potatoes included (number of portions depending on daily energy requirements: 1,700 kcal, 2,100 kcal, or 2,600 kcal).		
Cyprus	Bread / cereals / potatoes: 6-11 portions/d	Eat whole grains	1 serving = 1 slice of wholemeal or white bread (25-30 g), 1/2 cup (120 ml) rice, 1/2 cup (120 ml) groats / barley, 1/2 cup (120 ml) pasta, 90 g potato (boiled or baked small potato), 1/2 cup (120 ml) taro / sweet potato / pea
Latvia	6 servings (approx. 800 g) of cereals, cereal products and potatoes every day	Half of the energy requirements should come from this group. Prefer wholegrain. Avoid using cereal-rich foods that contain a lot of sugar (e.g.: sweetened breakfast cereals or quickly-cooked portions)	2-3 slices of bread, 1/2 - 1 cup of boiled pasta, groat or buckwheat porridge or a medium-sized potato
	Notes: Potatoes included		
Lithuania	Several times a day.	Should constitute more than half of daily food intake.	1 slice of bread, 1/2 cup of cereal porridge or pasta, 1/2 cup flakes, 1 medium-sized potato (about 75

			g).
	Notes: Several times a day eat cereal foodstuffs		
Luxembourg	Eat 1 portion of starchy foods (potatoes, pasta, rice, cereals, cereal products such as bread are included, pastries are excluded) with every main meal	Prefer wholegrain.	-
Hungary	3 servings of cereals per day, 1 of which should be wholegrain	Swap refined grain choices for wholegrain bread, rolls, pasta, biscuits or cookies, cereals, brown rice Durum wheat pasta could be a good choice as well	1 piece of pastry (e.g. cookie or bun) 1 medium slice of bread/cake 12 tablespoons (200 g) of cooked pasta/rice 3 tablespoons of cereals/muesli.
Malta	3-4 servings/d. At least 1 per meal.	Include whole grains such as oats, couscous, quinoa, bulgur, wheat, barley, millet, pasta and rice with meals and snacks.	1 medium slice of bread, 40 g of breakfast cereals, 80-100 g of raw cereals, pasta, and rice, preferably wholegrain or wholemeal.
Netherlands	Men 19-50 yr: Daily 6-8 slices of brown or wholemeal bread. Women	Consume mainly wholegrain products such as wholegrain bread, wholegrain pasta and brown rice.	Slice of bread: 35 g Medium potato: 70 g Tablespoon of prepared cereals: 50 g

	19-50 yr: Daily 4-5 slices of brown or wholemeal bread. And daily 4-5 portions wholegrain products or potatoes. Additional recommendations for children; elderly; pregnant women; lactating women. Weekly at least half of the recommendations for whole wheat products (excluding bread) or potatoes should consist of whole wheat products.		
Austria	4 portions/d.	Prefer wholegrain products.	1 portion is: (wholegrain) bread and bakery ware:1 handpalm müesli or cereal flakes: 1 handful cooked rice, cereals, potatoes: 2 fists
Poland	-	Eat cereal products, especially wholegrain ones. Cereal products	-

		should be part of most meals.	
Portugal	4-11 servings daily of cereals and cereal products, tubers.	-	1 unit (50 g) of bread, 1 slice (70 g) of bread, 1.5 medium-sized potatoes (125 g), 5 tablespoons of breakfast cereals (35 g), 6 semisweet-type biscuits (35 g), 2 tablespoons of raw rice/pasta (35 g), 4 tablespoons of cooked rice/pasta (110 g).
	Notes: Potatoes included		
Romania	6-11 servings	Bread, cereal, rice and pasta. Preferably unrefined type, with a low amount of SFA or added sugars. Consume large amounts of grain - this group should be the basis of your diet.	Slice of bread ½ cup cereal, rice or pasta (cooked) a biscuit
Slovenia	9-17 servings/d.	Prefer wholegrain products.	One serving = half a piece of bread, half a small bun, 2 large tablespoons of flakes/ muesli/cooked porridge/cooked rice/cooked pasta, 1 medium-large

			boiled potato.
	Notes: Potatoes included		
Slovakia	3-6 servings/d	Preference given to wholemeal products and with low salt content. No preservatives, flavourings and synthetic colours.	2-3 slices of wholegrain bread. 1/2 glass of oat flakes or 1 glass (200 ml) wholegrain cereal 1/2 glass of natural rice or wholegrain pastries.
	Notes: Potatoes not included.		
Finland	6 servings for women and about 9 servings for men. At least half should be wholegrain. Fiber content in bread should be at least 6 g/100 g.	Eat wholegrain cereals several times a day. Replace white with wholemeal alternatives.	1 dl cooked wholegrain pasta, barley, rice, or other whole grains, or one slice of bread. 1 plate of porridge is 2 portions.
Sweden	-	Switch to wholemeal! Choose wholegrain varieties when you eat pasta, bread, grain and rice. Look for the Keyhole symbol.	70 g wholegrain/ day for women and 90 g wholegrain for men is about the right amount. This is equivalent to two pieces of crispbread and a portion of wholegrain pasta, for example.
United Kingdom	Should make up just over a third of the food we	Base meals on potatoes, bread, rice, pasta or other starchy	-

	eat.	carbohydrates; choose wholegrain versions where possible. Check the labels and choose the products lowest in fat, salt and sugar.	
Switzerland	3 portions/d of cereal foods, potatoes, pulses	Give preference to wholegrain products.	1 portion = 75-125 g bread/dough or 45-75 g crisp bread/whole grain crackers/flakes/flour/pasta/rice/corn/ other grains (dry weight).
	Notes: Included in one group together with potatoes and pulses		
Iceland	Wholegrain foods at least twice a day.	Choose wholegrain bread or other foods from wholegrain at least twice a day. Use whole grain cereal products for baking and in porridge for example rye, barley, whole wheat and oats. Use barley, brown rice and whole-grain pasta instead of fine-grained products. Choose cereals with the Keyhole symbol if possible.	Wholegrain foods at least twice a day.
Norway	70-90 g wholemeal flour or wholegrain/d	Choose cereal products that are high in fiber and whole grains and	-

		low in fat, sugar and salt.	
	Notes: Potatoes included		

*Food Based Dietary Guidelines

1.3. The role of cereals in promoting and maintaining health

Cereals and cereal derivatives are basic products in the diet of people around the world.

The association between the consumption of whole grains and the reduction of the risk of noncommunicable chronic diseases such as cardiovascular diseases, digestive diseases, cancer, type 2 diabetes has been established by numerous observational studies (Kevin Burke Miller, 2020) and studies conducted in the USA have shown that cereal derivatives (including refined cereals), although they bring nutrients whose consumption must be limited (sugar and saturated fats), contribute to the nutritional density of the diet through the intake of fiber, magnesium and vitamins of group B, an effect especially highlighted when these products are fortified (Yanni Papanikolaou et al., 2016).

Numerous scientific evidence associates the beneficial effect of whole grains with its high fiber content (Huang, T., 2015).

Studies in animals and humans have confirmed the important role played by dietary fiber intake in cardiovascular protection.

This is due to soluble fibers that prevent the reabsorption of bile acids and the decrease of circulating cholesterol, as well as the formation of short-chain fatty acids that reduce the progression of atherosclerosis and inhibit cholesterol synthesis and its hepatic accumulation (Prasad, K.N., 2019).

Dietary fiber brought into the diet by cereals have a proven role in the prevention of obesity, type 2 diabetes and metabolic syndrome (Karl, J.P et al., 2014, Giacco, R. Et al., 2014). Among the most important advantages of eating cereals we mention:

1. Through its high content of carbohydrates it is the most important source of energy, covering 30-50% of the caloric requirement. By having as main representative starch, but also dietary fiber, cereal carbohydrates are clearly superior in terms of effects on the health of sugary products containing simple carbohydrates.

2. The increased protein content recommends cereals and their derivatives as a good source of protein in vegan and vegetarian diets, during periods of religious

fasting and especially in poor countries where the diet is poor in foods of animal origin, the main source of protein.

3. By the natural content of vitamins and mineral elements of whole grains and the fortification of refined cereal derivatives, cereals contribute to the intake of these micronutrients (Fe, Mg, Ca, vitamins of the B complex, vitamin A, vitamin E).
They also bring an important amount of bioactive antioxidant substances, with numerous beneficial effects in maintaining health.

4. Through the intake of soluble dietary fiber (predominantly in oats and barley) and the intake of insoluble fiber (mainly present in wheat), cereals contribute to maintaining health both directly, through the functional effects of fiber, and indirectly through the intestinal microbiota (Fig.1.9).

5. During the germination of cereals, phytohormones are synthesized, about which it has been shown that, against the background of an atherogenic diet, they have the ability to lower the level of hypercholesterolemia and prevent atherosclerosis (Andersson, A.A.M. et al., 2014).

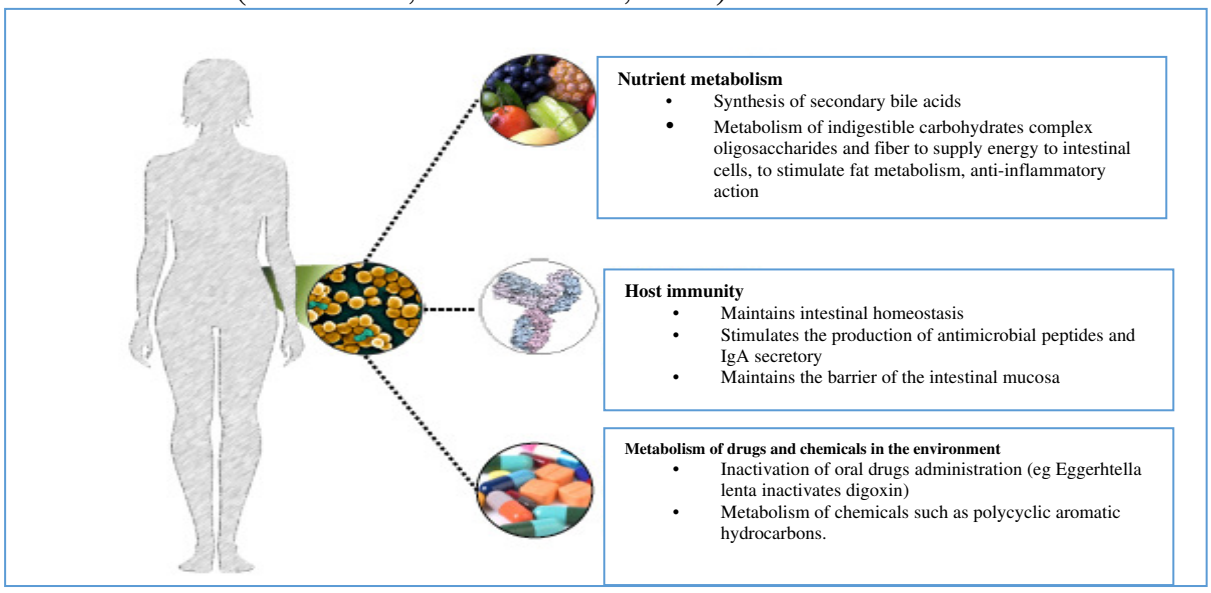

Figure 1.9 *The physiological role of the intestinal microbiota in maintaining health (National Academies of Sciences, Engineering, and Medicine. 2018)*

6. Through their nutritional value and energy density, cereals and cereal derivatives play an important role in people's diets being recommended for both healthy people and those with various diseases.

7. Cereals and cereal derivatives, especially those based on whole grains are a staple food in the most valued diets such as the Mediterranean diet, the diet to stop hypertension (DASH).

8. White bread is recommended together with whole grain bread for growing children and pregnant women, the elderly, people with poor nutrition, due to the disposal of excess phytates and in support of increasing the intake of energy and micronutrients.

9. Also, white bread is indicated in acute episodes of diseases in which there is an intolerance to fibrous material such as gastritis, gastric and duodenal ulcers, enterocolitis and ulcero-hemorrhagic colitis, as well as in malabsorption syndromes.

10. Whole cereals and their derivatives are recommended for young people and healthy adults, as well as in the nutritional therapy of metabolic diseases (obesity, metabolic syndrome, type 2 diabetes, dyslipidemia, hyperuricemia, hepatic steatosis), digestive diseases referred to in point 7 during the remission period, cardiovascular diseases, cancer, autoimmune diseases, chronic infections, while taking antibiotics, allergic diseases and neurodegenerative diseases.

1.4. The role of dietary fiber in the diet

1.4.1. Classification of dietary fiber (Nițescu M et al.,2019)

The definition and classification of dietary fiber have been much debated and related to both physiological considerations and the methods that can be used to analyze these compounds in food (European Food Safety Authority, 2010; Teixeira Macagnan, F. et al., 2016)

The U.S. Institute of Medicine established in 2002 the following classification of fibers in the diet (Position of the American Dietetic Association, 2008):

- **dietary fiber** represented by indigestible carbohydrates (non-starchy polysaccharides -NPS) and lignin, which are found intact in plants. These include wheat bran and oats.
- **functional fibers** are isolated indigestible carbohydrates, which have physiological effects in the human body (resistant starch and fruit-oligosaccharides)
- **total fibers** are the sum of dietary fiber and functional fibers.

The classification of dietary fiber is based on their physical properties, namely:

- solubility in water,
- fermentability
- viscosity.

Depending on the water solubility, the dietary fiber can be categorized into soluble (pectins, gums, mucilages, soluble polysaccharides, β-glucans, algae polysaccharides, bacterial polysaccharides, fructo-polysaccharides – inulin, fructo-oligosaccharides – oligofructose, resistant starch) and insoluble (cellulose, hemiceluloses, lignin) (Fernandez-Banarez, F. 2006, Gidley M.J. et al., 2018).

In terms of the degree of polymerization, dietary fiber includes resistant polysaccharides with a degree of polymerization > 10. Some research in recent years has reported that indigestible carbohydrates with a degree of polymerization between 3 and 9 also exhibit different physiological effects, as do most dietary fiber. These physiological effects include increased stool volume, better colonization of the colon by fermenting them, accelerated intestinal transit and reduced levels of blood cholesterol, postpranial blood glucose and insulin. Inulin belongs to this category, being a water-soluble carbohydrate that is fermented at the end of the small intestine and in the colon, leading to the formation of fatty acids with a short chain of carbon. These short-chain fatty acids are able to assist the growth of certain probiotics like Bifidobacteria, thereby enhancing colon health. In 2009, these carbohydrates with a degree of polymerization lower than 10 were also included in the category of dietary fiber (Dai, F.J et al., 2017).

Viscous dietary fiber thickens the contents of the intestinal lumen, helping to slow down the absorption of nutrients in the intestine. As a result, they can reduce the absorption of cholesterol, glycemic carbohydrates and other nutrients. In addition, high viscosity dietary fiber have the ability to prevent the reabsorption of bile salts in the small intestine, another factor that leads to a reduction in blood cholesterol levels. Reducing the glycemic response could further help reduce insulin and stimulate liver cholesterol synthesis. Some studies have mentioned that a consumption of insoluble fiber affects the absorption of minerals, but, on the other hand, indigestible oligosaccharides stimulate the intestinal microflora to produce vitamins and short-chain fatty acids, which in turn could promote the absorption of minerals (Dai, F.J et al., 2017).

In 2010, the European Food Safety Authority (EFSA) postulated another classification of dietary fiber, dividing them into 4 main types (European Food Safety Authority, 2010):

1. Non-starchy polysaccharides: cellulose, hemicelulose, pectin, hydrocolloids (e.g. gums, mucilages, glucans).
2. Resistant oligosaccharides: fruit-oligosaccharides, galacto-oligosaccharides, other resistant oligosaccharides.

3. Resistant starch consisting of physically closed starch, a few types of raw granules of starch, starch retrograde, chemically and/or physically modified starch.
4. Lignin associated with polysaccharides in dietary fiber.
Cellulose enters the structure of vegetable cell membranes and is removed undigested from the digestive tract because human digestive juice does not contain cellulose to digest cellulose.
Hemiceluloses are a heterogeneous mixture of pectins and other indigestible polysaccharides (arabans, xylans).
Pectins are made up of remnants of galacturonic acid, which together with water form gels, a property used in the vegetable and fruit industry for the preparation of jams.
Resistant starch is defined as the sum of starch and the products resulting from its digestion, which are not absorbed in the small intestine of a healthy person. This resistant starch can be classified into 4 types: physically inaccessible starch (type 1), native starch (type 2), retrograde starch (type 3) and chemically modified starch (type 4). Physically closed starch is inaccessible to hydrolysis in the small intestine because it is protected from the action of amylase by the integrity of the cell walls or other structures.
This type of starch is present in cereal products containing whole grains or fragments of partially ground grains and in vegetables.
Type 2 native starch is found in raw potatoes and it is also not digested in the small intestines of animals and humans. Instead, raw wheat starch is easily digested by human amylase.
The exact mechanism of this resistance to human digestive enzymes is not clear, but it seems to be related to a number of factors such as the size of starch granules, the ratio between crystallized and amorphous material, the architecture of the polysaccharide and the ratio between amylose and amylopectin (Mudgil, D et al., 2013).
The third type of resistant starch is the retrograde one. During boiling, the starch granules gelatinize and swell. In particular, amylose is easily solubilized, while amylopectin remains in the swollen structure of starch granules.
During cooling, recrystalization of amylose occurs, namely the downgrading, leading to a decrease in digestibility. Any starch has the potential for retrograde, but the higher the amylose content, the easier the downgrading occurs, resulting in more resistant starch.
Lignin is, along with cellulose, one of the main components of the cell wall of plants, being a phenolic derivative.

1.4.2. Metabolism of dietary fiber and their physiological effects *(Nițescu M et al., 2019)*

Indigestible carbohydrates are not degraded in the body, they give volume and consistency to the fecal bowl, thus regulating the intestinal peristalsis. The components of dietary fiber are, by definition, resistant to hydrolysis and absorption in the small intestine. They cross the upper gastrointestinal tract and enter the colon unmodified (Nedelescu, M., 2017).
In the digestive tract, dietary fiber exerts numerous effects, depending on their physical and functional properties.

Effects of dietary fiber on digestion and absorption

Water-soluble dietary fiber delay the emptying of the stomach and increase the viscosity of the intraluminal content, causing a decrease in the absorption rate of nutrients (glucose, fatty acids, cholesterol), being used for the prophylaxis and treatment of obesity or dyslipidemia (Brownlee, I.A, 2011). In addition, low postprandial absorption of glucose causes a reduced insulin response, thus, the pancreas's ability to maintain glucose homeostasis does not alter. It has been shown that the effect on carbohydrate metabolism does not depend on the total amount of fiber ingested, but on their cellular structure (Goff, H.D.et al, 2018).
For example, glucans and pectin can alter the response of blood glucose and the total concentrations of total cholesterol and LDL-cholesterol by interfering with the digestion and absorption of glycemic carbohydrates and cholesterol and /or bile acids respectively (Chater, P.I.et al, 2015).
The inhibitory effects on the absorption of mineral elements, namely iron, zinc and calcium, were attributed to the complexing compounds associated with fibers, especially to phytic acid from cereals, dried legumes and seeds (Brownlee, I.A., 2014).

Effects of dietary fiber on intestinal motility
Some dietary fiber, generally insoluble ones, provide the effect of loading the intestinal lumen, increasing the mass of the fecal bowl, alleviating constipation and improving the regularity of stools. The increased weight of the stool is due to the physical presence of dietary fiber, as well as water retained inside the fibrous matrix. In addition, the muscles of the digestive tract are stimulated, with favorable effects not only in case of constipation, but also of other diseases (hemorrhoids, colon diverticulosis) (Gill, S.et al, 2018). Soluble dietary fiber, which is easily fermentable, can increase the volume of the fecal bowl by promoting the growth of the intestinal microbiota and faeces, as well as the secondary products resulting from fermentation (for example, short-chain fatty

acids, SCFA). These properties could contribute to the normalization of transit in case of constipation and its strengthening in case of diarrhea (Qi, X et al., 2019).

Effects of dietary fiber on the colon microbiota

The intestinal microbiota is maintained within normal limits by intraluminal conditions, the body's immunity and intestinal transit time (rapid transit). The very diverse and numerous microbiota in the colon ferments the unabsorbed carbohydrates, namely the dietary fiber that resisted the digestive enzymes in the small intestine (mainly resistant starch), transforming them into fatty acids with short chains: acetic, propionic and butyric acid, but also by-products such as hydrogen, carbon dioxide and methane.These short-chain fatty acids are the source of energy for the cells of the colonic mucosa and fulfill numerous roles in maintaining the integrity of the colon mucosa and metabolic health.

Butyric acid or butyrite resulting from the fermentation of resistant starch contributes to the functioning of the large intestine, acting as a preferred source of energy for cells of the intestinal mucosa. Another advantage of resistant starch is the fact that it favors the bacterial conversion of bile acids, which have escaped reabsorption in the small intestine, into secondary bile acids (deoxycholic and lithocolic), thus protecting the intestinal mucosa from prolonged contact with bile acids, an important mechanism in preventing the risk of cancer (Richards, L.B. et al., 2016)

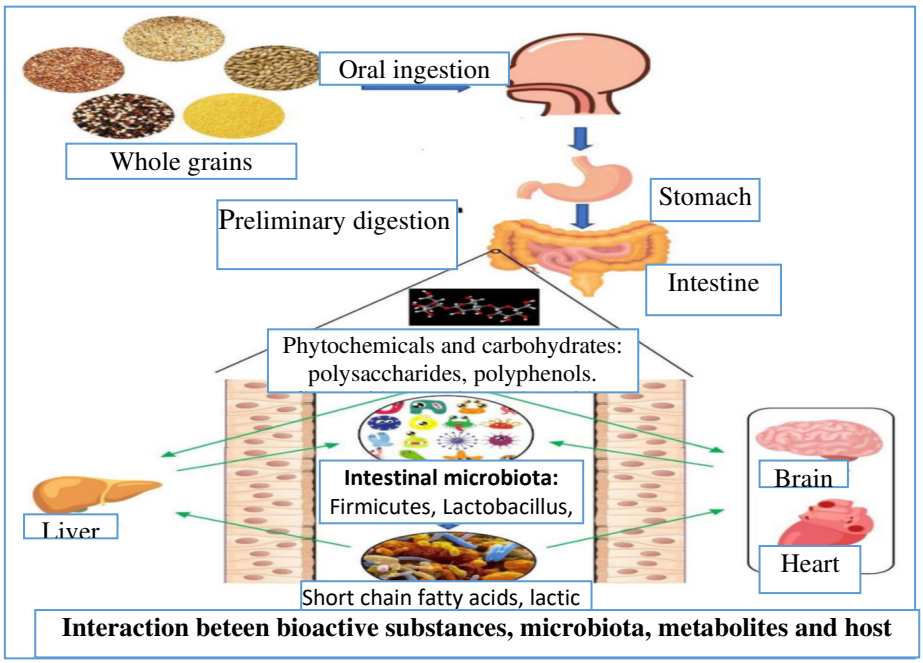

Figure 1.10: *Interaction of whole grains with intestinal microbiota (adapted by Ren,G. et al, 2021)*

Also, resistant starch is the substrate necessary for the colonic intestinal flora, sufficient amounts of resistant starch in the diet make the large number of colonic bacteria not to allow the development of pathogenic germs that have penetrated the digestive tract. The colon and rectum are colonized with about 400 species of bacteria, both Gram negative (Bacteroides), as well as Gram positive (Bifidus, lactobacilli, clostridia).
Certain components of dietary fiber are subjected to anaerobic fermentation by the microbiota of the colon. The amplitude of their fermentation depends on both the substrate and the factors of the host organism, for example the molecular structure and the physical shape of the substrate, the bacterial microbiota and the transit time.
Less fermentable fiber types, such as the lignified outer layers of cereals, generally have the most important effects in the formation of the fecal bowl due to their ability to bind water in the distal colon.
Fermentable dietary fiber also contribue to the volume of feces by increasing microbial mass. Some fermentation products, such as propionic acid and butyrite, can also influence systemic metabolism, namely cholesterol synthesis and possibly insulin sensitivity.
Fermentable components in dietary fiber, including oligosaccharides often referred to as "prebiotics", increase the population of Bifidobacteria and Lactobacilli that produce short-chain fatty acids. They inhibit the fermentation of protein components that reach the colon, which could produce potentially toxic compounds, especially ammonia and amines.
Short-strand fatty acids lower the pH of the colon content, which stimulates the absorption of some mineral elements, especially calcium, and inhibits the formation of potential co-carcinogenic compounds resulting from bile acids. Butyrite is a main source of energy for the colon mucosa and has effects on differentiation and cellular apoptosis, with possible implications for colon carcinogenesis (Richards, L.B. et al., 2016).

Effects of dietary fiber on gastrointestinal immunity

There are restricted data in humans on the relationship between eating foods rich in dietary fiber and the immune function associated with the small intestine. In contrast, animal studies have shown that diets containing either 'highly fermentable fiber' (a mixture of beet pulp, fruit-oligosaccharides and acacia gum) or a source of non-fermentable fibers (wood celulose) administered to dogs for two weeks affected the T cells in the composition of the small intestine-associated lymphoid tissue (GALT). It seems that the effects exerted by dietary

fiber on GALT are governed by the changes they bring in the composition of the intestinal microflora (Brownlee, I.A., 2011).

1.4.3. Dietary sources of fibers

Whole grains, dried legumes, fruits and vegetables are the main sources of dietary fiber. Nuts and seeds also count high amounts of dietary fiber.

• **Whole grain derivatives** contain the greatest amount of dietary fiber. Thus, whole grain bread has a content of 10% non-starchy polysaccharides – NPS, while white bread only 3% NPS. This difference is due to the fact that the whole grain flour is obtained by grinding the whole grain, so it contains all its component parts: bran, germ and endosperm, which, in the case of refined bakery products, obtained from white flour, are removed in the processing process (Nedelescu, M., 2017). Compared to white bread, whole grain bread can contain three times more dietary fiber, vitamins and trace elements, being poorer in calories than white bread, which has a higher starch content. Among cereals, oats and barley contain the most important amounts of dietary fiber, especially β-glucans, of viscous type, soluble in water.

• **Fruits**: among the fruits rich in dietary fiber we mention: dehydrated fruits (peaches, plums, apricots), then avocados, oranges, eggplants, kiwi, currants, raspberries, blackberries, apples, pears, strawberries, peaches, bananas, quince, apricots and fresh plums (Ghada A. Soliman, 2019).

• **Vegetables** richest in fiber are represented by potato flakes, sweet potato, artichokes, tomatoes baked in the sun, Brussels sprouts, sweet corn, broccoli, carrots, lettuce, onions, celery, and among the legumes stand out peas and green beans (Slavin, J.L et al., 2012, Ghada A. Suleiman, 2019).

1.4.4. Daily intake recommendations for dietary fiber

The role of dietary fiber in bowel function was considered the most appropriate criterion for establishing an adequate intake.

Based on the available evidence on gut function, the European Food Safety Authority considers that food fiber intakes of 25 g/day are adequate for normal laxation in adults.

A fiber intake of 2 g / MJ is considered suitable for a normal intestinal transit in children from the age of one year (European Food Safety Authority, 2010).

Although evidence of the effects of eating fibers in children is limited, it is important to encourage the consumption of total dietary fiber, provided by fruits, vegetables and whole grains, from school age, with intake gradually increasing during adolescence to adult levels.

This recommendation is important in the context of the prevention of obesity and chronic cardiovascular disease (Rajka, D. 2018).
A number of national and international organisations have established reference values for the intake of carbohydrates (total and/or glycemic or digestible), as well as for dietary fiber.
In general, the reference intakes are expressed as a percentage of the total energy consumption (E%).
For fiber, the intake is expressed in grams per day and / or on the basis of energy (per MJ or per 1000 kcal) (European Food Safety Authority, 2010).

Table 1.7. *Consumption recommendations (adequate intake) for dietary fiber (Adapted after the Institute of Medicine, 2005)*

Age (years)	**Men**	**Woman**
(g/day)		
1-3	19	19
4-8	25	25
9-13	31	26
14-18	38	26
19-50	38	25
>51[1]	30	21

For pregnant women, the recommended fibers intake is 28g/day and during lactation 29 g/day.

1.4.5. The role of dietary fiber in the prevention of noncommunicable chronic diseases *(Niţescu M. et al., 2019)*

Chronic noncommunicable diseases (NCDs) are an increasingly heavy burden on healthcare systems around the world. According to WHO statistics from 2018, cardiovascular diseases, cancer, diabetes and chronic lung diseases (asthma and chronic obstructive pulmonary disease) cause 70% of deaths recorded annually globally. Most of these deaths are recorded in low and average income countries, with 3/4 of all deaths from chronic diseases and almost 82% of the 16 million deaths recorded prematurely or before the age of 70. Among the top causes of death, cardiovascular diseases (almost 18 million deaths annually), cancer (with 9 million deaths annually), respiratory diseases (with almost 4 million deaths annually) and diabetes (with over 1.5 million deaths per year (WHO. Major NCDs and their risk factors).
In the occurrence of these diseases are involved many risk factors that have been classified into two categories: behavioral risk factors, modifiable, related to

lifestyle and metabolic risk factors. In the group of risk factors related to the lifestyle, an important role in the occurrence of chronic diseases is played by unhealthy diet, smoking, sedentary lifestyle and excessive alcohol consumption. Thus, smoking is considered to be responsible for 7 million deaths annually, over 4 million deaths occur due to increased salt consumption, over 3.3 million are attributed to excessive alcohol consumption and 1.6 million occur due to sedentariness. Metabolic changes caused by metabolic risk factors have an important contribution in the development of chronic diseases. We are talking therefore about hypertension (HTA), overweight/obesity, hyperglycemia and hyperlipidemia. 19% of deaths caused by chronic disease globally can be attributed to HTA, with lower percentages attributed to overweight/obesity and then hyperglycemia (WHO. Noncommunicable diseases, 2018). The role played by unhealthy diet in the development of these metabolic risk factors has been known for a long time.

According to the global study on morbidity and mortality in 2017, nutrition is an important risk factor for the occurrence of noncommunicable chronic diseases, being attributed to 20% of deaths (GBD 2017 Risk factor collaborators). The results of the study show that, in general, the diet is poor in vegetables, fruits, legumes, whole grains and is very rich in meat and red meat dishes.

Between 1950-1970, independent observational studies revealed the beneficial effects of eating fiber consumption. The first paper published was that of Eben Hipsley in 1953, which emphasized that pregnant toxemia is less common in women who have a diet rich in fiber. Later, in 1970, Burkitt and Trowell, highlighted the important metabolic effects of dietary fiber and their role in the prevention of cardiovascular disease, diabetes and cancer (Kendall, C.W.C. et al., 2010).

Observational and clinical studies that have researched the relationship between dietary fiber and total cardiovascular risk, or cardiovascular risk factors such as high blood pressure, central obesity, insulin sensitivity and increased plasma cholesterol levels, are numerous.

The protective effect of dietary fiber on the risk of cardiovascular disease is biologically plausible and there are many potential mechanisms by which fiber can act on individual risk factors. Soluble viscous fiber types can affect the absorption in the small intestine due to the formation of gels that attenuate postprandial blood sugar and lipid absorption. These gels also slow down gastric emptying, maintaining satiety levels and contributing to weight loss. Soluble fibers and resistant starch molecules are additionally fermented by bacteria in the large intestine, producing short-chain fatty acids that help reduce circulating cholesterol levels.

In 2015, based on studies and reports demonstrating the protection brought by the consumption of dietary fiber against coronary heart disease, the US Academy of Nutrition and Dietetics recommended a total daily consumption of fibers of 14 g per 1000 kcal, respectively between 19 and 30 g/day for children and adolescents, 25 g for women and 38 g for men. This recommendation is also relevant for protection against other chronic noncommunicable diseases, such as type 2 diabetes mellitus, different types of cancers, immune disorders. The consumption of dietary fiber can reduce the incidence of colorectal cancer, but also of other types of cancer, along with improving overall intestinal health. The ability of insoluble fibers to bind carcinogens, thus causing their elimination through faeces, together with the production of short-chain fatty acids through the fermentation of soluble fibers, can have a significant impact on the overall health of the body.

Preventing noncommunicable chronic diseases must be a government priority in every country.

Multisectoral collaboration (health, education, finance, agriculture, industry, transport, etc.) is needed to identify and implement solutions that address the aforementioned modifiable risk factors. At the same time, caring for one's own health must be a priority, but also a responsibility of each individual. In this direction, too, information-awareness campaigns and health and nutrition education programs are needed to address both children, teenagers and adults.

Therefore, we emphasize the importance of cereals (of which at least half are whole grain), which along with vegetables and fruits have numerous health benefits. In the following we will present a series of scientific evidence on the relationship between the consumption of fibers (including fibers from cereals and cereal derivatives) and the most common noncommunicable chronic diseases.

Dietary fiber and obesity (Nițescu M. et al., 2019)

The evidence on the benefits of a diet rich in dietary fiber needed to maintain an optimal weight and prevent obesity are very numerous. At the same time, the importance of fibers is also stressed for weight control in people with excess weight (Brownlee, I.A. et al., 2017) Several cross-sectional and longitudinal epidemiological studies have highlighted the fact that a fibers intake of more than 10 g/1000 kcal per day (Liu, S. Et al., 2010; Bozzetto, L. Et al., 2018) contributes to the decrease of the body mass index, to the decrease of the percentage of fat in the body, as well as to the reduction of the abdominal circumference. In the EPIC-Potsdam cohort study, it was observed, after a follow-up period of 4 years, that people who consumed 13.5 g fibers/1000 Kcal/day were able to maintain their weight and prevent weight gain, compared

to those who consumed only 8.8 g fibers/1000 Kcal/day (Bozzetto, L. Et al., 2018), regardless of the weight status at the beginning of the research.
Observational studies have shown an inversely proportional relationship between the amount of fibers in the diet and the abdominal circumference, respectively the percentage of visceral fat (Davis, J.N.et al., 2009).
It is important to emphasize that, in epidemiological studies, the beneficial effects of fibers consumption on weight and reduction of abdominal adipose tissue have been observed both in the case of total dietary fiber, as well as separately for cereal fibers (Du, H. Et al., 2010).
Regarding the clinical trials, their results are less consistent compared to those obtained in the epidemiological studies. It has been observed in several studies that there are no statistically significant differences in weight loss when eating whole grains compared to refined cereals.
Significant results both in terms of weight loss and reduction of the percentage of adipose tissue were observed following the increased consumption of fruits, vegetables and legumes, rich in fermentable soluble fibers (Kim, S.J. et al., 2016; Mytton, O.T. et al., 2014).
Several mechanisms are described that explain the favorable effects of dietary fiber in weight control (Bozzetto, L. Et al., 2018):

- soluble and insoluble fibers increase the intraluminal viscosity in the small intestine and provide a mechanical barrier, in this way there is a decrease in the absorption of glucose and fatty acids and the slowing down of the intestinal transit, which leads to the increase of lipid oxidation and the reduction of adipose tissue reserves;
- the decrease of glucose absorption causes a reduced insulin response, which prevents postprandial reactive hypoglycemia. This causes the feeling of hunger not to appear soon and the food intake to decrease;
- dietary fiber also influence weight through hormonal effects. These effects are mediated by insulin and gastrointestinal hormones (CCK, GIP, GLP-1), which influence glucose satiety and homeostasis, independent of the glycemic response;
- fermentable dietary fiber alter the gut microbial flora. Thus, a diet rich in fibers increases the bacterial species belonging to the taxonomic classes Bacteroidetes and Actinobacteria, characteristic of slim persons and reduce the species from the Firmicutes and Proteobacteria classes, characteristic of obese persons.
- through the colonic fermentation of fibers saturated fatty acids with short chains (acetic, propionic, butyric) appear and contribute to the regulation of body weight by delaying the emptying of the stomach followed by increasing

satiaty and improving insulin sensitivity, thus modulating the oxidation of glucose and fatty acids.

Dietary fiber, insulin resistance and diabetes (Nițescu M. et al., 2019)
Scientific evidence on the benefits of dietary fiber in relation to insulin resistance is scarce, and the results of some of the studies are inconsistent. A cross-sectional epidemiological study conducted in the United States, the Insulin Resistance Atherosclerosis Study (Liese, A.D. et al., 2003) found a direct relationship between consumption of whole grain fiber and insulin sensitivity. Randomized clinical trials have had contrary results, with the consumption of whole grains not significantly altering insulin resistance.

With regard to the viscous soluble fibers in oats and barley, published studies do not show significant differences in insulin resistance compared to the consumption of refined cereals in overweight, obese or normoponderal people. Other clinical research in which participants experienced an additional resistant starch and soluble fiber diet, emphasized a significant reduction in insulin resistance.
The possible mechanisms by which dietary fiber alter insulin resistance are represented by the production of short-chain fatty acids through colon fermentation and the prebiotic effect that some of the fibers have. It should also be remembered that diets rich in fiber are poorer in fat, so poorer in saturated and trans fats, responsible for endotoxemia and inflammation, processes that increase insulin resistance.
If we evaluate the relationship between fibers intake and the risk of diabetes, the evidence is similar to the relationship between fibers and insulin resistance. And in this case, epidemiological studies show an inverse relationship between the consumption of whole grain fiber and the risk of diabetes (The InterAct Consortium, 2015). Another study, Predimed (Martinez-Gonzalez, M.A. et al., 2015), showed the existence of a reverse relationship between the Mediterranean diet (rich in whole grains, vegetables and fruits) and the incidence of type 2 diabetes, after a follow-up of almost 4 years.
Regarding the control of blood glucose in people with type 2 diabetes, there is evidence from clinical and epidemiological studies, which shows a significant decrease in glycosylated Hb to a fiber intake of more than 15 g/1000 Kcal ((Bozzetto, L. Et al., 2018). The results are especially significant for the increased intake of soluble fibers.

Dietary fiber and cardiovascular diseases (Nițescu M. et al., 2019)
Cardiovascular disease is the leading cause of mortality globally. According to the World Health Organization, in 2015, worldwide, 31% of deaths were

recorded due to cardiovascular diseases (WHO, Cardiovascular diseases factsheet, 2017).
Cardiovascular diseases recognize many risk factors. Some of these risk factors cannot be altered, it is the case of age, breed, while a large part of them (dyslipidemia, high blood pressure, abdominal obesity and prediabetes) can be reduced through a healthy diet.
LDL-cholesterol, the major risk factor of atherosclerotic disease can be reduced by taking statins. However, these drugs are expensive, they have many adverse effects and the high non-therapeutic adherence and discontinuity of their administration jeopardize the achievement of an optimal LDL-c. Recently it has been proposed to improve the diet by adding dietary fiber in order to increase the effectiveness of statins (Brum, J. et al., 2018). Over the past two decades, numerous observational studies have drawn attention to the beneficial effect of dietary fiber in the prevention of coronary heart disease (Ghada A. Suleiman, 2019). Health benefits occur at a consumption of 12-33 g/day for fiber in food and at 42.5 g/day for fiber from supplements (Position of the American Dietetic Association, 2008).
The direct protective effect of dietary fiber in the etiology of coronary heart disease is to lower plasma lipids (viscous soluble dietary fiber decrease total cholesterol and LDL-cholesterol and possibly triglycerides as well). Of the fibers, soluble non-starchy polysaccharides seem to be effective, not the insoluble ones, nor the resistant starches (solid evidence demonstrates the cholesterol-lowering effect of oat bran, pectins and natural or synthetic gums) (Threapleton, D.E. et al., 2013).
Special beneficial effects for health are attributed to the ß-glucan present in significant quantities in cereals such as oats and barley. Unlike mushrooms and yeasts where ß glucan has a structure insoluble in water, that of oats and barley is soluble in water, forming a very viscous solution in the digestive tract (Kim, H.J., 2013). Although it contains more fibers than oats, because of its slightly attractive organoleptic characteristics (Bacic et al., 2009; Limberger-Bayer et al., 2014), barley is less consumed compared to oats that is more appreciated by consumers, has a good nutritional profile and a long shelf life (Sterna et al., 2016), being consumed in the form of breakfast cereals, bread, drinks and even in baby food.
The mechanisms that explain these effects are related to the digestion and absorption of fats. The effect of soluble fibers in slowing the absorption of fats and cholesterol, the direct inhibition of the synthesis of liver cholesterol by the propionate formed by the fermentation of soluble non-starch polysaccharides in the large intestine and the increase of the fecal excretion of unabsorbed bile acids in the distal ileum and neutral sterols is known.

However, cohort epidemiological studies have not shown any link between soluble, viscous fibers and coronary risk. The opposite is true, there are consistent epidemiological evidences that emphasize the benefit of an increased intake of whole grain fibers on the coronary risk, although clinical studies have not shown any metabolic effect thereof (Davis, J.N.et al., 2009).
It has been hypothesized that perhaps other compounds existing in cereals explain this effect (lignans, phytosterols, antioxidants etc.) (Jonson, I.T., 2005).
A response-dose meta-analysis separately evaluated the relationship between total fibers intake, fiber intake from whole grains, fruits and vegetables and coronary and cardiovascular risk respectively (the latter quantifying both stroke and coronary stroke). The results of the study revealed that for an additional total fibers intake of 7 g / day, a 9% reduction in both cardiovascular and coronary risk occurs
(Threapleton, D.E. et al., 2013).
A lower cardiovascular risk was also observed in the case of increased intake of insoluble fiber from cereals, fruits and vegetables. And for the coronary risk, there was a decrease as the intake of insoluble fibers from cereals and vegetables increases. The results of the study are valid only for the intake of fibers from foods, not from supplements. Another study revealed a 20% reduction in cardiovascular risk in people who consume a lot of fibers and separately in those who consume more whole cereals, when compared with people with low fibers or whole cereals intake (Ye, E.Q. et al., 2012).
It is believed that other physiological effects of dietary fiber also contribute to cardiovascular protection. Among them, the decrease in TA, especially in the elderly and hypertensive persons, as well as the reduction of inflammatory markers (C-reactive protein). A number of studies support these hypotheses, confirming the reverse relationship between fibers and coronary heart disease. Thus, the study to assess nutritional status and health status in the USA (NHANES I) showed that an increased intake of fibers, especially soluble ones, reduces cardiovascular risk by both lowering plasma cholesterol and C-reactive protein. Prospective studies in the U.S. and Europe have shown that a 10 g/day increase in dietary fiber reduces by 14% the risk of coronary events and by 27% death from coronary heart disease. There are also epidemiological studies that have revealed the decrease of diastolic TA to an adequate intake of dietary fiber (Position of the American Dietetic Association, 2008).
Referring strictly to the relationship between the fiber intake from whole cereals and bran and cardiovascular risk, a recently published systematic review (Eden M Barrett et al, 2019) hypothesizes that in the case of whole grains, the beneficial effect of cardiovascular protection would be due to other constituents such as vitamin E, magnesium and bioactive compounds (phytoestrogens).

Comparing the consumption of whole grains with the consumption of bran, a slightly higher reduction in the risk of cardiovascular disease was observed in the consumption of bran (Eden M Barett et al, 2019). In the case of both whole grains and bran, the risk of HTA and coronary heart disease was also low (Flint AJ et al, 2009).

Dietary fiber and cancer (Nițescu M. et al., 2019)
Globally, colorectal cancer is the third leading cause of mortality (Thomas M. Barber et al.,2020). It is the main cause of morbidity and mortality in industrialized countries.
Data obtained in epidemiological studies show that nutrition plays an important role in the prevention of cancer. Among the dietary factors, dietary fiber seems to have a protective effect in the development of cancer, especially colorectal cancer (CR) and breast cancer (McRae, M.P., 2018).
In 2011, the International Cancer Association updated the consensus on current studies from "probable" to "compelling."
Case-control studies on the incidence of CR cancer conducted in the USA, have found that an intake of 13 g fiber/day from food can reduce the risk of this type of cancer by 31%. Separate analysis of dietary fiber sources revealed a significant reduction in risk (10% for every 10 g of fiber) in the case of cereals, while for legume, fruit and vegetable fibers, no significant reduction was found (Position of the Academy of Nutrition and Dietetics: Health implications of Dietary Fiber, November 2015, Volume 115, Number 11) In Europe, the prospective EPIC study - The European Prospectiv Investigation into Cancer and Nutrition (500,000 people in 10 countries with high incidence of colorectal cancer), showed that those who consumed on average 33 g fibers/day, had a 25% lower incidence of CR cancer compared to those who consumed 12 g fibers/day. The authors claim that doubling the fiber intake in those with low consumption (12 g / day) can reduce the incidence of cancer by 40% (Position of the American Dietetic Association, 2008).
A systematic review and meta-analysis published by Gianfredi and his colleagues (out of the 376 studies, 25 databases were included in the analysis) studied the association between dietary fiber and the risk of colorectal cancer. They compared the people with the highest consumption of fibers with those with the lowest consumption and observed a high statistical significance of the amount of fiber consumed, highlighting the protective role of fiber against the risk of colorectal cancer (Gianfredi,V et.al., 2018)
The mechanisms by which dietary fiber exert a protective effect against colorectal cancer are numerous, all categories of fibers having beneficial effects.

Insoluble dietary fiber increased the volume of the fecal bowl, through this property they decrease the intestinal transit time and the contact of carcinogens with the intestinal mucosa is reduced. At the same time, a dilution of carcinogens is also taking place. By binding the primary and secondary bile acids, but also of other mutagenic agents, the insoluble fibers decrease the concentration of free mutagens in the intestine.
Resistant starch together with soluble and insoluble fibers alter the fecal flora and increase the number of bacteria. Secondary, decreases the concentration of bile acids that have carcinogenic potential, as well as the concentration of colonic ammonia, cytotoxic.
Another mechanism, especially due to resistant starch, is to decrease the fecal pH by producing fatty acids with short carbon chains. Thus, sensitive, potentially pathogenic, pH bacterial species that could produce potentially carcinogenic compounds are inhibited. It also decreases the absorption of toxic alkaline compounds (amines) and the solubility of bile acids.
The fermentation of resistant starch, but also of other non-starchy polysaccharides, by producing butyrate, promotes the normal phenotype of cells, delays the growth of malignant cells and favors DNA repair (butyrate is the preferred substrate of colon cells, providing 70% of the energy needed for them).
Regarding the relationship between total dietary fiber intake and breast cancer, a review published in 2018, which included 4 meta-analyses, showed that the incidence of cancer increases from 7% in people with the highest fibers intake to 15% in people with the lowest intake (McRae, M.P. (2018).
Several mechanisms through which dietary fiber protect from breast cancer and endometrial cancer have been formulated, being known the involvement of prolonged exposure to estrogens in the occurrence of both types of cancer.
It seems that dietary fiber bind estrogens to the colon and increase fecal elimination, thereby reducing their concentration in the blood.
On the other hand, fibers reduce the activity of an enzyme β-glucuronidase, which hydrolyzes conjugated estrogens before being absorbed in the colon.
Other compounds that are brought together with the fibers in food, such as antioxidants, lignans, phenolic acids, also have protective effects against breast and endometrial cancer.
Another mechanism is explained by the effect of fibers to prevent weight gain.
The fact that adipose tissue no longer accumulates, makes adipocytes secrete fewer estrogens, the synthesis of these hormones being proportional to the size of adipose cells.
A meta-analysis that evaluated the association between dietary fiber intake and endometrial cancer risk (which included 12 case-control studies and 3 cohort studies) identified a negative association between fibers intake and endometrial

cancer risk, but the three cohort studies included in the analysis suggested a positive association between increased total fibers intake, increased fibers intake from cereals and the risk of endometrial cancer (Kangning Chen et al., 2018).
And with regard to ovarian cancer, a metaanalysis performed by Zheng and collaborators emphasized the inversely proportional association between fibers consumption and cancer risk, a consistent association with the dose response relationship (Zheng et al., 2018).
It turns out that the proposed mechanism is represented by the decrease in the circulating level of estrogen by dietary fiber.
In addition, dietary fiber caused the glycemic load to decrease, which improves insulin sensitivity and in this way influence insulin-like growth factors, which is a risk factor for ovarian cancer.
Another study with important conclusions for public health is the one carried out by Liu et al. which found that people with increased dietary fiber consumption have a reduction in cancer mortality by 17% (Liu, L. et al., 2015).

1.4.6. The importance of enriching bakery products with fibers

The benefits of eating whole grains are well known, they are the main source of fibers, B-complex vitamins (thiamine, riboflavin), mineral elements and polyphenolic substances.
The fibers intake from bread and cereal derivatives varies from country to country, so in the USA and Spain, 32-33% of the fibers intake comes from cereals, while in the Netherlands and Ireland, cereals provide 48-49% of the total fibers intake (Jerzy Gebski et al., 2019). In some countries bread is the main source of fibers (11-30% of the total intake), the rest of the cereal products having a lower contribution (breakfast cereals 5-8%, pastry 3-11% and pasta 1-4%) (Stephen et al., 2017).
According to the results of the U.S. National Health and Nutrition Examination Survey, 2009–2012, for the American population cereals are important contributors to the intake of deficient nutrients such as dietary fiber, iron, folates, B-complex vitamins and other mineral elements (Yanni Papanikolaou et al., 2017). In Australia, according to the Australian health survey results 2011-2013, the adult population has an average intake of 21 g whole grains/day, children and adolescents have an average intake of 17 g whole grains/day, while 30% of study participants do not consume whole grains (Galea et al, 2017).
In Europe, too, bread and cereal derivatives are an important component of the diet, the amount consumed varying from country to country. Thus, Turkey and Bulgaria have a consumption of 104 and respectively, 95 Kg / inhabitant / year, opposite of the United Kingdom with only 32 Kg / inhabitant / year (AIBI,

2015). The consumption of foods rich in whole grains and fiber provides only 7% of the total fiber intake. In the American diet, 39% of fibers comes from cereal derivatives that do not contain whole grains, while foods containing refined cereals are widely consumed (Kranz et al, 2017).
So, although interest in foods rich in fiber has increased in recent years, the consumption of whole grains has remained low, perhaps also because of the not exactly appealing sensory properties, which makes people prefer the taste of less healthy foods and refined cereals low in fibers such as white bread and pasta (Kamar et al., 2016; McMackin et al., 2013; Nicklas et al., 2013).
Starting from the idea of reducing the deficiency of fibers in the diet, in 2009 the Codex Alimentarius, following long consultations with experts and authorities from all over the world, gave a comprehensive definition of dietary fiber in which it included alongside the fibers naturally present in plants, isolated fibers from plant raw materials and industrially synthesized fibers that have proven to exert beneficial physiological effects. It has been accepted the hypothesis that, similar to vitamins, fibers vary in structure, functions and necessary intake and that each of them, contributes to optimal health if they are present in adequate quantities.
In the context in which simple, white bread is still a very consumed and preferred food, enriching it with fibers can be a way to improve the fibers intake of the population. The reformulation of bread for the purpose of enrichment with fibers (resistant starch and bran) must consider especially the sensory qualities so as to have a positive impact on the consumer. As long as consumers negatively perceive the relationship between taste and health, their interest in healthy eating will be limited (Grunert et al, 2010, Jerzy Gebski et al., 2019).
Studies highlight the increase in the nutritional value of plain bread enriched with corn bran, rice bran and sorghum bran, both in terms of fibers content and certain mineral elements (Mounjouenpou Pauline et al., 2020; Bourre et al., 2008). The question of whether the health effects are equal when it comes to whole grains and refined cereals enriched with fibes is not completely clarified, so the transmission of messages on the consumption of whole grains must remain a priority.
Good results both in terms of sensory properties and metabolic effects (increased satiety, decreased blood glucose and postprandial insulinemia, increased fecal elimination and production of short-chain fatty acids) were obtained by the addition of resistant corn starch (Hi Maize) in bread, pasta, breakfast cereals (Ingredion, 2018).
Jose David Torres and collaborators (2019) have demonstrated that by adding soluble fibers and polyphenols from green tea, using an adequate proportion of ingredients and controlling the baking process, bakery products with a reduction

in acrylamide content of up to 64% can be obtained. In addition, the addition of soluble fibers reduces the digestibility of starch, implicitly the level of rapidly absorbed glucose.
Paolo Tessari and Anna Lante (2017) in research conducted on a group of patients with type 2 diabetes found that replacing white bread with bread enriched with soluble fibers (7 g fiber/100g and with beta glucan/starch ratio 7.6/100) reduces a jeune blood sugar and significantly, postprandial blood sugar. Regular consumption of bakery products enriched with soluble fibers can improve average and long-term glycemic control in the case of type 2 diabetes, along with hypoglycemic treatment.

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CHAPTER 2.
TYPES OF FUNCTIONAL BAKERY PRODUCTS

2.1. Types of functional bakery products

The main role of a proper diet is to provide enough nutrients to meet a person's nutritional requirements.
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There is now growing scientific evidence to support the hypothesis that certain foods and ingredients have beneficial physiological and psychological effects, beyond the supply of basic nutrients.
Today, the science of nutrition has moved from the classic concepts of avoiding nutrient deficiencies and basic nutritional adequacy to the concept of "positive" or "optimal" nutrition.
The focus of research has shifted more to identifying biologically active components in foods that have the potential to optimize physical and mental well-being and that can also reduce the risk of disease.
Many unprocessed foods such as fruits, vegetables, soy, grains and milk contain components with potential health benefits. In addition, new foods are currently being developed to improve or incorporate these components that are beneficial to consumer health.
The concept of functional foods emerged in Japan in the 1980s, with Japanese health authorities recognizing that an improvement in the quality of life must be accompanied by increasing life expectancy for the growing number of elderly people in the population if the costs of healthcare are to be controlled. The concept of foods that have been specifically developed to promote health or reduce the risk of disease has been introduced.
The food industry thus has moved in the increasingly current direction of meeting the needs for people with certain health conditions, regardless of the age of the consumer.
Functional foods have not been yet defined by legislation in Europe, and are generally considered to be foods that are intended for consumption as part of a normal diet and contain biologically active components that offer the potential for increased health or reduced risk of disease.
As a legislative basis for the manufacture of these functional products in the European Union, the requirements of the following regulation are being respected:

- REGULATION (EC) NO. 1924/2006 of the EUROPEAN PARLIAMENT AND OF THE COUNCIL from 20 December 2006 on nutrition and health claims made on foods
- REGULATION (EC) NO. 1925/2006 of the EUROPEAN PARLIAMENT AND OF THE COUNCIL from 20 December 2006 on the addition of vitamins and minerals and certain other substances to foods.
- REGULATION (EC) NO. 41/2009 of the Commission from 20 January 2009 on the composition and labelling of foods suitable for people intolerant to gluten
- Implementing Regulation (EU) no. 828/2014 of the Commission from 30 July 2014 regarding the requirements for the provision of information to consumer on the absence or presence or reduced amounts of gluten in food.

According to a classification made by the American Dietetic Association, all foods are classified as functional at a certain physiological level because they provide nutrients or other substances with an energetic role that support growth or maintain / remodel vital processes.

https://federatiaromanadiabet.ro/cutas%CC%A6-ancut%CC%A6a-alimentele-functionale/

Because our project is focused on functional bakery products, it is very important to present the current context in terms of the concern of specialists in the field on the subject.

Thus, because today, consumers want bakery products with a special taste, created from safe, authentic and healthy ingredients, technological specialists in collaboration with nutritionists have developed specific manufacturing technologies.

We can say that it has been taken into account that taste is a complex thing - a modern multi-sensory experience of appearance, texture, aroma and flavors; all influenced by our cultures, stages of life, individual preferences, and more. Our understanding of taste is rooted in our food heritage specific to each country involved in the project, sensory science but also know-how in applications.

The category of functional bakery products in Romania is not very developed at present, but the attention of specialists is turning more and more towards this area.

Our task is to identify exactly how the science of nutrition should affect the production of functional foods. We are moving towards a better understanding of how these vast global changes in nutritional requirements and consumer awareness will shape our technological directions.

Thus, from a technological point of view, we improve the bakery product and optimize it from a functional point of view beyond the taste, so that it is better, more nutritious and healthier. This is in fact the trend of the future, precisely in the idea of coming to the aid of the population that has specific consumption

needs depending on age, lifestyle, health conditions and last but not least the usual national consumption. Particular attention will be paid to the following aspects: taste, texture, increasing the shelf life of the product, nutritional values, labeling requirements for correct and complete consumer information.
Today, when the consumer is more and more informed and concerned about personal nutrition, it has been found that quality is preferred over quantity.
In order to meet the requirements of consumers with various health conditions, specialists in the bakery sector are considering the following trends from a technological point of view:
→ Sugar reduction solutions
→ Fat reduction solutions
→ Solutions for enriching products with various nutrients
→ Solutions for using natural ingredients that should be reflected in a "clean label" etc.
All these solutions are studied and designed so as to maintain the taste, texture and satiety of the products but also to increase the shelf life of the product and to reach appropriate nutritional values and recommended for consumption.
In Europe, the consumption of bread enriched with bioactive compounds is on the rise as consumers understand the role of the health benefits of these products. Therefore, in the near future, bakery products can be used to introduce biologically active compounds into the diet and to increase their intake. Another way is to use bread with high nutritional value to prevent certain diseases (Brodowska, M., 2014).
Questions and answers meant to chart research trends in the bakery industry and beyond

Questions	Does lowering sugar help lower the number of calories in a low-sugar bakery product?
Answer	Reducing the amount of sugars will not necessarily reduce the number of calories. This is because the fiber used to replace sugar are carbohydrates and therefore have a caloric content similar to that of sugar. A high caloric reduction can be achieved by reducing the fat content, because fat has a higher caloric content.
Q	Do the proposed reformulation solutions come with process limitations?
A	The research carried out in the bakery units leads to the development of new solutions, which do nothing but develop

	new technological processes.
Q	Is the development of solutions based on clean label?
A	Yes, the solutions are aimed at developing products with the label as clean as possible, and where there are "E" numbers, they try to be limited to those that are usually already found in the ingredients.

2.2. Analysis of the assortment range of bakery products with a functional role

Dietary foods have been created for people suffering from certain diseases. It is also called products for particular nutritional uses (PARNUTS). These products have a composition adapted to meet the requirements of people with various ailments for which they are intended.

This category includes products from which certain components have been removed (salt-free, gluten-free, low-acid bakery products) and bakery products in which certain components are added (dietary fiber, trace elements, vitamins, etc.) (Rumeus I., 2016)

In the case of the development of functional bakery products, the main directions are related to obtaining:

A) Allergen-free products

B) Enriched products

C) Products with low content of salt, sugar, fat, etc. (Szabó P. Balázs, 2017)

In the development of functional bakery products (including bread), it is important to realize that achieving quality functional foods involves not only delivering the active ingredient to the right level for physiological efficiency, but also providing a product that meets the standards of appearance, taste and texture (Alldrick, AJ, 2007).

A) Allergen-free products

The allergen is an antigen that causes allergic reactions in the human body. Most allergens are proteins, often with carbohydrate side chains (glycoproteins), but less often are pure carbohydrate allergens, small molecule chemicals (isocyanates, anhydrides or formaldehyde), and some metals (eg. chromium and nickel).

When they are used in food production and remain in them, certain ingredients, other substances or products (such as technological aids) can cause allergies or intolerances in some people, and some of these allergies or intolerances pose a danger to the health of those in cause.

It is important to provide information on the presence of food additives, processing aids and other substances or products with an allergenic effect, or scientifically proven intolerance to allow consumers, especially those suffering from food allergies or intolerances, to be able to make an informed choice about safe products (Reg. (UE) no. 1169/2011, 2011).
Allergens are contained and carried by various external factors:
• physical factors: heat, cold (cryoallergen)
• chemical factors: chemicals, substances used in the food industry, medicines, cosmetics, animal and insect poisons, latex, etc.
• biological factors: bacteria, viruses, parasites, microbial toxins, insects, pollen, fruits (strawberries, raspberries, kiwi, pineapple, etc.), dust, flakes, hair and animal scales, heterologous sera, vaccines, etc.
Allergy is an abnormal, disproportionate, exaggerated and excessive reaction of an organism's immune system to exogenous antigens that are well tolerated by normal subjects.

A1) Gluten-free products

Gluten intolerance or celiac disease is an autoimmune genetic disease caused by a sensitivity to gluten. In the case of people suffering from this disease, gluten consumption produces a toxic immune reaction. This reaction causes damage to the lining of the small intestine, inflammation and malabsorption of important nutrients such as fats, calcium and iron.
About 1% of the world's population is affected by celiac disease, but unfortunately many people remain undiagnosed even though much progress has been made.
During the disease, the small intestine is damaged, resulting in diarrhea, abdominal distension, weight loss, digestive and nutritional abnormalities. In the latter case, there are disorders of absorption of fat-soluble vitamins, disorders of bone metabolism and anemia.
Allergenic bakery products are especially designed for the needs of gluten-sensitive or celiac-sensitive consumers. In both cases, the symptoms are similar, but more severe in celiac disease (https://glutenerzekeny.hu/akkor-mitol-puffadok-gabonaallergia-glutenerzekenyseg-coliakia/).
Gluten sensitivity, also known as gluten intolerance, occurs after a digestive disorder, during which the permeability of the intestinal wall increases, so that a certain amount of gluten is no longer tolerated (https://glutenerzekeny.hu/akkor-mitol-puffadok-gabonaallergia-glutenerzekenyseg-coliakia /) .
Gluten sensitivity can be treated with a gluten-free diet. Celiac disease, also known as gluten-sensitive enteropathy, is a multifactorial autoimmune response in which antibodies are produced against gluten proteins in cereals and involve gastrointestinal symptoms and nutrient absorption disorders.

(https://glutenerzekeny.hu/akkor-mitol-puffadok-gabonaallergia-glutenerzekenyseg-coliakia/).
People diagnosed with celiac disease are advised to follow a gluten-free diet for life. This involves the exclusion from the diet of proteins from wheat, rye, barley and their hybrids such as kamut and triticale.
This diet prevents early death and reduces the risk of gastrointestinal malignancies. The disadvantage is that it is difficult to follow because it involves the elimination of a large number of gluten-containing products (Rumeus I., 2016).
Celiac disease cannot be cured, but the intestinal flora can be restored especially through the gluten-free diet specially developed to treat the symptoms.
In allergen-free bakery products, wheat and rye flour are replaced with soy flour, corn, corn and other grains. (https://glutenerzekeny.hu/mit-ehet-es-mit-nem-egy-glutenerzekenyosszefoglalo-tablazat/).
Thus, the development of new gluten-free products in order to diversify the range is for the benefit of people suffering from this disease because it offers them more product variants thus improving their quality of life.
Most bakery products are made from corn and rice, so the consumer has a limited choice.
Because it is natural, hypoallergenic and has a sweet taste, rice flour is one of the most widely used types of flour for making gluten-free products. It provides a high amount of digestible carbohydrates but is low in protein. Thus, it is necessary to add other components in order to obtain a product with optimal nutritional content.
There is a growing interest in obtaining new types of gluten-free bread that can incorporate starch, non-gluten-free milk proteins and combinations thereof.
By adding other ingredients you can achieve viscoelastic properties similar to gluten that can lead to visibly improved products in terms of structure, chewing sensation, structure of acceptability and shelf life.
The most researched ingredients for addition to gluten-free bakery products are pseudo-cereal flours such as quinoa, amaranth, buckwheat, sorghum or tef from which products with visibly improved protein content can be obtained.
Among the most used cereal flours that do not contain gluten are barley flour, oats and rice.
Pea flour, Psyllium flour, sugar beet fiber, soy milk or egg albumin are used to improve the nutritional value of the finished product.
By adding protein, gluten-free bread with a visibly improved quality is obtained.
To achieve this, other additives have been studied, such as: tapioca starch, dietary fiber, hydrocolloids and gums.

Other research has focused on the treatment of gluten-free flours with microbial transglutaminase (Rumeus I., 2016).

A2) Functional bakery products for people with celiac disease

Celiac disease, also known as gluten-sensitive enteropathy, is an autoimmune reaction of the body to the consumption of gluten, a protein found naturally in grains such as wheat, barley and rye. The autoimmune reaction causes damage to the intestinal villi, which covers the inner walls of the small intestine, leading to chronic malabsorption of various nutrients, especially minerals and vitamins (Koskimaa et al., 2020).

The exact causes of celiac disease are not fully understood. Some studies have highlighted the role of genetic factors in the manifestation of the disease and its occurrence in genetically predisposed individuals, as there are many cases in which more family members suffer from diagnosed celiac disease. However, other medical and lifestyle factors are currently being considered, including dietary practices, which can trigger celiac disease, as follows: autoimmune diseases, gastrointestinal infections, surgery, pregnancy, emotional or traumatic stress.

Celiac disease should not be confused with gluten intolerance or gluten sensitivity. People who suffer from gluten intolerance may have symptoms of celiac disease and it is recommended to avoid eating gluten-free foods, but in their case no autoimmune response is triggered and there is no risk of damage to the small intestine.

Currently, there is no cure for celiac disease, the only therapy is to follow a strict gluten-free diet throughout life. However, the complete avoidance of gluten-containing cereal products is quite difficult to achieve and maintain, as certain products, such as wheat flour, are found in most of the foods we eat. In patients with celiac disease, only a permanent gluten-free diet will lead to the recovery of the intestinal mucosa.

Gluten is a protein found naturally in wheat, barley, rye and by-products such as bread, pasta, cereals and other bakery products.

Wheat proteins (Triticum species) can be divided into two groups (Brites et al., 2018):

- water-soluble proteins - albumin and globulin, which represent 15% of the total protein;
- water-insoluble proteins - gliadin (prolamine) and glutenin (glutelin).

The main function of gluten is to contribute to the absorption capacity of water, to the viscosity, cohesion and elasticity of the dough so that it maintains its shape (Ahmad et al., 2019).

In addition to baked goods containing wheat, rye and barley, gluten can be added to many other foods. In wheat, rye and barley, the prolamins present are

gliadin, secaline and hordein, respectively. Unlike wheat, rye and barley, oats containing avenin, a prolamine, have been shown to be non-immunogenic in most people with celiac disease. Various researches have reported that gliadin and glutenin are responsible for most of the negative health effects in patients with celiac disease (Koehler et al., 2014; Ahmad et al., 2019; Sharma et al., 2020).

According to Codex Alimentarius 118-1979, foods labeled as gluten-free must contain less than 20 mg / kg of gluten in the final product. The “Cut Spike” symbol is internationally recognized for identifying products for patients with celiac disease (Koehler et al., 2014b).

Also, foods with a very low gluten content, consisting of or containing one or more ingredients derived from wheat, rye, barley, oats or their cross-bred varieties, which have been specially processed to reduce the gluten content, the label is marked "Very low gluten content", it must contain less than 100 mg / kg of gluten in the final product (European Commission, 2014).

The supplementary provision for foods containing oats is laid down in European Union legislation by Implementing Regulation (EU) No 182/2011. Commission Regulation (EC) No 828/2014 of 30 July 2014 on requirements for the provision of information to consumers on the absence or reduced presence of gluten in foods: has been specially produced, prepared and / or processed in such a way as to avoid contamination with wheat, rye, barley or their cross-varieties and the gluten content of these oat products must not exceed 20 mg / kg.

Gluten-free bakery products can be made from gluten-free natural grains such as corn, rice, sorghum and millet, but also from pseudocereals such as buckwheat, amaranth and quinoa (Xu et al., 2020, Fernandes Drub et al., 2021). In other gluten-free products, sunflower protein concentrate or insect flour is used as a gluten substitute (Zorzi et al., 2020; Da Rosa Machado and Cruz Silveira Thys, 2019). In addition, gluten-containing raw materials from wheat, rye or barley can be converted to gluten-free materials by specialized processing, such as extensive starch removal, peptidase treatment for beverages or the use of low-gluten cereal strains (Koehler et al., 2014b).

A3) Lactose-free products

One of the most common forms of food intolerance is lactose intolerance. It is characterized by an inability to digest and absorb lactose. It is manifested by gastrointestinal symptoms caused by the consumption of milk and its derivatives.

Lactose cannot be absorbed in the intestine as such but must be broken down by the body's own lactase. Problems occur when this enzyme is missing from the body and the non-cleavage process can no longer take place.

Thus, about 30-120 minutes after eating lactose-containing foods, signs of intolerance appear.
This type of intolerance is classified as:

- ✓ Congenital - the absence of the enzyme at birth
- ✓ Primary - genetically predetermined reduction of activity in childhood, adolescence or adulthood
- ✓ Secondary - reduced enzymatic activity in diffuse intestinal diseases: lambliasis, rotavirus infections, popular intestinal bacterial, intestinal resections.

In general, the effects of intolerance are manifested 10-15 minutes after ingestion of lactose-rich milk and are manifested by: periumbilical agitation, bloating, migraine cramps, possibly in association with dizziness, tachycardia, sweating, pallor, followed by urinary bowel movements. watery, aerated.
People who are lactose intolerant can control it by changing their diet, reducing the consumption of lactose-rich foods.
In most patients it is not necessary to completely exclude lactose but to consume small amounts (<12 g of lactose, representing approximately 240 ml of milk) (Dr. Laszlo M., 2019).

B) Enriched products

Enriched products are functional products that have proven to have beneficial effects on health along with basic nutritional effects. It is important that the process does not affect the basic organoleptic properties of the product (Markovics E., 2007).
For cooked foods, basic nutrients (eg. protein, carbohydrates), auxiliary nutrients (eg. vitamins, minerals) and adjacent substances (eg. fiber) are added to foods to enhance nutrition.
As it is the product with the widest daily use, bread can be used to supplement the diet with biologically active substances.
Compensating for lysine deficiency, for example, with the help of rich protein sources can improve the nutritional qualities of bread proteins, such as soy flour or sunflower flour.
In order not to affect the volume, porosity, elasticity and taste of the kernel, the addition of soy flour should not exceed 3-5% of the wheat flour used.
With the help of skimmed milk powder, whey but also caseinates and coprecipitates, an effective fortification of the bread can be obtained.
An effective vector for some vitamins and minerals is bread. The bread is fortified with the help of micronutrients, which can be added to the water used to prepare the dough.

The strengthening of bread with calcium, magnesium and vitamins A, E and B6 is regulated in some countries around the world. Sometimes it is preferable to use micronutrient-enriched salt.
In some cases, other ingredients in food premixes are encapsulated in food membranes that will disintegrate into the dough. The most common in these premixes are thiamine, niacin, riboflavin, iron and less often folic acid, calcium and vitamin D.
One of the most common cases of fortification is iodine, which is also required by law in Romania, so iodized salt is used in bakery products.
Research has been conducted on the fortification of bread with thiamine and black rice extracts, rich in anthocyanins, vitamin D, iron and fiber (Rumeus I., 2016).

B1) Vitamin-enriched products

Vitamins are vital biological compounds essential for the body [6]. By enriching with vitamins, the amount of vitamins, essential for the human body, is increased. For bakery products, B vitamins, such as vitamins B1, B2, B3, B6 and B9 are added. B-complexes are most commonly used for this purpose (Markovics E., 2007).
Determining the correct dosage ratio is a complicated task, due to the recommended daily dose, the stability of vitamins, and the loss of vitamins during storage.
Based on practical experience, it can be stated that these vitamins generally need an additional dose of 10-20% for the product to contain the intended dose throughout the shelf life (Markovics E., 2007).
The amount of vitamin added is generally small, so it is recommended that the dough be mixed with a carrier such as sucrose. In technology, it must be borne in mind that vitamins are highly reactive and therefore unstable, in addition, certain vitamins have organoleptic properties and possible side effects (Markovics E., 2007).

B2) Mineral enriched products

The minerals in our body promote the proper functioning of enzymes and stimulus transmission processes. Bakery products are often enriched with minerals such as Fe, Ca and P. The essential amount of iron in humans is small, but obvious for the enzymes hemoglobin, cytochrome, peroxidase and catalase (https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx)
The daily dose of Ca and P is 800 mg, which is the highest of the minerals (Markovics E., 2007).
The Ca: P ratio is optimal 1: 2 (Fenyvessy J., Forgács J., 2000).
Mineral dosage levels apply to the same rules as for vitamin enrichment.

B3) Functional bakery products with added folic acid

Except β - glucan, and other ingredients, characterized by beneficial properties for health can be added to bread and bakery products. These ingredients are either substances that are not contained in conventional products, or substances that already exist but in small quantities - often too small to influence people's health and well-being.

Additives, such as the B vitamin complex, are ingredients that are naturally observed in cereals and are removed during grinding.

An attractive idea for consumers is to increase the intake of folic acid using a biotechnological technique by which yeast is used to increase the concentration of folic acid that naturally exists in fermented foods.

The folic acid content in fermented yeast products can be significantly increased by the use of selected yeast strains and an appropriate cultivation procedure dedicated to this strain.

Hjortmo et al. performed such an analysis using *Saccharomyces cerevisiae* CBS7764 and baker's yeast as reference strain.

Saccharomyces cerevisiae was grown in a defined environment and harvested in the fermentation phase of growth (respiro). The compressed baking yeast was bought from a local store and stored in the refrigerator until ripe.

The folic acid content was 3-5 times higher in white wheat bread with a strain of Saccharomyces cerevisiae CBS7764 than in conventional bread.

The dough obtained contained 135-139 µg of folic acid / 100 g of dry matter, compared to wheat flour bread with compressed baking yeast containing 27-43 µg of folic acid / 100 g of dry matter.

The practicality of applying this strategy indicates that the use of a suitable strain for bread production is an attractive alternative compared to fortifying bread with synthetic folic acid.

Wholemeal bread is generally characterized by a better nutritional value than white bread because it has a higher content of dietary fiber, vitamins, especially those of the B complex as well as micro and macronutrients.

However, wholemeal bread is also characterized by a high level of phytates (myo-inositolhexakisphosphate, InsP 6), which can form chelates and bind minerals, forming insoluble complexes, which can lead to mineral absorption and decreased bioavailability.

As a result, it can reduce the nutritional value of the whole product. Leenhardt et al. analyzed changes in phytolysis of phytates by fermenting leaven and adding in vitro an exogenous organic acid.

It was observed that the reduction of the pH of the dough to about 5.5 caused by the addition of leaven or lactic acid, in both cases, was associated with a reduction of about 35% of the phytate content. Other authors confirm that both

fermentation methods are useful techniques that reduce the amount of phytate in whole grains as a consequence of maintaining the high nutritional value of the product.

B4) Functional bakery products enriched with phytosterols

Phytosterols (plant sterols) are some of the compounds that make up plant cell membranes. Their chemical structure is similar to the structure of cholesterol, so they can be treated by the human body as cholesterol, and as a result, their consumption can cause a drop in blood cholesterol levels.

In the gut, phytosterols are combined with the same intestinal cell receptors as cholesterol, so its absorption is blocked and its excretion is increased.

In addition to lowering total cholesterol levels, phytosterols can affect the lipid profile by lowering the level of LDL (Low Density Lipoprotein Cholesterol), also called bad cholesterol.

The therapeutic dose of phytosterols, which lowers LDL cholesterol, is 2 g per day.

However, the intake of phytosterols in a typical diet is not possible to obtain a beneficial result but they must be incorporated into functional foods.

In the case of the development of functional products with added phytosterols, it is necessary to take into account the average amount of enriched product consumed in the diet so as to ensure the dose of 2 g of phytosterols in the average daily portion.

In the case of bakery products with added phytosterols, they have had the effect of increasing the amount of HDL (High Density Lipoprotein Cholesterol) which can reduce the risk of cardiovascular disease.

Other studies have shown that rye bread is high in fiber and enriched with phytosterols in lowering blood cholesterol.

Consumption of two servings of bread enriched with cholesterol, compared to the consumption of a single serving, had a positive effect (LDL cholesterol was reduced by 10.4%, instead of a reduction of 8.1%).

The Scientific Committee on Food (SCF) stated on the long-term effects of the intake of phytosterols from various food sources that there is no evidence of additional benefits of consuming more than 3 g / day, it is even possible that some effects may occur. unwanted and therefore it is more prudent to avoid it (Brodowska M, 2014).

B5) Advantages of consuming probiotic / prebiotic / symbiotic enriched bakery products

The term "probiotic" is derived from the Greek word "pro bios" which means "for life" and is associated with bacteria that have beneficial effects on human and animal health.

The first mention of probiotics was made by Elie Meltchnikoff, who introduced the concept of "probiotic" for the long and healthy life of Bulgarian peasants who consumed fermented dairy products daily. The researcher concluded that this longevity was attributed to products fermented with Lactobacillus that positively influence the intestinal microflora, by protecting the intestine.
The term probiotic was later used by Lilly and Stillwell (1965) to describe "substances produced by some microorganisms that prolong the logarithmic phase of others", in contrast to the term "antibiotics" (Lilly and Stillwell, 1965).
The FAO / WHO definition of probiotics is currently used: "living microorganisms which, when administered in appropriate amounts, confer a health benefit to the host" (FAO / WHO, 2006). The current definition clarifies that probiotics should be living micro-organisms and also emphasizes the importance of "adequate quantity" for consumption.
The main bacterial strains commonly used in probiotics are lactic acid bacteria of the genera Lactobacillus and Bifidobacterium. Other lactic acid bacteria used in probiotics are Pediococcus, Lactococcus, Leuconostoc, Streptococcus and Weissella. Certain yeast strains and fungi are also known for their probiotic effects.
Several aspects, including safety, functional and technological characteristics, must be taken into account in the selection process of probiotic microorganisms (Mitropoulou et al., 2013).
Safety aspects include specifications such as origin (healthy human gastrointestinal tract), non-pathogenicity, non-digestive side effects, and characteristics of non-antibiotic resistance. Functional aspects include viability and persistence in the gastrointestinal tract, survival in the face of digestive stress, immunomodulation and antagonistic and antimutagenic properties. Probiotic strains must be carefully examined according to their technological destination. In addition, it should not change the taste of the products.
Probiotic products should contain microorganisms with probiotic function in amounts greater than 106 CFU / g (CFU / ml) by the end of their shelf life. This is called the “minimum therapeutic level” (Neffe-Skocińska et al., 2018).
Probiotics are linked to various health benefits (FAO / WHO, 2006; Coté et al., 2013; Shakeri et al. 2014; Novik and Savich, 2020):
1. Disorders associated with the gastrointestinal tract (prevention of diarrhea caused by certain pathogenic bacteria and viruses; infections and complications with Helicobacter pylori; constipation; dyspepsia; inflammatory diseases and intestinal syndromes; cancer)
2. Mucosal immunity (modulating host immunity, defense against infections, cancer prevention)

3. Allergies (modulation of the immune response and prevention of allergic diseases)
4. Cardiovascular disease (benefits for the heart, including prevention and treatment of ischemic heart syndrome, lowering serum cholesterol)
5. Disorders of the urogenital tract (bacterial vaginosis, yeast vaginitis and urinary tract infections)
6. Alzheimer's disease (counteracts its progression).

Possible mechanisms of probiotic action in the control of intestinal pathogens include (FAO / WHO, 2006):

• Production of antimicrobial substances
• Competitive exclusion of pathogen binding
• Nutrient competition
• Modulation of the immune system.

A **prebiotic** is an indigestible food ingredient that benefits the body by selectively stimulating the growth and / or altering the metabolic activity of one or a limited number of bacterial species in the colon that have the potential to improve host health.

Inulin and oligofructose, indigestible fermentable fructans, are among the most studied prebiotics (Gibson, 2004).

The key criteria for a food ingredient to be classified as prebiotic is that it must result in a significant transfer to the colon and not be hydrolyzed or absorbed in the upper gastrointestinal tract. It must be a selective substrate for one or more beneficial bacteria that are stimulated to grow and can induce local (in the colon) or systemic effects through bacterial fermentation products that are beneficial to the host's health.

In addition to their potential to alter intestinal microflora and beneficial metabolic changes, many other effects of prebiotics are being investigated. These include their ability to activate the immune system, increase the absorption of certain minerals, such as calcium, and inhibit the lesions that are precursors of adenomas and carcinomas. Thus, they could have the potential to help reduce some of the risk factors involved in colorectal cancer.

Strategies for developing prebiotic products as functional foods should aim to provide specific fermentable substrates for beneficial bacteria, such as bifidobacteria, lactobacilli and Bacteroides. They can provide beneficial amounts and proportions of fermentation products, especially in the distal colon, where the effects are thought to be most favorable.

A **synbiotic** is a mixture of probiotics and prebiotics in order to increase the survival of health-promoting bacteria, with the ultimate goal of changing the intestinal flora and its metabolism.

Para-probiotics have recently been defined as inactivated probiotic microorganisms that are able to provide health benefits (by Almada et al. 2016; Granato et al., 2020).

Bakery products enriched with prebiotics, probiotics and synbiotics

Functional bakery products enriched with probiotics require a different approach due to the high temperatures at which they are baked. Since most probiotic microorganisms would be eliminated through the baking process, an alternative to benefit consumers is dough technology (Longoria-García et al., 2018; Gobbeti et al., 2018).

Cereals and bakery products can be used as fermentable substrates for growing probiotic microorganisms. Cereals can also be used as a source of dietary fiber (indigestible carbohydrates) which can selectively stimulate the growth of lactobacilli and bifidobacteria present in the colon and act as prebiotics.

Cereals containing water-soluble fiber, such as beta-glucan and arabinoxylan, oligosaccharides, such as galacto- and fructo-oligosaccharides, and resistant starch, may have prebiotic effects.

Cereal components, such as starch, can be used as probiotic encapsulating materials to improve their storage stability and increase their viability during their passage through adverse gastrointestinal tract conditions (Ozyurt and Ötles 2014; Kailasapathy, 2002; De Prisco and Mauriello, 2016).

B6) Carbohydrate-enriched products

Carbohydrates, including mono and disaccharides, are an important source of energy for our body due to their easy and fast digestibility (https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx)

During exercise, carbohydrates are a quick source of energy. Phenylketonuria (PKU) is a genetically inherited disease in which phenylalanine, an essential enzyme that dissociates phenylalanine - hydroxylase, is absent, resulting in the amino acid that builds up in the blood and then in the brain, causing severe and often irreversible brain damage. (https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx)

The disease currently has no cure, only additional damage can be avoided. Due to brain damage caused by disease, foods high in carbohydrates have a higher glucose content than the brain's energy needs.

B7) Fiber-enriched products

Dietary fiber (eg. cellulose, hemicellulose, pectin and other stored polysaccharides) are complex, indigestible carbohydrates. Digestion of cellulose in foods high in fiber helps to intensify bowel movement, thus reducing the time required to pass through the intestinal tract.

Fiber is useful in preventing many diseases and abnormal conditions. Blood cholesterol levels may be lowered, blood sugar stabilized, and some fiber plays a

significant role in preventing colon cancer, obesity, and constipation. (https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx)
As a result, fiber intake is essential for the body to facilitate normal functioning. To support a balanced diet, fiber-rich products have emerged in the bakery industry. Due to their high fiber content, apples and oats are mostly used to increase fiber content.
The technology must consider the use of dietary fiber that affects the hydration capacity of the dough.

B8) Protein-enriched products

Proteins are our basic building materials, help capture water, transfer nutrients, participate in metabolic processes and are an important source of energy (Markovics E., 2007). The emergence of protein-rich products among bakery products is now extremely fashionable and necessary.
Most plant-derived proteins are incomplete because the essential amino acids for the human body are few or absent, so their exclusive consumption causes deficiencies (Markovics E., 2007). To prevent this, more and more often, technological processes are used to supplement the protein content of products. Filling can be done with amino acid or natural protein preparations with a favorable set of amino acids, most often preferring the latter.(https://glutenerzekeny.hu/mit-ehet-es-mit-nem-egy-glutenerzekenyosszefoglalo -tablazat /).
As an additional plant-derived additive, various soy preparations are mainly used because they contain lysine and threonine.
Most often, milk protein is used as a dietary supplement, but in other experiments, blood serum protein can be dosed. The biological value of bakery products can be increased by using eggs in the product because the nutritional value determined on the basis of protein content and amino acid composition is the highest of all foods except breast milk.
It should be noted that by increasing the protein content, the carbohydrate content is reduced.
Rising consumer awareness of the relationship between diet and health benefits has led the industry to improve its industrial profile of a very wide range of foods (Bogue, Collins and Troy, 2017; Granato, et al., 2020).
Over the last decade, the bakery industry has seen a decline in bread consumption due to a greater availability of optimized bakery products (such as reduced sodium, gluten-free, reduced sugar and reduced calories). More recently, the trend of increasing the protein content in the bakery field has been a growing demand from consumers (Popa, Ungureanu, Mitelut, Popa, & Jurcoane, 2021)

Nutrition claims are allowed only if they are listed in the Annex to Regulation (EC) No 882/2004. 1926/2006, amended by Regulation (EC) no. 1047/2012.
A claim that a food has a high protein content, and any claim that may have the same meaning for the consumer can only be made if at least 20% of the energy value of the food is provided by protein.
Proteins are natural compounds already present in many ingredients in the bakery and can be divided into two main groups: functional and non-functional proteins.
Wheat protein is a complex binary mixture of gliadin and glutelin and belongs to the first group. When hydrated during the kneading phase, gliadin and glutelin self-assemble into a viscoelastic network called gluten.
Several studies have shown that the gluten network is responsible for its rheological properties, the ability of the dough to retain carbon dioxide during fermentation and in the early stages of baking (Barak, Mudgil, & Khatkar, 2013; Cappelli, Oliva, & Cini, 2020 ; Tietze, Jekle, & Becker, 2019).
In addition, the presence of gluten affects the quality of the final product (bread volume and texture). Therefore, high quality bread cannot be produced without gluten (Sahin, Wiertz, & Arendt, 2020).
While wheat protein may be functional, other sources of protein may be used in the formulation of bread in order to increase the protein content. However, these non-functional proteins can interfere with the formation of gluten and compromise the processing efficiency (stiffer and stickier dough) and the qualitative properties of bread such as chewability, lower volume, firmer texture and unpleasant taste (Boukid, Rosell, & Castellari, 2021).
Consequently, it is a key factor in identifying the right level of water in high protein bread to have enough water available for the ingredients in the system. Therefore, increasing both the water level and the kneading time should facilitate the hydration of the ingredients.
One of KERRY's collectible ingredients is Prodiem Rice 5020. Prodiem Rice 5020 is a rice protein that offers good taste and good texture.
The protein component of rice is generally considered hypoallergenic (Romero, 2014), and its nutritional quality is estimated to be equivalent to or higher than that of other cereals, but considerably lower compared to proteins derived from animal sources, and vegetable crops and oilseeds (Day, 2013).
It is also very available and at low cost. For all these reasons, Prodiem Rice 5020 has been identified as the right ingredient to meet the demand of consumers and producers.
In this paper, Prodiem Rice 5020 was used for the white bread on the tray to support the term "high in protein". The approach and actions taken to obtain high quality bread will be presented in this paper.

C) Bakery products with reduced content

Low-fat foods are functional foods in which the quantitative reduction of substances with excessive intake has a detrimental effect on health. In the bakery industry, low-carbohydrate, low-salt or low-fat products have emerged for this purpose.

C1) Low carbohydrate content bakery products

Low-carbohydrate products are preferred primarily by consumers with metabolic problems, but also by dieters.

The most severe form of carbohydrate metabolism disorder is diabetes, where type 1 and type 2 can be distinguished (https://cukorbetegseg-inzulin.hu/cukorbetegseg-fajtai).

Insulin, produced by the pancreas in the body, helps to integrate plasma glucose units into cells.

As blood sugar levels drop, insulin release is also reduced. The normal range of blood glucose levels is provided by the liver. In the case of diabetes, this process does not work properly, therefore sugar accumulates in the blood. In type 1 diabetes, the pancreas does not produce enough insulin to maintain normal blood glucose levels, while type 2 diabetes makes the cells insulin resistant. (https://cukorbetegseg-inzulin.hu/cukorbetegseg-fajtai).

In contrast, type 2 diabetes is triggered by other disease and risk factors, so it can be cured by resolving the health problems that cause diabetes or by reducing risk factors (e.g., obesity). In the latter case, diabetes can be treated with an individualized diet, which limits and minimizes carbohydrate intake.

A low-carbohydrate product is considered to be a bakery product if the carbohydrate content is reduced by at least 30% (Markovics E., 2007). In practice, this is mainly done by protein filtration. For technology, it must be taken into account that the quantitative reduction of carbohydrates will have a technical-functional effect and the water absorption capacity of the dough will decrease. To remedy this, hydrocolloids are used in industry, such as guar gum.

C2) Low salt bakery products

In the current context, the concentration of salt in food has become a real problem. Due to the high salt content in the diet, there are problems such as high blood pressure that can lead to stroke and heart disease.

At the end of the 17th century, salt began to be added to bread because it was expensive and difficult to obtain. But its role in bread is very important:

- intensify the taste of the other ingredients in the dough / bread
- slows down the fermentation rate and activity of enzymes and controls the growth of yeast

- obtaining a product with an improved texture due to the effect it has on the gluten network, which better retains the carbon dioxide from fermentation and helps to obtain a better volume.
- because it has a hygroscopic character, it helps to keep the bread moist
- helps to reduce spoilage, especially inhibiting the development of mold

In European bread, the salt content varies between 1.0-1.5% compared to the amount of flour used.

For people with health problems, especially for those with high blood pressure, it is recommended to consume products with low salt content.

In order to meet these needs, the bakery industry has developed products without salt or with low salt content.

Since 2003, European legislation has allowed the label "low salt content" to be labeled for products with a salt content below 0.3% (Rumeus. I, 2016).

Reducing salt content has become a national program in Hungary today, with the main goal of inhibiting excessive salt intake in the population, thus reducing the prevalence of hypertension in the population and thus the risk of stroke and heart attack.

https://www.ogyei.gov.hu/stop_so_nemzeti_socsokkento_program/ .

In reducing the sodium chloride content of bakery products, it must be taken into account that the salt has technofunctional properties and will affect the structure of the dough.

C3) Low fat bakery products

Fats provide our body with energy and chemical compounds essential for maintaining the structure of membranes, building materials for hormones and vitamins (Fenyvessy J., Forgács J., 2000).

Excessive intake will accumulate in our body which can lead to obesity and complications.

To prevent this, today's low-fat products have become fashionable. In the bakery industry, the manufacture of these types of products is still in the experimental stage.

2.3. Types of functional bakery products identified in the partner countries Romania, Ireland, Hungary and Italy

2.3.1 Functional bakery products in Romania

According to Euromonitor International, the market value of packaged organic food products in Romania has increased in recent years.

This development is due to the growing concern for health in general and the incidence of lifestyle diseases such as cardiovascular disease, obesity, osteoporosis and diabetes, all of which lead consumers to turn to daily

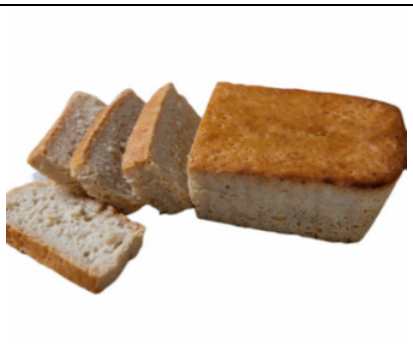
alternatives to natural alternatives. This increase has also been correlated with the increase in the number of retail stores offering a wide range of products and which has contributed to greater visibility of this type of product.
In Romania, there are several types of functional bakery products on the market, among which we mention:
a) Allergen-free products
b) Enriched products
c) products with low content

a) Allergen-free products

➢ **Gluten free products**

a1. Product name: GLUTEN FREE PEASANT BREAD / PÂINE ȚĂRĂNEASCĂ FĂRĂ GLUTEN

Gluten-free peasant bread is a natural product made from 100% natural ingredients, has a well-formed crust, dense core, slightly moist.

	Nutritional value
	Per 100 g product Energetic value: 236,34 kcal/987,90 kJ Fat: 1,02 g; Carbohydrates: 52,42 g of which sugars 0,60 g Proteins: 4,37 g Fibers: 2,54 g Salt: 1,18 g
Ingredients	**Nutrition and health claims**
Rice flour, corn flour, buckwheat flour, corn starch, psyllium bran, yeast, salt, water.	Obtained from 100% natural ingredients

https://www.gustusor.ro/paine/p%C3%A2ine-%C8%9B%C4%83r%C4%83neasc%C4%83-f%C4%83r%C4%83-gluten.html

a2. Product name: BREAD WITH RICE FLOUR AND HEMP / PÂINE CU FĂINĂ DE OREZ SI CÂNEPĂ – MAMAPAN

	Nutritional value
	Per 100 g produs Energetic value: 194 kcal/810 kJ Carbohydrates: 34,65 g Proteins: 5,69 g Fat: 1,17g

	Fibers: 6,59 g
Ingredients	**Nutrition and health claims**
wholemeal rice flour, wholemeal rice yeast, hemp flour, potato starch, psyllium bran, salt.	It can be used in severe gastric disorders, gastric ulcers, respiratory disorders - asthma, emphysema or chronic bronchitis.

Bread with rice flour and hemp is a "medicine" bread used to treat various ailments or in very strict diets. It is a bread with a bitter taste due to the hemp, but also moist inside.
Due to its analgesic properties, hemp can be administered in severe gastric disorders, gastric ulcers, respiratory diseases - asthma, emphysema or chronic bronchitis.
(https://mamapan.ro/produs/paine-cu-faina-de-orez-si-canepa/).

a3. Product name: Gluten free bread - Franzelă fără gluten, 450 g – NATRIANA

Gluten-free bamboo fiber bread, millet flour, psyllium, sorghum, sweet potatoes; tapioca starch, Himalayan salt, apple cider vinegar, etc.

	**Nutritional value**
	Per 100 g product Energetic value**:** 185,4 kcal / 774,98 kJ Proteins: 3,9 g; Fat: 1,5 g; Carbohydrates:353,1 g; Fibers: 10,2 g; Salt: 1 g
Ingredients	**Nutrition and health claims**
făină: mei, sorg, tapioca, cartofi dulci, fibre de bambus, susan, psyllium, nucă de cocos, oțet de mere, sare de Himalaya, ulei de cocos, agent de afânare: bicarbonat de sodiu Na, stabilizator de acidifiere: acid citric.	Pâine din fibre de bambus fără gluten, făină de mei, psyllium, sorg, cartofi dulci.

https://natriana.ro/shop/franzela/

a4. Product name: <u>SEED VEGAN WALLET WITHOUT GLUTEN, 385 g / BAGHETĂ VEGANĂ CU SEMINȚE, FĂRĂ GLUTEN, 385 g - NUTRIANA</u>

Gluten-free baguette made from buckwheat flour, millet, psyllium, bamboo fibers; tapioca starch; seed mixture (sesame, flax, sunflower, pumpkin).

	**Nutritional value**
	<u>Per 100 g produs</u> Energetic value: 230,4 kcal / 963,07 kJ Proteins:5,6 g Fats:3,4 g Carbohydrates:38,6 g Fibers: 8,8 g Salt:1,3 g
Ingredients	**Nutrition and health claims**
Flour: buckwheat, millet, psyllium, bamboo fibers; tapioca starch, apple cider vinegar, Himalayan salt, loosening agent: Na bicarbonate, acidification stabilizer: citric acid; seed mixture (sesame, flax, sunflower, pumpkin).	Gluten free

https://natriana.ro/shop/bagheta-vegana-cu-seminte/

a5. Product name: <u>GLUTEN-FREE BAGELS WITH SEEDS / COVRIGI FĂRĂ GLUTEN, CU SEMINȚE – 55 g- NATRIANA</u>

Bagels with 100% gluten-free, fluffy and tender seeds.

	**Nutritional value**
	<u>Per 100 g product</u> Energetic value: 134,4 kcal / 561,79kJ Proteins: 5,1 g; Lipids: 5,7 g; Carbohydrates: 11,2 g; Fibers: 7,1 g; Salt: 1,5 g

Ingredients	**Nutrition and health claims**
Tapioca flour, bamboo fiber, sesame, psyllium, coconut, sweet potatoes; Himalayan salt, coconut oil, apple cider vinegar, eggs, seed mixture (sunflower, flax, sesame, pumpkin), loosening agent: baking soda, acidifying stabilizer: citric acid.	Gluten free

https://natriana.ro/shop/covrigi-cu-seminte/

a6. Product name: <u>BREAD WITH MILLET / PÂINE CU MEI, 450 g – NATRIANA</u>

Gluten-free millet bread, additives. Quality ingredients, carefully chosen with certification from the manufacturer.

	Nutritional value
	<u>Per 100 g product</u> Energetic value: 62,3 kcal /260,41 kJ Protein: 2,7 g Fats: 1,3 g Carbohydrates: 26 g Fibers: 16,7 g Sare: 1,6 g
Ingredients	**Nutrition and health claims**
Bamboo fibers, flour: millet, psyllium, sorghum, sweet potatoes; tapioca starch, Himalayan salt, apple cider vinegar, loosening agent: Na bicarbonate, acidification stabilizer: citric acid.	Gluten free

https://natriana.ro/shop/paine-cu-mei/

a7. Product name: <u>GLUTEN FREE BAGELS WITH SESAME / COVRIGEI CU SUSAN FĂRĂ GLUTEN, 100 g – NATRIANA</u>

Gluten-free sesame pretzels from: tapioca, bamboo fibers, sesame, *Psyllium*, coconut, sweet potatoes; Himalayan salt, eggs, sesame (56%) etc.

	**Nutritional value** Per 100 g product Energetic value: 324,7 kcal / 1357,24 kJ Proteins: 13,5 g Lipids: 11,7 g Carbohydrates: 30 g Fibers: 18,7 g Salt: 2,6 g
Ingredients	**Nutrition and health claims**
Flour: tapioca, bamboo fibers, sesame, psyllium, coconut, sweet potatoes; Himalayan salt, apple cider vinegar, eggs, sesame (5%), loosening agent: Na bicarbonate, acidification stabilizer: citric acid.	Gluten free

https://natriana.ro/shop/covrigei-susan/

b) **Enriched products**

b1. Product name: BENECOL BREAD WITH RYE / PÂINE BENECOL CU SECARĂ, 240g – DOBROGEA GRUP S.A.

Launched in 2010 in collaboration with Raisio Finland, Benecol Secară is a wonderful bread that lowers cholesterol after a regular consumption of 14 days.

Dobrogea Benecol rye bread has a low carbohydrate content of 26.1 carbohydrates100g of product, being suitable for a low-calorie diet, and the high fiber content (10.1g/100g of product) is recommended in healthy and balanced diets.

- Rich in fiber - 10.1 g fiber / 100g product
- Rich in protein - 13.5 g protein / 100g product
- Low carbohydrate content - 26.1 g carbohydrates / 100g product

	Nutritional value:
	Per 100 g product Energetic value: 1106 KJ /263 kcal Fats –5,2 g; of which saturated fats 0.88 g Carbohydrates: 35,46 g of which sugars: 4,5 g Fibers: 10,1 g of which insoluble – 6,3 g of which soluble – 3,8 g Proteins – 13,5 g Salt - 1,26 g Plant stanol content 2,7 g / 100 g product; 2 g / portion of 80 g
Ingredients	**Nutrition and health claims**
Rye flour 26%, water, white wheat flour 650, black wheat flour 1250, wheat gluten, plant stanol esters (2.7% plant stanols), yeast, soluble chicory fiber (inulin), fermented flour of wheat, iodized salt, natural and dehydrated leaven from rye (fermented rye flour, iodized salt), barley malt flour.	Proven to lower cholesterol It is a high-fiber, high-protein product.

b2. Product name: <u>BENECOL WHITE BREAD –BENECOL PÂINE ALBĂ 240 g – DOBROGEA GRUP S.A.</u>

Launched in 2020, Benecol White Bread with the addition of plant stanol esters is a wonderful bread that lowers cholesterol after a regular consumption of 14 days, a daily dose of only 4 slices.

Dobrogea Benecol white bread has a high fiber content of 8.4g / 100g produced and is recommended in healthy and nutritionally balanced diets.

It is scientifically proven that high fiber diets reduce the incidence of cardiovascular disease and diabetes.

- Rich in fiber - 8.4 g fiber / 100g product

- Rich in protein - 12 g protein / 100g product

- Low carbohydrate content - 31.6 g carbohydrates / 100g product

	Nutritional value
	<u>Per 100 g product</u> Energetic value: 1062 KJ / 253 kcal Fats : 6,9g of which saturated fats: 0,77 g Carbohydrates: 31,6 g of which sugars :3,7 g Fibers: 8,4 g of which insoluble: 5 g of which soluble: 3,4 g Proteins : 12 g Salt: 1,37g Plant stanol content 2,7 g / 100 g product; 2 g / portion of 80 g
Ingredients	**Nutrition and health claims**
Wheat flour 550 (59%), water, vegetable stanol esters (2.7% vegetable stanol), wheat gluten, yeast, sunflower seeds, fermented wheat flour, iodized salt, dehydrated natural wheat leaven (fermented wheat flour, iodized salt), wheat fiber, soluble chicory fiber (inulin).	Proven to lower cholesterol It is a high-fiber, high-protein product.

b3. Product name: <u>BONGRANA SANA ULTRAFIBER / BONGRANA SANA ULTRAFIBRE</u> – DOBROGEA GRUP S.A.

For an additional intake of fiber in the diet, Bongrana Ultrafibre is the ideal choice due to its high fiber content (8.8g / 100g), but also the rich mix of seeds and cereals (sunflower, flax, pumpkin, sesame, millet, flakes rye, poppy seeds).

	Nutritional value
	<u>Per 100 g product</u> Energetic value: 1200 kJ/286 kcal Fats: 8,76 g of which saturated:1,05g Carbohydrates: 33,26 g Of which sugars: 2,53 g Fibers: 8,8 g Proteins: 14,1 g Salt: 1,1 g

Ingredients	Nutrition and health claims
White wheat flour 650, water, dietary wheat flour 22.6% (whole wheat flour), yeast, wheat gluten, black wheat flour 1250, sunflower seeds 5.1%, flax seeds 3.2 %, natural and dehydrated wheat leaven 2.9% (flavored flour) iodized salt), pumpkin seeds 2.7%, sesame seeds 1.8%, fermented wheat flour, iodized salt, millet seeds 0, 9%, rye flakes 0.9%, dextrose, barley malt flour, 0.4% poppy seeds, vinegar.	High fiber content

b4. Product name: <u>BONGRANA SANA HYPOGLUCIDIC / BONGRANA SANA HIPOGLUCIDICĂ</u>, 500 g - DOBROGEA GRUP S.A.

- Calorie worry disappears with Bongrana Hipoglucidica due to its low carbohydrate content (28.24g / 100g vs. 45.8g / 100g for consumer bread)
- The high fiber content (11.5g / 100g) adds to the digestion.
- Also recommended in the diet of diabetics of grade II or diet, with the doctor's recommendation

	**Nutritional value**
	<u>Per 100 g product:</u> Energetic value: 992 kj/236 kcal Fats: 4,23g of which saturated: 1,3g Carbohydrates : 28,24 g of which sugars : 2,97 g Fibers: 11,54 g Proteins : 15,48 g Salt : 1,08 g
Ingredients	**Nutrition and health claims**
White wheat flour 650, water, wheat bran, wheat gluten, wheat black flour 1250, yeast, soluble chicory fiber (inulin), sunflower vegetable oil, natural and dehydrated wheat leaven 2.1% (fermented wheat flour, iodized salt), fermented wheat flour, iodized salt, vinegar.	High fiber content Also recommended in the diet of grade II diabetics or diet with a doctor's recommendation

b5. Product name: <u>BONGRANA RYE TOAST / BONGRANA TOAST SECARĂ</u>, 500 g – DOBROGEA GRUP S.A.

The high fiber content (6 g fiber / 100 g product) from rye flour helps to have a healthy and balanced diet every day.

	**Nutritional value**
	<u>Per 100 g product:</u> Energetic value : 1022 kj/242 kcal Fats : 2,7 g of which saturated : 1,07 g Carbohydrates : 43 g of which sugars : 1,35 g Fibers : 6 g Proteins : 8,4 g Salt : 1,2 g
Ingredients	**Nutrition and health claims**
White wheat flour 650, water, rye flour (17%), wheat food flour (wholemeal flour), black wheat flour 1250, yeast, wheat gluten, sunflower vegetable oil, fermented wheat flour, iodized salt, sugar, wine vinegar, vegetable fiber (*Psyllium*), cumin seeds, barley malt flour.	Product rich in fibers

b6. Product name: <u>BONGRANA WHOLEMEAL TOAST / BONGRANA TOAST INTEGRAL</u>, 500 g – DOBROGEA GRUP S.A.

Wheat dietary flour, wholemeal millet used to make delicious bread Bongrana Toast Integral is obtained from the whole grain millet of wheat grain thus recovering its natural nutritional components (vitamins, minerals, fiber).

The high fiber content (6 g/100 g product) recommends Bongrana Toast Integral for daily consumption, thus increasing the intake of fiber in the diet.

	**Nutritional value**
	Per 100 g product Energetic value: 1024 kj/242 kcal Fats: 2,7g of which saturated: 1,09 g Carbohydrates: 43 g of which sugars: 1,28 g Fibers: 6,05 g Proteins: 8,5 g Salt: 1,225 g
Ingredients	**Nutrition and health claims**
White wheat flour 650, water, dietary wheat flour (whole wheat) (30%), black wheat flour 1250, yeast, sunflower vegetable oil, wheat gluten, fermented wheat flour, iodized salt, sugar, vinegar wine, vegetable fiber (psyllium), barley malt flour.	Product rich in fibers

b7. Product name: BONGRANA TOAST GRAHAM, 500 g – DOBROGEA GRUP S.A.

The combination of graham flour and dietary wheat flour from whole ground wheat is ideal in the daily diet because it brings a significant intake of fiber (4.8g / 100g product)

	**Nutritional value**
	Per 100 g produs Energetic value : 1019 kj/241 kcal Fats: 2,6 g of which saturated : 1,05 g Carbohydrates: 44 g of which sugars: 1,24 g Fibers: 4,8 g Proteins: 8 g Salt: 1,2 g
Ingredients	**Nutrition and health claims**
White wheat flour 650, water, dietary wheat flour (graham flour) (14.5%), black wheat flour 1250, yeast, sunflower vegetable oil, wheat gluten, fermented wheat flour, iodized salt, sugar, wine	Fiber source

vinegar, vegetable fiber (psyllium).	

b8. Product name: <u>BONPANA ROUND MULTI-GRAIN BREAD/ BONPANA PÂINE MULTICEREAL ROTUNDĂ</u>, 400 g

The classic taste of homemade bread is now enriched with a mix of seeds (flax, millet, sunflower, pumpkin) and bran.

Bongrana Multicereal is an important source of fiber (4.4 g / 100 g product).

	Nutritional value
	<u>Per 100 g product</u> Energetic value: 951 KJ/225 kcal Fats: 3,1 g of which saturated fatty acids 0,48 g Carbohydrates – 38,4 g of which sugars: <0,5 g Fibers – 4,4 g Proteins – 8,7 g Salt – 0,975 g
Ingredients	**Nutrition and health claims**
White wheat flour 650 (57.7%), water, wheat bran, 11,5% seed mixture (flax seeds, millet seeds, sunflower seeds, pumpkin seeds), yeast, black wheat flour 1250, wheat gluten, iodized salt, acidity corrector: sodium diacetate; preservative: sorbic acid, vegetable fiber (*Psyllium*).	Fiber source

b9. Product name: <u>BONPANA ROUND WHOLEMEAL BREAD / BONPANA PÂINE INTEGRALĂ ROTUNDĂ</u>, 400 g – DOBROGEA GRUP S.A.

Bonpana Integrale is a bread rich in fiber (8.6 g / 100 g product) due to the mixture of black flour and dietary wheat flour-wheat flour.

	Nutritional value
	Per 100 g product Energetic value: 976 kj/ 231 kcal Fats: 1g, of which saturated fatty acids: 0.13 g Glucids: 42,7 g, of which sugars < 0,5g Fibers: 8,6 g Proteins: 8,3g Salt: 1,150 g
Ingredients	**Nutrition and health claims**
Dietary wheat flour (whole wheat) 43% water, black wheat flour 1250, white wheat flour 650, yeast, iodized salt, wheat gluten, acidity corrector: sodium diacetate, preservative: sorbic acid, vegetable fiber (*Psyllium*).	Rich in fibers

b10. Product name: BONPANA ROUND BREAD WITH RYE/ BONPANA PÂINE CU SECARĂ ROTUNDĂ, 600 g – DOBROGEA GRUP S.A.

Bread with leaven is made according to an old recipe based on long-term fermentation. The result is a rich aroma, robustness and elastic texture of the core. Bonpana with leaven and rye is a special bread, with an important intake of fiber for the daily diet (6.12 g / 100 g product).

	Nutritional value
	Per 100 g produs Energetic value: 229 kcal/969 kJ Fats: 1.05 g, of which saturated fatty acids: 0.28 g Carbohydrates: 42.12 g of which sugars: 1.56 g Fiber: 6.12g Proteins: 9.73 g Salt : 1.11 g
Ingredients	**Nutrition and health claims**
White wheat flour 650, water, dietary rye flour whole wheat flour, 14.4%, dehydrated natural rye leaven, 3.6% (fermented rye flour, iodized salt), yeast,	Rich in fibers

wheat gluten, dehydrated natural leaven from wheat, 0,65%, (fermented wheat flour, iodized salt), iodized salt, preservatives: sorbic acid, calcium propionate; vegetable fiber (psyllium).	

b11. Product name: <u>DIETARY BREAD MADE FROM WHOLEMEAL GROUND FLOUR / DIETA PÂINE DIETETICĂ DIN FĂINĂ MĂCINIȘ INTEGRAL</u>, 400g – DOBROGEA GRUP S.A.

Dietary bread is ideal in diets, but also to keep a healthy and balanced diet due to the high intake of fiber (10 g / 100 g) and protein (11 g / 100 g product).

	Nutritional value
	<u>Per 100 g produs</u> Energetic value**:** 950kj /225 kcal Fats : 1 g of which saturated fatty acids 0,15g Carbohydrates : 38 g of which sugars 0,19g Fibers: 10 g Proteins: 11 g Salt : 1,325g
Ingredients	**Nutrition and health claims**
Whole wheat dietary flour flour 74%, water, wheat gluten, yeast, iodized salt, fermented wheat flour, wine vinegar.	Rich in fibers

b12. Product name: <u>DIETA BLACK BREAD WITH LEAVEN / DIETA PÂINE NEAGRĂ CU MAIA</u>, 400g – DOBROGEA GRUP S.A.

Black flour in combination with dietary wheat flour, whole wheat flour develops an important content of fiber (6.61 g / 100 g product) and protein: (11 g / 100 g product).

	Nutritional value
	Per 100 g produs Energetic value:1107kj/262 kcal Fats : 1,96 g of which saturated fatty acids 0,63g Carbohydrates : 46,73g, of which sugars: 2,36g Fibers: 6,61g Proteins : 11,01 g Salt : 1,7g
Ingredients	**Nutrition and health claims**
Black wheat flour 1250 (23%), water, dietary wheat flour (whole wheat flour), white wheat flour 650, yeast, wheat gluten, iodized salt, natural wheat leaven (1%) (water, wheat flour fermented wheat), barley malt flour, natural and dehydrated wheat leaven (0.6%) (fermented wheat flour, iodized salt), preservatives: calcium propionate, sorbic acid	Rich in fiber

b13. Product name: <u>DIETA WHITE BREAD WITH SEEDS AND LEAVEN / DIETA PÂINE ALBĂ CU SEMINȚE ȘI MAIA</u>, 400g – DOBROGEA GRUP S.A.

The white bread diet with seeds and leaven has a high content of 19.5% seeds (sunflower, flax, sesame, millet, poppy, quinoa, hemp, chia) which gives it a delicious taste. The high protein content (11 g / 100g product), ensures a significant intake of protein in the daily diet.

	Nutritional value
	Per 100 g produs Energetic value: 1059kj/ 252 kcal Fats : 6,8 g of which saturated fatty acids: 0,8 g Carbohydrates : 35 g of which sugars: 0,5 g Fibers : 3,2 g Proteins : 11g Salt : 1 g

Ingredients	Nutrition and health claims
White wheat flour 650 (62%), water, mixture of seeds in variable proportions 19.5% (sunflower, flax, sesame, millet, poppy, quinoa, hemp, chia); yeast, wheat gluten, iodized salt, 0.5% dehydrated natural rye leaven (fermented rye flour, iodized salt), barley malt flour, preservatives: calcium propionate, sorbic acid.	Fiber source

b14. Product name: <u>DIETA WHITE BREAD WITH SEEDS, CEREALS AND LEAVEN / DIETA PÂINE ALBĂ CU SEMINȚE, CEREALE ȘI MAIA</u>, 400g – DOBROGEA GRUP S.A.

The white bread diet with seeds and leaven has a unique taste from the mix of cereals, seeds and leaven (rye, buckwheat, sunflower, flax, millet, pumpkin, sesame and poppy).

The high content of fiber (8,44 g / 100 g product) and protein (9,1 g/100 g product) recommends Dieta in the daily diet for extra balance and health.

	**Nutritional value**
	<u>Per 100 g produs</u> Energetic value: 1118 kJ/265 kcal Fats: 2,94g of which saturated fatty acids 0,55g Carbohydrates : 46,3g of which sugars : 3,29g Fibers: 8,44g Proteins : 9,1g Salt : 1,68g
Ingredients	**Nutrition and health claims**
White wheat flour 650 (67%), water, rye grains and buckwheat hydrated in rye leaven 6% (pasteurized liquid rye leaven 55%, rye grains 31%, buckwheat grains 4%, iodized salt), yeast , wheat gluten, chicory fiber (inulin), iodized salt, sunflower seeds 1.15%, seeds in 1.15%, millet seeds 0.95%, pumpkin seeds 0.7%, sesame seeds 0.45%, poppy seeds 0.25%,	Rich in fibers

preservatives: calcium propionate, sorbic acid.	

b15. Product name: <u>BREAD WITH BRAN / PÂINE CU TĂRÂȚE – PANIMON S.A.</u> – PANIMON S.A.

Rich in active substances, with high therapeutic value, wheat bran sums up all the qualities of a natural medicine.
Due to the source of vitamins and minerals, they have a laxative and detoxifying effect, thus helping to maintain the figure.
Experts say that bran bread contains three times more vitamins and five times more magnesium, calcium and phosphorus than conventional white bread.
General exterior - Long format of notched bagel, well developed product
Bark - Matt surface, no cracks, dark brown rumen
Core - Sponge dough, elastic consistency, without traces of unmade flour, with thick bran particles.

	Nutritional value
	<u>Per 100 g produs</u> Energetic value: 230kcal/927KJ Fats: 4,42g, of which saturated fatty acids: 1,5g Carbohydrates: 39,65g, of which sugars: 2,55g Proteins: 11,5g Fibers: 7,1g Salt: 1,4g
Ingredients	**Nutrition and health claims**
Ingredients: white wheat flour 650, min. 40% leaven (white wheat flour 650, water, baking yeast), wheat bran 12.8%, iodized salt, baking enhancers (Clean Label): white wheat flour 650, enzymes.	Rich in fibers

b16. Product name: ”STELA FRANZELA” BREAD WITH RYE FLOUR, SLICED / PÂINE ”STELA FRANZELA”, CU FĂINĂ DE SECARĂ, FELIATĂ – VEL PITAR S.A.

Bread with rye flour, sliced, 300g, tasty, fluffy and fresh until the last day.

	Nutritional value
	Per 100 g product Energetic value: 1026 kJ/242 kcal Fats: 1,7 g of which saturated fatty acids: 0,7 g Carbohydrates: 45,4 g, of which sugars: 4,7 g Fibers: 6,4 g Proteins: 8,8 g Salt: 1 g
Ingredients	**Nutrition and health claims**
Black wheat flour, water, 650 wheat white flour, 9% rye flour, yeast, wheat gluten, iodized salt, wheat malt flour, preservatives (sorbic acid, calcium propionate).	MS notification: for the packaging: “Fiber source”. The product appears in the National Register of nutritional and health claims entered on foodstuffs

b17. Product name: MANORIAL BREAD WITH RYE FLOUR AND LEAVEN, SLICED / PÂINE BOIEREASCĂ CU FĂINĂ DE SECARĂ ȘI MAIA, FELIATĂ - VEL PITAR S.A.

Bread with rye flour and leaven, sliced, 700g, leavened in wooden baskets and "dusted" with selected flour.

	Nutritional value
	Per 100 g product Energetic value: 1001 kJ/ 237 kcal Fats: 1,4 g, of which saturated fatty acids: 0,3 g Carbohydrates: 44,7 g, of which sugars: 7,4g Fibers: 5,4 g Proteins: 8,6 g Salt: 1,2 g
Ingredients	**Nutrition and health claims**
White wheat flour 650, water, rye flour (19%), yeast, wheat gluten, iodized salt,	MS notification: for the expression “Fiber source” written on the package. The product

dried rye leaven (1.2%) (rye flour, water, starter crops), preservatives (sorbic acid, propionate calcium), malt flour, (wheat), cumin.	appears in the National Register of nutritional and health claims entered on foodstuffs

b18. Product name: ECOLOGICAL BREAD WITH MULTICEREALS AND SEEDS, SLICED / PÂINE ECOLOGICĂ CU MULTICEREALE ȘI SEMINȚE, FELIATĂ - VEL PITAR S.A.

Ecological bread with cereals and seeds, sliced, 300g, tasty, fluffy and fresh until the last day.

Nutritional value
Per 100 g product Energetic value: 1150 kJ/272 kcal Fats: 3,9 g, of which saturated fatty acids: 0,4 g Carbohydrates: 47,3 g, of which sugars: 3 g Fibers: 3,6 g Proteins: 10,3 g Salt: 1,4 g

Ingredients	Nutrition and health claims
White wheat flour 650, water, cereal mix and seeds 20.6% (whole rye flour, oat groats, spelled cracker, sunflower seeds, flax seeds, rye leaven, sesame seeds, sugar, flour barley malt, spices, in varying proportions) yeast, iodized salt, wheat gluten, wheat malt flour, wheat leaven, vinegar.	The product is obtained from ingredients from organic farming, is ECO certified and has a high protein content.

b19. Product name: ECOLOGICAL BREAD WITH LEAVEN, SLICED / PÂINE ECOLOGICĂ CU MAIA, FELIATĂ - VEL PITAR S.A.

Ecological bread with leaven, sliced, 300g, tasty, fluffy and fresh until the last day.

	Nutritional value
	Per 100 g product Energetic value: 1087 kJ/257 kcal Fats: 1,5 g, of which saturated fatty acids: 0,2 g Carbohydrates: 49,2 g of which sugars: 4,6 g Fibers: 3,4 g Proteins: 9,8 g Salt: 1 g
Ingredients	**Nutrition and health claims**
White wheat flour 650, water, rye mix, (rye meal, roasted rye malt flour, flax seeds, soybean meal, dry rye acid dough, wheat bran, pregelatinised maize flour, spices, in variable proportions) yeast, iodized salt, wheat gluten, wheat malt flour, 1% wheat leaven, vinegar.	The product is obtained from ingredients from organic farming, is ECO certified and has a high protein content.

b20. Product name: MANORIAL BREAD WITH BLACK FLOUR, SLICED / PÂINE BOIEREASCĂ DIN FĂINĂ NEAGRĂ DE GRÂU, FELIATĂ - VEL PITAR S.A.

Manorial bread made of black wheat flour, sliced, 700 g, leavened in wooden baskets and "dusted" with selected flour.

	Nutritional value
	Per 100 g product Energetic value: 965 kJ/ 229 kcal Fats: 2,4 g, of which saturated fatty acids: 0,3 g Carbohydrates: 39 g, of which sugars 3,2 g Fibers: 7,2 g Proteins: 9,6 g Salt: 1 g
Ingredients	**Nutrition and health claims**
Black wheat flour, water, yeast, iodized salt, sunflower vegetable oil, wheat gluten, preservatives (sorbic acid, calcium propionate), wine vinegar.	MS notification: for the expression “Rich in fiber” written on the package. The product appears in the National Register of nutritional and health claims entered on foodstuffs

b21. Product name: <u>WHOLE WHEAT BREAD / PÂINE GRÂU ÎNTREG 500G</u> - VEL PITAR S.A.

Dietary flour bread - whole wheat, sliced

	Nutritional value
	<u>Per 100 g product</u> Energetic value: 942 kJ/ 223 kcal Fats: 1,7 g, of which saturated fatty acids: 0,3 g Carbohydrates: 36,8 g, of which sugars 2,2 g Fibers: 8,7 g Proteins: 10,8 g Salt: 1,3 g
Ingredients	**Nutrition and health claims**
Dietary flour - whole wheat flour, water, yeast, iodized salt, wheat gluten, soy flour (0.6%), wheat leavemn.	Made in Romania, without E-s, without preservatives Compared to white bread, Whole Wheat Bread has: - 25% less carbohydrates - 2 times more minerals - 2.3 times more fiber

b22. Product name: <u>CLASSE NOIRE – 100% OF WHOLEMEAL RYE FLOUR, 500 G</u> - VEL PITAR S.A.

Wholemeal rye flour bread on a tray, sliced

	Nutritional value
	<u>Per 100 g product</u> Energetic value: 949 kJ/ 225 kcal Fats: 0,7 g, of which saturated fatty acids: 0,2 g Carbohydrates: 34,9 g of which sugars: 3,1 g Fibers: 8,5 g Proteins: 15,5 g Salt:1,2g
Ingredients	**Nutrition and health claims**
wholemeal rye flour, water, wheat gluten, dehydrated rye leaven, yeast, sunflower vegetable oil, sugar beet molasses, iodized salt, fermented wheat starch, wine vinegar	100% wholemeal rye flour No E's Without preservatives High in fiber Source of phosphorus Source of magnesium

b23. Product name: <u>BREAD WITH RYE FLOUR / PÂINE CU FĂINĂ DE SECARĂ</u> 500 g – VEL PITAR S.A.

White and black wheat flour bread with added rye flour 9%, sliced

	Nutritional value
	<u>Per 100 g product</u> Energetic value: 878 kJ/ 207 kcal Fats: 0,4 g, of which saturated fatty acids: 0,4 g Carbohydrates: 29,5 g, of which sugars 4,3 g Fibers: 6,4 g Proteins: 16,4 g Salt: 1,5 g

Ingredients	Nutrition and health claims
Black wheat flour, water, 650 white wheat flour, 9% rye flour, yeast, wheat gluten, iodized salt, barley malt flour, preservatives (sorbic acid, calcium propionate), wine vinegar, agent flour treatment (ascorbic acid).	Source of protein and fibers

b24. Product name: <u>GRAHAM BREAD - PAINE GRAHAM</u>, 500g – VEL PITAR S.A.

Graham diet flour bread

	Nutritional value
	<u>Per 100 g product</u> Energetic value: 1053 kJ/ 207 kcal Fats: 1,3 g, of which saturated fatty acids: 0,3 g Carbohydrates: 44,7 g of which sugars 2,9 g Fibers: 6,2 g Proteins: 11,4 g Salt: 1,14 g

Ingredients	Nutrition and health claims
white wheat flour 650, water, dietary wheat flour graham (30%) yeast, wheat gluten, iodized salt, preservatives (sorbic acid, calcium propionate), wine vinegar, flour treatment agent (ascorbic acid).	Contains 30% Graham

b25. Product name: <u>10 SEEDS BREAD / PÂINE 10 SEMINȚE</u> – OLTINA IMPEX PROD COM S.R.L.

Wheat flour bread with a mixture of seeds, is obtained in a technological process that preserves several elements of the artisanal style: slow kneading for 40 minutes of the dough, followed by a bulk fermentation for an hour, leavening in baskets wood and baking on the hearth. Bread 10 seeds is based on a technological concept that allows the integration in the composition of the product of as many seeds as possible without losing the sensory qualities specific to a quality product: uniform texture, soft and non-sticky core, homogeneous porosity with medium-sized pores distributed on the whole section of the slice, crispy shell with walnut flavor specific to ripe seeds. The nutritional benefits of Bread 10 Seeds derive from maximizing the amount of seeds introduced in the recipe, as well as their variety. The product addresses modern consumer trends that integrate elements of vegetarian and paleo diets. Seeds are important sources of bioactive compounds with potentially beneficial mechanisms in regulating blood lipid and cholesterol levels, reducing oxidative stress (antioxidant), vitamins and minerals. Bread is a source of fiber with good digestibility and is characterized by a full and intense taste that invites satiety and relaxation. The original packaging is designed to preserve the true freshness of the product even after you have opened the bread at home.

<table>
<tr><td rowspan="2">  </td><td>Nutritional value</td></tr>
<tr><td><u>Per 100 g product:</u>
Energetic value: 296 kcal/1242 kJ;
Fats 7,5 g of which saturated fatty acids 1,31;
Trans fatty acids <0,05;
Carbohydrates 40,8 of which sugars 4,96;
Proteins 11,42;
Fibers 9,85;
Salt 1,3</td></tr>
<tr><td>Ingredients</td><td>Nutrition and health claims</td></tr>
<tr><td>White wheat flour 650, water, 18% seed mixture (sunflower, flax seeds, soybeans, sesame seeds, chia seeds, poppy seeds, millet seeds, black sesame seeds, pumpkin seeds, oatmeal), iodized salt, rye malt flour, wheat gluten, dehydrated rye leaven, emulsifier: stearoyl-2 sodium lactylate,</td><td>Rich in fibers</td></tr>
</table>

barley malt flour, flour tartar: ascorbic acid, preservatives: acid sorbic, calcium propionate.	

b26. Product name: <u>FITNESS BREAD / PÂINE FITNESS</u> – OLTINA

Bread made from rye flour and wheat with a mixture of seeds, sliced, leavened in rattan baskets and baked on the hearth.

Fitness bread contains a balanced combination of rye flour, wheat flour, sunflower seeds, oatmeal, pumpkin seeds and wheat bran based on the recipe used by CJK Henry and HJ Lightowler of Oxford Brooks University in their research on the control of postprandial blood glucose levels. That recipe has an associated glycemic index of 54 and is patented by the European group Bakels. The Romanian recipe enhances the rye flour content from the original recipe, and this option was followed precisely because, compared to wheat, rye has a better impact on the processes involved in reducing body weight, blood glucose and satiety. Fitness bread comes with a rich dowry of seeds thus aligning with modern consumption trends related to vegan diets. The seeds provide an additional supply of fiber, minerals, vitamins and lipids with antioxidant potential. The product is intended to be a net supplier of energy and bioactive substances to compensate for the lack of monotonous diets that we fall prey to in our daily lives.

The unique design of the recipe, the fermentation in wooden baskets, the baking on the hearth, goes beyond the borders of the conventional products of which the consumer has a part in a visit in a supermarket.

	Nutritional value
	<u>Per 100 g product:</u> Energetic value: 298 kcal/1253 kj; Fats : 8,1 g, of which saturated fatty acids: 1,33; Trans fatty acids <0,05; Carbohydrates: 38,7 of which sugars 3,55; Proteins: 13,4; Fibers: 8,46; Salt: 1,36

Ingredients	Nutrition and health claims
Whole rye flour, white wheat flour 650 water, vital gluten, iodized salt, yeast, sunflower seeds, flax seeds, pumpkin seeds, oat flakes, sugar, dried wheat leaven, wheat bran, emulsifiers: esters of mono- and diglycerides with diacetyltartaric acid and sunflower lecithin, preservatives: sorbic acid and calcium propionate, flour treatment agent: ascorbic acid, enzymes	Rich in fibers

b27. Product name: WHOLEMEAL BREAD LIGHT WHEAT / PAINE INTEGRALA GRAU UȘOR - OLTINA

Whole wheat bread with leaven, baked on the hearth.
The concept behind the product recipe was to create an alternative to the products on the market in the form of a more airy bread, with high digestibility, palatability, smoothness and optimized swallowing.
The achievement of these characteristics was obtained by using wholemeal flour with a specific granulation, practically without the use of improvers.
The product has a good volume, with a slice surface at the same time generous but also with a lower caloric density, compared to the usual bread variants.
The taste of the slice is reminiscent of the natural simplicity of boiled wheat and bread wrapped in a towel, the basis of simple and honest living in the country.

Nutritional value
Per 100 g product: Energetic value: 263 kcal/1110 kJ; Fats: 2,6 g of which saturated fatty acids : 0,67; Trans fatty acids: <0,05; Carbohydrates: 47,2 of which sugars: 5,91; Proteins: 10,45; Fibers: 4,71; Salt: 1,36

Ingredients	Nutrition and health claims
Whole wheat dietary flour (70%), water, liquid wheat leaven (water, white wheat flour, selected lactic acid bacteria (15%), dehydrated durum wheat corn, vital gluten, rye and barley malt flour, flour fermented wheat, yeast, iodized salt, soy flour, wine vinegar, vegetable oil (sunflower), flour treatment agent (ascorbic acid).	Fiber source

b28. Product name: <u>BREAD WITH ANCIENT GRAINS ULPIA THESAURUM / PÂINE CU GRÂNE ANTICE ULPIA THESAURUM</u> – OLTINA

White bread with seeds and cereals, sliced, leavened in rattan baskets and baked on the hearth.
Ulpia Thesaurum bread is sold in a packaging designed to reflect the historical traditions of our people: the Daco-Roman fusion as an archetype of the combination of agriculture and technology, respectively the syncretism of the rustic aromas of traditional Romanian bread with the sweet Mediterranean flavors we long for on vacation; the first bakery product on the Romanian market with Nutriscore, meant to facilitate the consumer's decision in choosing healthy products.

Bread complements consumers' interest in food made by methods close to artisanal style (basket leavening, hearth baking, etc.), through the use of genetic and nutritional ingredients used in making bread thousands of years ago.
Old grains are seen as a healthier option in modern grains, obtained through genetic improvement, responsible for the different types of wheat intolerance identified in today's consumers.

On the other hand, the recovery of these old varieties in culture is seen by some experts as a solution to the future challenges posed by climate change.
The old wheat spices used as ingredients in the bread recipe are Spelta and Alac. They generally have a higher protein content (with a higher amino acid profile), a higher fat content (and a better fatty acid nutritional profile), as well as a higher percentage of minerals, such as magnesium, copper and zinc than modern wheat varieties.

	Nutritional value
	Per 100 g product: Energetic value : 296 kcal/1242 kJ ; Fats : 7,5 g of which saturated fatty acids : 1,31 ; Trans fatty acids : <0,05 ; Carbohydrates : 40,8 of which sugars : 4,96 ; Proteins : 11,42 ; Fibers : 9,85 ; Salt : 1,3
Ingredients	**Nutrition and health claims**
Wheat flour 650, water, mixture of seeds and cereals hydrated in liquid wheat and rye leaven (spelled wheat grains, spelled beans, sunflower seeds, oats, millet, flax seeds, chia seeds), dietary flour wheat, dehydrated leaven of wheat and durum wheat, iodized salt, wheat gluten, yeast, wheat bran, potato flakes, ascorbic acid	Fiber source

b29. Product name: WHOLEMEAL BREAD / PÂINE INTEGRALĂ – PAMBAC

Wholemeal bread is a bread made from dietary wheat flour (whole wheat flour), being a bread with a high fiber content and a special taste.

	Nutritional value
	Per 100 g product: Energetic value: 1010 kJ / 239 kcal Fats:1,3 g of which saturated fatty acids - 0,5 g; Carbohydrates: 42,8 g of which sugars1,6 g Fibers: 7,2 g Proteins: 10,4 g Salt: 1,19 g
Ingredients	**Nutrition and health claims**
Dietary wheat flour (whole wheat) 51%, white wheat flour 650, water, wheat wheat vital gluten, baking yeast, sunflower vegetable oil, iodized salt, bakery enhancer	Rich in fibers

[wheat wheat gluten, emulsifier: esters of mono and diacetyltartaric acids with mono and diglycerides of fatty acids, white wheat flour 650, technological adjuvants (wheat), flour treatment agents: ascorbic acid, L-cysteine], preservatives: calcium propionate and sorbic acid, wine vinegar.	

b30. Product name: <u>BREAD WITH WHEAT GERM AND PUMPKIN SEEDS / PÂINE CU GERMENI DE GRÂU ȘI SEMINȚE DE DOVLEAC</u> – PAMBAC S.A.

Wheat germ and pumpkin seed bread is a bread made from black wheat flour and 650 white wheat flour, wheat germ, pumpkin seeds, rye grains and buckwheat. It is a bread with a high fiber content.

	Nutritional value
	<u>Per 100 g product:</u> Energetic value: 1012 kJ / 240 kcal Fats: 3,5 g; of which saturated fatty acids 0,8 g; Carbohydrates: 37,6 g of which sugars: 1,8 g Fibers: 7,9 g Proteins: 10,6 g Salt: 1,4 g
Ingredients	**Nutrition and health claims**
Black wheat flour, 650 white wheat flour, water, rye and buckwheat grains hydrated and infused in rye leaven [pasteurized rye leaven, rye and buckwheat grains, iodized salt, preservative: potassium sorbate], pumpkin seed kernels 4%, vital wheat gluten, wheat germ 2%, baking yeast, iodized salt, baking enhancer [vital wheat gluten, emulsifier: mono and diacetyltartaric acid esters with mono and diglycerides of fatty acids, black wheat flour, technological adjuvants (wheat), flour treatment agents: ascorbic acid, L-cysteine], preservatives: calcium propionate, sorbic acid, wine vinegar.	Rich in fibers

b31. Product name: <u>BREAD WITH WHEAT BRAN / PÂINE CU TĂRÂȚE DE GRÂU</u> – PAMBAC S.A.

Wheat bran bread is a bread made from dietary wheat flour, 650 white wheat flour and with the addition of wheat bran, being a bread with a high fiber content.

	Nutritional value
	<u>Per 100 g product:</u> Energetic value: 956 kJ / 227 kcal Fats: 2,5 g; of which saturated fatty acids - 0,4 g; Carbohydrates: 36,8 g of which sugars: 1,5 g Fibers: 9,3 g Proteins: 9,6 g Salt: 1,06 g
Ingredients	**Nutrition and health claims**
Dietary wheat flour (whole wheat flour), white wheat flour 650, wheat bran (3%), water, vital wheat gluten, baking yeast, iodized salt, sunflower vegetable oil, baking enhancer [vital gluten from wheat, emulsifier: esters of mono and diacetyltartaric acids with mono and diglycerides of fatty acids, white wheat flour 650, technological adjuvants (wheat), flour treatment agents: ascorbic acid, L-cysteine], preservatives: calcium propionate and acid sorbic, wine vinegar.	Rich in fibers

b32. Product name: <u>BLACK BREAD / PÂINE NEAGRĂ</u> – PAMBAC S.A.

Black bread is a bread made only from black wheat flour, being a bread with a special taste and a source of fiber.

	Nutritional value
	Per 100 g produs: Energetic value: 988 kJ / 233 kcal Fats: 0,9 g; of which saturated fatty acids - 0,5 g; Carbohydrates: 45 g; of which sugars 2,3 g Fibers: 5,6 g Proteins: 8,5 g Salt: 1,08 g
Ingredients	**Nutrition and health claims**
63% black wheat flour, water, baking yeast, iodized salt, baking improver (wheat wheat vital gluten, emulsifier: mono and diacetyltartaric acid esters with mono and diglycerides of fatty acids, black wheat flour, technological adjuvants) , flour treatment agents: ascorbic acid, L-cysteine], preservatives: calcium propionate and sorbic acid, wine vinegar.	Fiber source

b33. Product name: BREAD WITH RYE FLOUR AND SEEDS / PÂINE CU FĂINĂ DE SECARĂ ȘI SEMINȚE – PAMBAC S.A.

Bread with rye flour and seeds is a bread made with rye flour and white wheat flour 650, with sunflower seeds, sesame, flax, millet. It is a product rich in fiber and with a special taste.

	Nutritional value
	Per 100 g product: Energetic value: 1015 kJ / 240 kcal Fats: 2,2 g of which saturated fatty acids: 0,7 g Carbohydrates: 42,3 g of which sugars:1,6 g Fibers: 7,3 g Proteins: 9,2 g Salt: 1,4 g

Ingredients	Nutrition and health claims
White wheat flour 650, rye flour 22%, water, premix with rye flour and seeds 7% [rye flour 41%, sunflower seeds 16%, buckwheat 9%, sesame seeds 9%, malt flour (barley), millet seeds 4%, flax seeds 3%, dehydrated natural wheat leaven (fermented wheat flour and salt), dextrose], vital wheat gluten, baking yeast, decoration mix seeds 2% (flakes : wheat, oats, rye, flax seeds 10%, sunflower seeds 10%, sesame seeds 10%), sunflower vegetable oil, iodized salt, baking enhancer (vital wheat gluten, emulsifier: acid esters mono and diacetyltartaric with mono and diglycerides of fatty acids, white wheat flour 650, technological adjuvants (wheat), flour treatment agents: ascorbic acid, L-cysteine], preservatives: calcium propionate, sorbic acid, wine vinegar.	Rich in fibers

b34. Product name: BREAD WITH BLACK WHEAT FLOUR – PAMBAC / PÂINE CU FĂINĂ DE GRÂU NEAGRĂ – PAMBAC S.A.

Black wheat flour bread is a bread made from black wheat flour, 650 white wheat flour and dietary wheat flour, it is a source of fiber.

	**Nutritional value**
	Per 100 g product: Energetic value: 937 kJ / 221 kcal Fats: 0,6 g of which saturated fatty acids: 0,4 g Carbohydrates: 41,4 g; of which sugars: 3,5 g Fibers: 5,8 g Proteins: 9,7 g Salt: 0,84 g
Ingredients	**Nutrition and health claims**
Black wheat flour 43%, white wheat flour 650, dietary wheat flour (whole wheat flour), water, baking yeast, baking improver [wheat wheat vital gluten, emulsifier: esters of mono and diacetyltartaric acids with mono and diglycerides fats, black wheat flour,	Fiber source

processing aids (wheat), flour treatment agents: ascorbic acid, L-cysteine], iodized salt, preservatives: calcium propionate and sorbic acid, wine vinegar.	

b35. Product name: <u>BUNS WITH CHIA SEEDS / CHIFLE CU SEMINȚE CHIA,</u> 100 G – HARMOPAN S.A.

Buns Chia Seeds 100 g is obtained from leavened dough with the addition of Chia seeds.

Chia seeds have a number of beneficial physiological effects: they absorb a large amount of water and increase in the stomach, thus increasing the feeling of saturation, so it can be a useful supplement in the case of a diet.

	Nutritional value
	<u>Per 100 g produs:</u> Energetic value: 1127 kJ/267 kcal Fats: 5,2 g of which saturated fatty acids: 1 g; Glucids: 44 g of which sugars: 1,7 g Proteins: 11 g Salt: 1,3 g
Ingredients	**Nutrition and health claims**
White wheat flour (contains gluten), Rex Chia premix (wheat flour, sunflower seeds, chia, pumpkin and flax, wheat gluten, wheat wheat dough, tomato powder, mashed potato flakes, emulsifiers: E 471, E 472e; wheat flour from wheat, sugar, thickener; guar gum, wheat fiber, barley malt extract, tapioca starch, spices, flour treatment agent: ascorbic acid, enzymes) , water, iodized salt, yeast, flour treatment agent (wheat flour, emulsifier E 472e, flour treatment agent: ascorbic acid, enzymes)	-

b36. Product name: <u>BLACK BREAD WITH WHEAT BRAN / PÂINE NEAGRĂ CU TĂRÂȚĂ DE GRÂU,</u> 800 G – HARMOPAN S.A.

The product Black bread with wheat bran 800 g is obtained from black wheat flour 1100, wheat bran, water, yeast, salt and mayonnaise. The brown color of

the bread is due to the wheat bran. Edible wheat bran: contains wheat husk and some wheat germ, has a higher granularity than flour. It is high in minerals, vitamins and dietary fiber. A significant part of the fiber content is not digestible, but it is useful for the human body, has a good effect on metabolic processes, helps digestion, reduces the feeling of hunger, and can be a supplement to a diet.

	Nutritional value
	Per 100 g produs: Energetic value: 1019 kJ/240 kcal; Fats: 1,8 g of which saturated fatty acids: 0,3 g Carbohydrates: 46 g of which sugars: 2,1 g Proteins: 10 g Salt: 1,4 g
Ingredients	**Nutrition and health claims**
Black wheat flour, water, wheat bran 7,3%, yeast, iodized salt	

b37. Product name: BLACK BREAD WITH RYE / PÂINE NEAGRĂ DE SECARĂ, 900 G – HARMOPAN S.A.

The product Black Rye Bread 900 g is obtained from 1100 black wheat flour, rye flour, water, salt and yeast. Due to the long maturation (8 hours) of the bread, the bread has an intense taste and aroma, and the core is denser and wetter, specific to rye bread.

The properties of starch in rye flour are different from those of wheat starch: it binds more water, so the product stays fresh for a longer time.

	Nutritional value
	Per 100 g produs: Energetic value: 987 kJ/233 kcal Fats: 1,6 g of which saturated fatty acids: 0,2 g; Carbohydrates: 47 g of which sugars: 2,0 g Proteins: 7,6 g Salt: 1,6 g

Ingredients	Nutrition amnd health claims
Black wheat flour, rye flour 34%, white wheat flour, water, iodized salt, yeast, cumin	

b38. Product name: <u>MAMMA MIA ROLL / CORN MAMMA MIA</u>, 90 G – HARMOPAN S.A.

Corn Mamma Mia 90 g is a product developed in Austria especially for women. The seed mixture used contains: rye meal, soybean meal, malt extract, bran, flax seeds, sunflower seeds, barley flour.

It contains certain amounts of vitamins and minerals that are most often missing from women's diets.

Vitamin D: important in the functioning of the immune system.

Folic acid: can reduce fatigue and is especially important during pregnancy.

Iron: Supports the immune system and the formation of red blood cells.

Calcium: It is especially important for bones and teeth.

Magnesium: makes a significant contribution to the proper functioning of general metabolism and energy, as well as muscle function.

Enjoying a single Mamma Mia horn, a woman provides her body with more than 15% of the recommended dose of vitamin D and 20% of the recommended dose of Calcium, Magnesium and Iron.

Mamma Mia corn is rich in dietary fiber - more than 6%.

Corn contains valuable grains such as crushed wheat grains, rye flour, and a variety of oil-rich seeds, such as sunflower, sesame, and flax.

Mamma Mia has a pleasant, balanced taste, is deliciously juicy and is a real royal palette thanks to the sunflower and sesame seeds that cover it.

Nutritional value
<u>Per 100 g produs:</u> Energetic value: 1209 kJ/287 kcal; Fats: 7,4 g of which saturated fatty acids: 1 g; Carbohydrates: 44 g of which sugars: 2,6 g; Proteins: 11 g; Salt: 1,5 g

Ingredients	Nutrition and health claims
White wheat flour (contains gluten), water, Mamma Mia premix (wheat (white flour, meal, bran, malt meal, gluten, fiber), flax seeds, sunflower seeds, rye (meal, dry acid dough) , soybeans (wheat, flour) barley (malt extract, malt flour), vitamin-mineral mixture (calcium carbonate, maltodextrin, magnesium oxide, iron phosphate, vitamin D3, folic acid), sugar, emulsifiers: E472e, rapeseed lecithin; stabilizers: carboxymethylcellulose, xanthan gum; anti-caking agent: calcium phosphate, flour treatment agent: ascorbic acid, enzymes] 22%, sesame seeds, sunflower seeds, yeast	-

c) products with reduced content of glucids and salt

c1. Product name: <u>HYPOGLUCIDIC BREAD / PÂINE HIPOGLUCIDICĂ</u> – PAMBAC S.A.

Hypoglucidic bread is a bread made with a special recipe in order to obtain a low carbohydrate content.

	**Nutritional value**
	<u>Per 100 g product</u> Energetic value: 1082 kJ / 257 kcal Fats: 3,6 g; of which saturated fatty acids :1,1 g Carbohydrates: 33,6 g of which sugars - 2,9 g Fibers: 8,1 g Proteins: 18,4 g Salt: 0,87 g
Ingredients	**Nutrition and health claims**
Semi-white wheat flour, wheat bran, vital wheat gluten, white wheat flour 650, water, baking yeast, vegetable fat (vegetable oils of palm, sunflower and coconut, water, emulsifier: mono and diglycerides of fatty acids, salt and flavor), iodized salt, cumin	Low carbohydrate content

seeds, preservative: calcium propionate and sorbic acid.	

c2. Product name: <u>WHITE BREAD WITH LOW SALT CONTENT/ PÂINE ALBĂ CU CONȚINUT SCĂZUT DE SARE</u> – PAMBAC S.A.

Low-salt white bread is a bread made from 650 white wheat flour and no iodized salt is added to the recipe.

The salt content is due exclusively to the natural presence of sodium in the ingredients.

	Nutritional value
	<u>Per 100 g product</u> Energetic value 1013 kJ / 239 kcal Fats: 1,1 g; Of which saturated fatty acids: 0,3 g; Carbohydrates: 48,5 g; of which sugars: 1,3 g Fibers: 0,8 g Proteins: 8,3 g Salt: 0,025 g
Ingredients	**Nutrition and health claims**
White wheat flour 650 (67%), water, baking yeast, baking improver [wheat vital gluten, emulsifier: esters of mono and diacetyltartaric acids with mono and diglycerides of fatty acids, white wheat flour 650, technological adjuvants (wheat), flour treatment agents: ascorbic acid, L-cysteine], preservatives: calcium propionate and sorbic acid.	Reduced salt content

c3. Product name: <u>WHOLEMEAL BREAD WITH LOW SALT CONTENT / PÂINE INTEGRALĂ CU CONȚINUT SCĂZUT DE SARE</u> - PAMBAC

Wholemeal bread with low salt content is a bread made with dietary wheat flour and white wheat flour 650 and no iodized salt is added to the manufacturing recipe.

The salt content is due exclusively to the natural presence of sodium in the ingredients.

	Nutritional value
	Per 100 g product Energetic value: 1171 kJ / 277 kcal Fats: 3,5 g Of which saturated fatty acids – 0,7 g Carbohydrates: 47,1 g of which sugars: 1,8 g Fibers: 5,7 g Proteins: 11,5 g Salt: 0,033 g
Ingredients	**Nutrition and health claims**
Dietary wheat flour (52%), white wheat flour 650, water, baking yeast, wheat vital gluten, sunflower vegetable oil, baking enhancer [wheat wheat gluten, emulsifier: mono and diacetyltartaric acid esters with mono and diglycerides of fatty acids, white wheat flour 650, technological adjuvants (wheat), flour treatment agents: ascorbic acid, L-cysteine], preservative: calcium propionate.	Low salt content

c4. Product name: WHITE BREAD WITHOUT SALT / PÂINE ALBĂ FĂRĂ SARE – PANIMON S.A.

✓ Natural bread, without the addition of additives, molded according to the recipe with natural leaven by the three-phase method.

✓ Advantage - suitable for people with high blood pressure.

✓ General exterior - Long bagel shape, with oblique notches, specific to the assortment, well developed, not flattened

✓ Peel - Smooth, without cracks, glossy, golden yellow or slightly reddish golden brown

✓ Core - Table with uniform pores, elastic consistency (after a light pressure, it returns to its original state), without lumps or traces of unpasteurized flour.

	**Nutritional value**
	Per 100 g product Energetic value: 218kcal/911kJ Fats: 0,24g of which saturated fatty acids: 0,04g Carbohydrates: 45,34g of which sugars: 0,8g Proteins: 9,54g Fibers: 2,04g Salt: naturally present 0,002g
Ingredients	**Nutrition and health claims**
white wheat flour 650, min. 40% leaven (650 white wheat flour, water, baking yeast), baking enhancers (Clean Label): 650 white wheat flour, enzymes.	

c5. Product name: BREAD WITHOUT ADDED SALT, SLICED/ PÂINE FĂRĂ ADAOS DE SARE, FELIATĂ – VELROM S.A.

White wheat flour bread, without added salt, sliced, 300g.

	**Nutritional value**
	Per 100 g product Energetic value: 938 kJ/221 kcal Fats: 0,43 g Of which saturated fatty acids - 0,08 g Carbohydrates: 45,2 g of which sugars - 4,12 g Fibers: 1,97 g Proteins: 8,11 g Salt: 0.16 g
Ingredients	**Nutrition and health claims**
White wheat flour type 650, water, yeast, wine vinegar.	Notification of MoH regarding: registration of the nutrition claim "no salt added". The product appears in the National Register of nutritional and health claims entered on foodstuffs

2.3.2 Functional bakery products in Ireland

Examples of functional products from Ireland:

1. Product name: FAMILY PAN PREMIUM WHITE BREAD

Brennans Family Pan Premium White Bread has been repackaged in an 800g pack with a limited edition design for St Patrick's Day 2020.- 1st in quality, freshness and taste- Low fat- No added sugar- Made from the finest ingredients and baked with special care, it comes hot from the manufacturer's ovens to reach each shelf within hours- Suitable for home freezing- Suitable for vegetarians- Suitable for vegans- Logos and certifications: Guaranteed Irish

	Nutritional value
	Per 100g product: Energetic value: 920kJ/219kcal Fat: 1,4g (of which saturates 0,4g) Carbohydrate: 43g (of which sugars 2,42g) Fibres: 2,8g Protein: 8,7g Salt: 1,1g
Ingredients	**Nutrition and health claims**
Wheat Flour (Wheat, Calcium Carbonate, Iron, Vitamin B1, Niacin), Waters, Yeast, Salt, Soybean Flour, Diacetyltartaric And Fatty Acid Esters Of Glycerol (Emulsifiers), Palm Fat (Sustainable, RSPO-certified, Palm Derived), Vitamin C (Food Acids, Treatment Agent, Flour Treatment Agents), Rapeseed Oil (Rapeseed Derived)	Low/No/Reduced Fat Vegetarian Premium Seasonal Vegan/No Animal Ingredients Limited Edition, No Added Sugar

2. Product name: DUNNES STORES THICK CUT CHEESE & GARLIC BAGUETTE SLICES

Dunnes Stores Thick Cut Cheese & Garlic Baguette Slices are now available.

The product is described as crusty white part baked baguette slices with garlic and parsley filling made with butter and margarine, and topped with mozzarella and extra mature cheddar cheese.

It is suitable for vegetarians, is free from hydrogenated fat, artificial colours, flavours and preservatives.

The baguette slices can be ready in 12 minutes, and retail in a 295g pack containing nine units, and featuring cooking instructions.

	Nutritional value
	Per 100g product: Energetic value: 1,603kJ/383kcal Fat: 20g (of which Saturated Fat 6,6g) Carbohydrates: 40g (of which Sugars 2,6g) Fibres: 1,4g Protein: 11g Salt: 0,98g
Ingredients	**Nutrition and health claims**
Baguette (Slices) (Wheat Flour (Fortified, Fortification) (Wheat Flour, Calcium Carbonate, Iron, Niacin, Vitamin B1), Waters, Yeast, Salt, Vitamin C (Food Acids, Treatment Agent, Flour Treatment Agents), Parsley Garlic (Filled) (Unsalted Butter (Unsalted), Margarine (Rapeseed Oil (Rapeseed Derived), Palm Oil (Palm Oil Derived), Waters, Salt, Mono- and Di-glycerides of Fatty Acids (Emulsifiers, Food Acids, Fatty), Flavouring Substances, Carotenes (Food Colours)), Garlic Puree (Puree), Parsley, Salt, Lemon Juice (Made From Concentrate))), Cheddar Cheese (Extra Mature), Mozzarella Cheese	No Additives/Preservatives Vegetarian Low/No/Reduced Transfat

3. Product name: CRUSTY GARLIC TIGER BAGUETTE

Dunnes Stores Crusty Garlic Tiger Baguette comprises a part baked white bloomer baguette with tiger crust and a garlic and parsley filling made with butter and margarine.

The vegetarian product can be ready in 25 minutes, is free from artificial colours, flavours, preservatives and hydrogenated fat. It retails in a 300g pack.

	Nutritional value
	Per 31g serving (9 servings per pack): Energetic value: 491kJ/117kcal (6% RDA) Fat: 5,9g (8% RDA) (of which Saturates

	2,4g (12% RDA)) Carbohydrates: 14g (of which Sugars 1g (1% RDA)) Fibres: 0,7g Protein: 2,4g Salt: 0,27g (5% RDA)
Ingredients	**Nutrition and health claims**
white baguette (78%) (Wheat Flour (Fortified, Fortification) (Wheat Flour, Calcium Carbonate, Iron, Niacin, Vitamin B1), Waters, Palm Oil (Palm Oil Derived), Yeast, Salt, Vitamin C (Food Acids, Treatment Agent, Flour Treatment Agents)), Parsley Garlic (Filled) (Unsalted Butter (Unsalted), Margarine (Rapeseed Oil (Rapeseed Derived), Palm Oil (Palm Oil Derived), Waters, Salt, emulsifier (Mono- and Di-glycerides of Fatty Acids (Food Acids, Fatty), Flavouring Substances, Carotenes (Food Colours)), Garlic Puree (Puree), Garlic Powder (Powdered), Parsley, Salt, Onion Powder (Powdered), garlic flavoured olive oil (Olive Oil (Olive Oil Derived), Flavouring Substances)), tiger style topping (2%) (Rapeseed Oil (Rapeseed Derived), Palm Oil (Palm Oil Derived), Wheat Flour (Fortified, Fortification) (Wheat Flour, Calcium Carbonate, Iron, Niacin, Vitamin B1), flour treatment agents (Vitamin C (Food Acids), L-cysteine), Barley Malt Extract (Extract), Diphosphates (Stabilizers)), Barley Malt Extract (Extract))	No Additives/Preservatives Vegetarian Low/No/Reduced Transfat

2.3.3. Functional bakery products in Hungary

In the baking industry, continuous development of products is required because consumers with different nutritional needs are pushing for new requirements for foods.

Along with the low caloric content, there is growing attention to the functional effects of foods. Foods for particular nutritional uses, as a result of their special composition and the special procedure used to product them, meet the specified nutritional purposes.
In case of bakery products, a series of functional food products including biscuits, cereal, cereal bars and beverages has launched in recent years.
In the case of bakery product development, the main trends are:

- allergen-free products,
- enriched products,
- products with reduced content (Szabó P. Balázs 2017).

In the development of functional bakery products (including bread), it is important to realize that achieving functional food quality does not simply involve delivering the active principle at the appropriate level for physiological effectiveness, but also supplying a product which meets the consumer's requirements in terms of appearance, taste and texture (Alldrick, A. J. 2007).

a. Allergen-free products

Allergens are all substances, products that cause an allergic reaction in our body. When manufacturing allergen-free bakery products, the amount of gluten as an allergen is reduced to the minimum available level. Gluten is a complex form of flour's water insoluble proteins, gliadin and glutenin. Product is defined as "gluten-free" in case the gluten content does not exceed 20 ppm or is called "gluten-reduced" for products with a gluten content not exceeding 100 ppm. Allergenic baking products are mainly designed for the needs of gluten-sensitive or celiac consumers. In both cases, the symptoms are similar, but more severe in the case of celiac disease (https://glutenerzekeny.hu/akkor-mitol-puffadok-gabonaallergia-glutenerzekenyseg-coliakia/)
During the disease, small intestine is damaged, resulting in diarrhea, abdominal distension, weight loss, digestive and nutritional abnormalities. In the latter case, the disorder of absorption of fat-soluble vitamins, bone metabolism disorder, and anemia occur.
Gluten sensitivity, also known as gluten intolerance, often occurs after a digestive disorder, during which the permeability of the intestinal wall increases, so a certain amount of gluten is no longer tolerated (https://glutenerzekeny.hu/akkor-mitol-puffadok-gabonaallergia-glutenerzekenyseg-coliakia/)
Gluten sensitivity can be treated with individualized gluten-free diet. Celiac disease, also known as gluten-sensitive enteropathy, is a multifactorial autoimmune response in which antibodies are produced against cereal gluten proteins and mainly involve gastrointestinal symptoms and nutrient absorption

disorders (https://glutenerzekeny.hu/akkor-mitol-puffadok-gabonaallergia-glutenerzekenyseg-coliakia/).
Celiac disease cannot be cured, but the intestinal flora can be remedied by specially tailored gluten-free diet to treat the symptoms.
In allergen-free baking products, wheat and rye flour are replaced by flour of soy, maize, rice and other grains (https://glutenerzekeny.hu/mit-ehet-es-mit-nem-egy-glutenerzekenyosszefoglalo-tablazat/)

- **Gluten-free bakery products**

a1. Product name: **SPAR FREE FROM SZELETELT GLUTÉN- ÉS LAKTÓZMENTES KENYÉR, 200 g**

Gluten and lactose free sliced bread.

	**Nutritional value**
	Per 100 g product (roll with seeds/ white roll): Energetic value: 1021 KJ/243 kcal Fat: 5,7 g (of which saturated fat 0,76 g) Carbohydrates: 41,2 g (of which sugars 1,95 g) Protein: 1,9 g Fiber: 9,7 g Salt: 1,1 g
Ingredients	**Nutrition and health claims**
Potato starch, water, rye flour, refined oil (soy, sunflower, rape), bamboo fiber, glair, yeast.	gluten free lactose free rich in dietary fibers

a2. Product name: **SPAR FREE FROM KENYÉR MIX GLUTÉNMENTES & LAKTÓZMENTES SZELETELT KENYÉR** 10 x 50 g (500g)

Gluten and lactose free sliced bread.

	**Nutritional value**
	Per 100 g product (roll with seeds/ white roll): Energetic value: 883 KJ/209 kcal Fat: 3,7 g (of which saturated fat 0,5 g) Carbohydrates: 35 g (of which sugars 1,2 g) Protein: 6,2 g Fiber: 4,3 g Salt: 0,95 g

Ingredients	Nutrition and health claims
Sunflower seeds, rice flour, millet, corn grist, linseed, buckwheat flour, yeast.	gluten free lactose free

a3. Product name: **SPAR FREE FROM GYORSFAGYASZTOTT KÉSZRE SÜTÖTT GLUTÉNMENTES BAGETT**, 2 db, 200g

Quick-forzen baked gluten free baguette.

	**Nutritional value**
	Per 100 g product (roll with seeds/ white roll): Energetic value: 1103 KJ/261 kcal Fat: 3,3 g (of which saturated fat 0,5 g) Carbohydrates: 54 g (of which sugars 3,2 g) Protein: 3,2 g Fiber: 2,1 g Salt: 1,9 g
Ingredients	**Nutrition and health claims**
Rice flour, starch, sugar, sunflower oil, fibers (potate, psyllium husk), yeast.	gluten free

a4. Product name: **TOAST BREAD (SLICED)**

Gluten free white bread with seeds, and fibers, sliced.

	**Nutritional value**
	Per 100 g product: Energetic value: 1034 KJ/247 kcal Fat: 7.7 g (of which saturated fat 0.8 g) Carbohydrates: 52 g (of which sugars 5 g) Fibers: 12 g Protein: 6 g Salt: 1.2 g
Ingredients	**Nutrition and health claims**
Water, Corn starch, Yeast (rice flour, water), seed mix (sunflower, linseed, *Salvia hispanica* seed), quinoa seed, rice	gluten-free rich in fiber

starch, invert sugar syrup, quinoa flour, rapeseed oil, soy protein, glycerin, dextrose, salt, thickeners (guar gum, xanthane gum, hydroxypropyl cellulose), *Psyllium* husk fiber, potato fiber	

a5. Product name: WHITE BREAD (WITH OR WITHOUT SEEDS)

Gluten free white bread and white bread with seeds.

	Nutritional value
	Per 100 g product (bread with seeds/ white bread): Energetic value: 1034 KJ/249 kcal/ 1008 KJ/239 kcal Fat: 2,7 g (of which saturated fat 0,3 g)/ 9,3 g (of which saturated fat 1 g) Carbohydrates: 44,8 g (of which sugars 3 g)/ 29,7 g (of which sugars 1,3 g) Protein: 7,2 g/ 6,4 g Salt: 2,1 g/ 1,14 g
Ingredients	**Nutrition and health claims**
Bread with seeds: Corn starch, linseed, sunflower seed, soy protein, thickeners (E415, E464), rice flour, sugar, *Psyllium* husk fiber, dried yeast, salt, acidifier, water, sunflower oil, preservative **White bread:** Corn starch, rice flour, soy protein, thickeners (E415, E464), sugar, psyllium husk fiber, salt, dextrose, sugar syrup, linseed, yeast, acidifier (E262), water, sunflower oil, preservative (potassium sorbate)	Gluten free Lactose free

a6. Product name: WHITE BREAD ROLL

Gluten free white bread roll and roll with seeds.

	Nutritional value
	Per 100 g product (roll with seeds/ white roll): Energetic value: 1152 KJ/274 kcal/ 1052 KJ/248 kcal Fat: 8,9 g (of which saturated fat 0,9 g)/ 2,2 g (of which saturated fat 0,3 g) Carbohydrates: 39 g (of which sugars 3,4 g)/ 54,8 g (of which sugars 3,5 g) Protein: 1 g Salt: 1,46 g/ 1,53 g
Ingredients	**Nutrition and health claims**
Roll with seeds: Corn starch, linseed, sunflower seed, soy protein, thickeners (E415, E464, E412), rice flour, sugar, psyllium husk, yeast, inulin, dextrose, coloring agaent (E150a), stewed, ground lens, maltodextrin, salt, acidifier (E262), water, sunflower oil, preservative (potassium sorbate) **White roll:** potato starch, rice strach, thickeners (E415, E464, E412), sugar, psyllium husk, rapeseed oil, yeast, salt, stewed and ground lens, acidifier (E262), water, sunflower oil, preservative (potassium sorbate)	gluten free lactose free

• Lidl supermarket - "Free from" product line
a7. Product name: <u>SLICED BREAD</u>

White and multigrain bread, sliced.

	Nutritional value
	Per 100 g product (white bread/ multigrain bread): Energetic value: 951 KJ/226 kcal/1129 KJ/263 kcal Fat: 3,6 g (of which saturated fat 0,4 g)/ 9,5 g (of which saturated fat 1,1 g) Carbohydrates: 39 g (of which sugars 1,2 g)/ 36 g (of which sugars 2,6 g)

	Fiber: 8,3 g/ 77,3 g Protein: 5 g/ 6,3 g Salt: 1,4 g/ 1,2 g
Ingredients	**Nutrition and health claims**
White bread: Water, rice flour, sourgough (rice flour, buckwheat flour), corn starch, rice starch, invert sugar syrup, millet flour, rapeseed oil, psyllium husk, potato fiber, soy protein, glucose, salt, yeast, thickeners (guar gum, xanthan gum) **Multigrain bread:** Water, rice flour, sourgough (rice flour, buckwheat flour), corn starch, oily seeds (sunflower seed, linseed, pumpkin seed), rice starch, invert sugar syrup, millet flour, rapeseed oil, psyllium husk, potato fiber, soy protein, glucose, salt, yeast, thickeners (guar gum, xanthan gum)	gluten free

- **Lactose free bakery product**

a8. Product name: **SPAR VITAL LAKTÓZMENTES TOAST KENYÉR**
Lactose free toast bread.

	Nutritional value
	Per 100 g product (roll with seeds/ white roll): Energetic value: 1108 KJ/262 kcal Fat: 3,4 g (of which saturated fat 0,8 g) Carbohydrates: 46 g (of which sugars 2,8 g) Protein: 9,4 g Fiber: 5,1 g Salt: 1,2 g
Ingredients	**Nutrition and health claims**
Wheat flour, rye flour, yeast, sunflower oil, olive oil, dried rye sourdough, soy lecithin, malted wheat flour.	Lactose free

b. Enriched products
Enriched bakery products are, overall, functional foods that have proven beneficial health effects along with their basic nutritional effects. It is important

during nutrition that the process does not affect the basic organoleptic properties of the product (Dr.MarkovicsErzsébet 2007).

For baked goods, basic nutrients (e.g. proteins, carbohydrates), auxiliary nutrients (e.g. vitamins, minerals), and accompanying substances (e.g. fibers) are added to the food to increase nutrition.

b1. Vitamin-enriched products

Vitamins are vital biological compounds that are essential for the body (https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx).

By vitamin enrichment, the amount of vitamins, essential to the human body in that food, is increased. For baking products, vitamins B, such as vitamins B1, B2, B3, B6 and B9 are added. B-complexes are most commonly used for this purpose (Dr.MarkovicsErzsébet (2007). Determination the right dosage ratio for vitamin is a complicated task, due to the recommended daily value, stability of the vitamin, and the vitamin loss during storage. On the basis of practical experiences, it can be stated that these vitamins generally require a 10–20% additional dose that the product contains the intended quantity up to the shelf-life (Dr.MarkovicsErzsébet (2007). The amount of added vitamin is generally low, so it is advisable to mix and disperse the dough with a carrier such as starch and sucrose. In the technology, it must be borne in mind that the vitamins are highly reactive and therefore unstable, furthermore certain vitamins have characteristic organoleptic properties and possibel side effects (Dr.MarkovicsErzsébet (2007).

b2. Products enriched with minerals

Minerals in our body promote the proper functioning of enzymes and stimuli transmission processes. Baking products are often enriched with minerals such as Fe, Ca and P. The essential amount of iron in human is small but evitable for hemoglobin, cytochrome, peroxidase and catalase enzymes (https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx)

The daily intake of Ca and P is 800 mg, which is the highest of the minerals (Dr. Markovics Erzsébet (2007). The Ca: P ratio is optimally 1: 2 (Dr. habil Fenyvessy József, Jankóné dr. Forgács Judit (2000).

The dosage levels of minerals apply to the same rules as for the enrichment with vitamins.

b3. Protein-enriched products

Proteins are our basic building materials, help to water catchment, nutrient transfer, participate in metabolic processes, and are important energy source (Dr. habil Fenyvessy József, Jankóné dr. Forgács Judit (2000).

The appearance of protein-enriched products among bakery products is nowadays extremely fashionable and necessary. Most of the plant-derived proteins are not complete because the amino acids essential to the human body

are less or absent, so their exclusive consumption causes deficiency disease (Dr. Markovics Erzsébet (2007). To prevent this, more and more often, technological processes are used to complete the protein content of the products. Completion may be carried out with amino acid preparations or with natural proteins having a favorable amino acid set-up, most often preferring the latter (https://glutenerzekeny.hu/mit-ehet-es-mit-nem-egy-glutenerzekenyosszefoglalo-tablazat/)

As a plant-derived supplementary additive, mainly different soy preparations are used, as it contains lysine and threonine (Dr. Markovics Erzsébet (2007).

Most commonly, milk protein is used as an animal supplement, but in other experiments, blood serum protein is also being dosed.

The biological value of baking products can be further increased by using whole eggs in the product because the nutritional value determined on the basis of the protein content and the amino acid composition is the highest among all foods besides breast milk.

It should be noted that by increasing the content of the protein, the carbohydrate content is reduced.

b4. Carbohydrate-enriched products

Carbohydrates, including mono- and disaccharides, are an important source of energy for our body system due to their easy and fast digestibility (https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx).The enrichment of bakery products with carbohydrates is of great importance in patient nutrition and in the feeding of phenylketonuric patients. During exercise, carbohydrates are source of rapid energy utilization.

Phenylketonuria (PKU) is a genetically inherited disease in which phenylalanine, an essential amino acid dissociating phenylalanine hydroxylase enzyme, is absent, resulting in the amino acid accumulating in the blood and then in the brain, causing severe and often irreversible brain damage (https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx).The disease currently has no cure, only further damage can be avoided. Because of brain damage due to disease, carbohydrate-enhanced foods have a higher glucose content in the brain's energy needs.

b5. Fiber-enriched products

Food fibers (e.g. cellulose, hemicellulose, pectin, and other stored polysaccharides) are complex, non-digestible carbohydrates. Digestion of cellulose in high fiber-content foods helps to intensify the intestinal movement, thereby reducing the time it takes to pass through the intestinal tract. The fibers are useful in prevention of several diseases and abnormal conditions. The blood cholesterol levels might be reduced, blood glucose stabilized, and some fibers play significant role in colon cancer prevention, obesity and constipation

(https://www.news-medical.net/health/What-is-Phenylketonuria-(PKU).aspx).As a result, fiber intake is essential for the body in order to facilitate its normal operation. To support balanced nutrition, fiber-enriched products have appeared in the baking industry. Due to their high fiber content and their economics, apples and oats are used most often to increase fiber content. The technology must take into account that the use of dietary fibers affects the water absorption capacity of the dough.

c. Products with reduced content of carbohydrates, salt and fat

Foods with reduced content are functional foods in which a quantitative reduction of substances with excessive intake has a detrimental effect on health. In the baking industry carbohydrate-reduced, salt-reduced or low-fat foods have appeared for this purpose.

- **Carbohydrate-reduced products**

Carbohydrate-reduced products are favored primarily by consumers with carbohydrate metabolism problems, but dieters also prefer it.

The most severe form of carbohydrate metabolism disorder is diabetes, where we distinguish between type 1 and type 2 (https://cukorbetegseg-inzulin.hu/cukorbetegseg-fajtai). Insulin, produced by the pancreas in the body, helps integrate glucose units from the blood plasma into cells. As blood glucose levels decrease, the release of insulin is also reduced. The normal range of blood glucose levels is provided by the liver. In the case of diabetes, this process does not function properly, therefore the sugar accumulates in the blood. In the case of Type 1 diabetes, the pancreas does not produce enough insulin to maintain normal blood glucose levels, while Type 2 diabetes causes cells to become resistant to insulin (https://cukorbetegseg-inzulin.hu/cukorbetegseg-fajtai).

Type 1 is presumably due to genetic predisposition, so it cannot be cured and can only be treated.

By contrast, type 2 diabetes is triggered by some other disease and risk factors, thus it can be cured by resolving diabetes-causing health issues or reducing the risk factors (e.g. obesity). In the latter case, diabetes can be treated with an individualized diet, which limits and minimizes carbohydrate intake.

A carbohydrate-reduced product is considered to be a baking product if carbohydrate-content is lowered at least 30% (Dr. Markovics Erzsébet (2007).

In practice, this is mostly achieved by protein filtration. For technology, it should be taken into account that the quantitative reduction of carbohydrates will have a technofunctional effect and the water absorption capacity of the dough will decrease.

To remedy this, hydrocolloids are used in the industry, such as guar gum, locust bean flour.

- **Salt-reduced products**

Salt reduction has become a national program in Hungary today, with the main purpose of inhibition of excessive salt intake of the population, thus reducing the prevalence of hypertension in the population, thus the risk of stroke and heart attack
(https://www.ogyei.gov.hu/stop_so_nemzeti_socsokkento_program/)
In reducing the sodium chloride content of bakery products, it should be taken into account that the salt has technofunctional properties and it will affect the structure of the dough.

- **Fat-reduced pastries**

Fats provide our body with energy and the essential chemical compounds to maintain the structure of the membranes, building materials for hormones and vitamins (Dr. habil Fenyvessy József, Jankóné dr. Forgács Judit (2000). Excessive intake will accumulate in our body that can lead to obesity and its complications.
To prevent this, today's fashionable fat-reduced products have appeared. In the baking industry, the manufacture of these kinds of products is still in the experimental stage.
In Hungary, the available gluten-free products are belonging to brands Schär, Gullon, Balviten, Cornito, Éden and Mester. The available foods are shortcakes, breads, bread roll, crescent roll, wafer and cookies. Several of them offer in chain stores, such as Aldi, Lidl, Auchan and Tesco.
There are bakeries distributing their products nationwide, e.g. Lipóti, Ceres, Félegyházi.
Among their products mainly whole grain bakery products (bread, raised products) can be found.

c1. Product name TREND+ FITT & WELL (LUDWIG ÉS MENTESI KFT.)

Carbohydrate reduced bread with seeds, sliced.

	Nutritional value
	Per 100 g product (roll with seeds/ white roll): Energetic value: 1184 KJ/285 kcal Fat: 16,8 g (of which saturated fat 2,2 g) Carbohydrates: 6,1 g (of which sugars 2,4 g) Protein: 21,4 g Fiber: 11,8 g Salt: 1,5 g

Ingredients	Nutrition and health claims
Water, Fitt base mixture, linseed, soy flour, sunflower seed, ground soybean, sesame seed, yeast	higher protein and lower carbohydrate content

C2. Product name: PRÍMA PLUSZ (PRÍMAPÉK FINOMPÉKÁRU KFT.)

Carbohydrate reduced bread.

Nutritional value
Per 100 g product (roll with seeds/ white roll): Energetic value: 1099 KJ/262 kcal Fat: 11,4 g (of which saturated fat 1,7 g) Carbohydrates: 14,1 g (of which sugars 1,4 g) Protein: 25 g Salt: 1,4 g

Ingredients	Nutrition and health claims
water, wheat protein, soy, whole grain wheat flour, soy protein concentrate, salt, commeal, malt extract, wheat flour, apple fiber, acidifier (sodium diacetate, E270), linseed, sunflower seed, sesame seed, yeast	higher protein and lower carbohydrate content

c3. Product name: NEW LIFESTYLE (PÉCSVÁRADI ARANYCIPÓ KFT.)

Carbohydrate reduced bread.

Nutritional value
Per 100 g product (roll with seeds/ white roll): Energetic value: 1149 KJ/276 kcal Fat: 15,6 g (of which saturated fat 2,5 g) Carbohydrates: 6 g (of which sugars 1,5 g) Protein: 23 g Fiber: 9,9 g Salt: 1 g

Ingredients	Nutrition and health claims
Water, wheat protein, soy flour, linseed, soy, sunflower seed, yellow linseed, whole grain spelt flour, sesame seed, apple fiber, salt, wheat bran, yeast, spelt sourdough, herbs	carbohydrate reduced

c4. Product name: **PROBODY (LIPÓTI SÜTŐIPARI KFT.)**

Carbohydrated reduced bread.

Nutritional value
Per 100 g product (roll with seeds/ white roll): Energetic value: 1149 KJ/276 kcal Fat: 15,6 g (of which saturated fat 2,5 g) Carbohydrates: 6 g (of which sugars 1,5 g) Protein: 23 g Fiber: 9,9 g Salt: 1,13 g

Ingredients	Nutrition and health claims
Water, premixture, covering seed mixture (linseed, sesame seed, oatmeal, sunflower seed), linseed, sunflower seed, sesame seed, yeast	higher protein and lower carbohydrate content

c5. Product name: **VITA-WELl , 300 g (VITA SÜTŐ KFT.)**

Whole grain bread.

Nutritional value
Per 100 g product (roll with seeds/ white roll): Energetic value: 1019 KJ/242 kcal Fat: 4.2 g Carbohydrates: 32 g Protein: 13.3 g Fiber: 11.9 g Salt: 1.3 g

Ingredients	Nutrition and health claims
Water, wheat flour, flour mix (wheat protein and fiber), fat (palm oil), commeal,	carbohydrate reduced

bulking agents (polydextrose, guar gum, xanthane gum, ascorbic acid, lactic acid), whole grain flour, soy flour, rye flour, corn semolina, sesame seed, salt, yeast, margarine, emulsifiers, colouring agents (carotenoids), thickener, lactic acid, milk powder	

c6. Product name: **<u>LIPÓTI SZÉNHIDRÁTCSÖKKENTETT VEKNI (LIPÓTI SÜTŐIPARI KFT.)</u>**

Carbohydrate reduced bread prepared with sourdough, sliced.

	Nutritional value
	Per 100 g product (roll with seeds/ white roll): Energetic value: 939 KJ/223 kcal Fat: 3,1 g (of which saturated fat 1.4 g) Carbohydrates: 31 g (of which sugars 0,3 g) Protein: 13 g Fiber: 8,4 g Salt: 1,3 g
Ingredients	**Nutrition and health claims**
Water, wheat flour, premixture, yeast, salt	- carbohydrate reduced

c7. Product name: **<u>NORBI UPDATE LOW CARB SZELETELT TOAST KENYÉR</u>**

Carbohydrate reduced bread prepared with sourdough, sliced.

	Nutritional value
	Per 100 g product (roll with seeds/ white roll): Energetic value: 1,178 KJ/282 kcal Fat: 12 g (of which saturated fat 5,4 g) Carbohydrates: 16 g (of which sugars 1,2 g) Protein: 23 g Fiber: 8,8 g Salt: 1,2 g

Ingredients	Nutrition and health claims
Water, wheat flour and gluten, defatted soy flour, dried sourdough, yeast, powdered egg glair, salt	carbohydrate reduced

c8. Product name: **CERES SÜTŐ NEWLINE SZÉNHIDRÁTCSÖKKENTETT TOAST KENYÉR**

Carbohydrate reduced toast bread, sliced.

	Nutritional value
	Per 100 g product (roll with seeds/ white roll): Energetic value: 966 KJ/230 kcal Fat: 4,7 g (of which saturated fat 2,3 g) Carbohydrates: 24 g (of which sugars 0,9 g) Protein: 17 g Fiber: 11 g Salt: 1,3 g
Ingredients	**Nutrition and health claims**
Water, wheat flour and gluten, soy protein extract, oil (palm, sunflower), cornflakes flour, sourdough, rye flour, soy flour, yeast	carbohydrate reduced rich in fibers and proteins

c9. Product name: **CERES SÜTŐ SLIMM TOAST KENYÉR**

Carbohydrate reduced toast bread prepared with sourdough, sliced.

	Nutritional value
	Per 100 g product (roll with seeds/ white roll): Energetic value: 983 KJ/234 kcal Fat: 3,3 g (of which saturated fat 1,1 g) Carbohydrates: 34,4 g (of which sugars 1,8 g) Protein: 10 g Fiber: 8,9 g Salt: 1,4 g

Ingredients	Nutrition and health claims
Wheat flour, corn starch, wheat gluten, yeast, refined sunflower oil, water, sourdough.	Carbohydrate reduced With ingredients contributing better glycemic index Rich in fibers

Table 2.1. Nutritional value of breads with lower carbohydrate content (/100 g)

No	Product name	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (kcal)
1	Trend+ Fitt & Well (350 g)	6,1	21,4	16,8	285
2	New Lifestyle, csökkentett szénhidráttartalmú cipó (300 g)	6	23	15,6	276
3	ProBody (250 g)	6	23	15,6	276
4	Príma Plus kocka (250 g)	10,3	25,8	11,4	250
5	Szénhidrátcsökkentett vekni, (Kanizsa Pékség) (300 g)	8	23,3	16,7	297
6	Vita-Well (300 g)	32	13,3	4,2	242
7	Lipóti szénhidrátcsökkentett vekni (300 g)	31	13	3,1	223

2.3.4 Types of functional products in Italy

Functional baked products produced in Italy includes gluten-free products, high-fiber/low glycemic index products, and low-proteins baked products.
Gluten-Free products (which must be notified to the Ministry of Health) are recommended for people with celiac disease. For review see Gobbetti et al. (2018). Up to now, most of the research available to produce gluten-free bread is based on substituting wheat flour with flours obtained from gluten-free cereals.

Recently patented protocols based on fermentation have been developed by a private company (Giuliani) supported by University's research to produce gluten free bread from wheat flour (Patents No. 9560854 B2 and No. 10240139B2) which led to a marketable wheat flour-based bread for people suffering coeliac disease. (https://giulianipharma.com/en/product/giusto).

a. **Gluten-free baked products** (https://www.giustofarma.com/linea-pane-e-snack-salati/; https://www.schaer.com/it-it/prodotti/pane-sostituti):

a1. Product name: GLUTEN-FREE HOME-STYLE BREAD

Gluten-Free home-style bread recommended for people with celiac disease.

	Nutritional value
	Per 100 g product: Energetic value: 968 kJ/230 kcal Fats: 4,4 g of which saturated: 0,5 g Carbohydrates: 39 g of which sugars: 3,5 g Fibers: 7,4 g Proteins: 4,9 g Salt: 1,2 g
Ingredients	**Nutrition and health claims**
water, sourdough (water, rice flour, lactobacilli), maize starch, buckwheat flour, sunflower oil, rice flour, sorghum flour, vegetable fibres, rice syrup, thickener: hydroxy-propyl methyl cellulose; vegetable protein, salt, sugar, citrus fibres, yeast,	Gluten-Free product recommended for people with celiac disease; Without hydrogenated fats Preservative free Rich in fiber

emulsifiers: mono- and diglycerides of fatty acids.	

https://www.giustofarma.com/prodotto/pane-casareccio/

a2. Product name: GLUTEN-FREE LOAF OF BREAD

Gluten-Free loaf of bread, with long leavening, recommended for people with celiac disease.

	Nutritional value
	Per 100 g product: Energetic value: 1255 kJ / 299 kcal Fats: 8,8 g, of which saturated 1,4 g Carbohydrates: 42 g, of which sugars: 3,4 g Fibers: 9 g Proteins: 8,7 g Salt: 0,84 g
Ingredients	**Nutrition and health claims**
sourdough 48.2% (water, rice flour, maize starch, buckwheat flour, salt, lactic acid bacteria), water, potato starch, maize starch, humectant: glycerol; inulin, sunflower oil, olive oil 3.4%, egg white, soy protein isolate, sugar, yeast, thickener: xanthan gum; glucose-fructose syrup, thickener: guar gum; emulsifiers: soy lecithin, mono- and diacetyl tartaric acid esters of mono- and diglycerides of fatty acids; flavouring, enzyme: alpha-amylase.	Gluten-Free product recommended for people with celiac disease; Without hydrogenated fats. Preservative free. Rich in fiber.

https://www.giustofarma.com/prodotto/pagnottella-delicata/

a3. Product name: GLUTEN-FREE "TARALLI"

Gluten-free "taralli" with fennel seeds, recommended for people with celiac disease.

	Nutritional value
	Per 100 g product: Energetic value: 2234 kJ / 536 kcal Fats: 32 g, of which saturated: 3 g Carbohydrates: 59 g of which sugars: 0,7 g Fibers: 2,9 g Proteins: 1,1 g

	Salt: 2,4 g
Ingredients	**Nutrition and health claims**
white wine 22%, rice flour, potato starch, rice starch, high oleic sunflower oil, maize starch, extra virgin olive oil 3%, fennel seeds 2%, salt, thickener: guar gum; raising powder (raising agents: disodium diphosphate, sodium hydrogen carbonate; maize starch), dextrose, thickener: xanthan gum; emulsifier: sunflower lecithin; natural olive extract 0.01%.	Gluten-Free product recommended for people with celiac disease; Without hydrogenated fats.

https://www.giustofarma.com/prodotto/taralli-al-finocchio-s-g/

a4. Product name: GLUTEN-FREE BREADSTICKS

Gluten-free mini breadsticks, recommended for people with celiac disease.

	Nutritional value
	Per 100 g product: Energetic value: 1774 kJ / 421 kcal Fats: 9,5 g of which saturated: 1,3 g Carbohydrates: 79 g of which sugars: 1,3 g Fibers: 4 g Proteins: 2,8 g Salt: 2,3 g
Ingredients	**Nutrition and health claims**
deglutinated wheat starch, rice flour, extra virgin olive oil 8%, fresh eggs, sugar, psyllium fibre, maize starch, yeast, salt, natural rosemary extract.	Gluten-Free product recommended for people with celiac disease; Without hydrogenated fats.

https://www.giustofarma.com/prodotto/grissini/

a5. Product name: GLUTEN-FREE CROUTONS

Gluten-free croutons recommended for people with celiac disease.

	Nutritional value
	Per 100 g product: Energetic value: 1805 kJ / 429 kcal Fats: 11 g, of which saturated 4,8 g Carbohydrates: 77 g of which sugars: 3,6 g Fiber: 5,9 g Proteins: 2,1 g Salt: 1,5 g
Ingredients	**Nutrition and health claims**
maize starch, water, vegetable margarine (palm oil, water), brewer's yeast, dextrose, maize flour, lupine protein, salt, vegetable fibre (psyllium), sugar, thickener: guar gum; emulsifier: hydroxy-propyl-methylcellulose.	Gluten-Free product recommended for people with celiac disease; Without hydrogenated fats. Preservative free.

https://www.giustofarma.com/prodotto/crostini/

a6. Product name: GLUTEN-FREE "FOCACCIA"

Gluten-free "focaccia" recommended for people with celiac disease. It goes well with the typical Italian aperitif as an appetizer, or as a quick dish.

	Nutritional value
	Per 100 g product: Energetic value: 1064 kJ/ 253 /kcal Fats: 6,1 g, of which saturated: 0,8 g Carbohydrates: 42 g of which sugars: 4,1 g Proteins: 3,8 g Salt: 1,3 g
Ingredients	**Nutrition and health claims**
Sourdough (rice flour, water) 27%, maize starch, water, maize flour, extra virgin olive oil 5%, vegetable fibre (psyllium), rice flour, rice starch, thickener: hydroxypropyl methylcellulose, dextrose, sunflower oil 2.2%, soy protein, yeast, sea salt, rosemary 0.2%, natural flavouring.	Gluten-Free product recommended for people with celiac disease; Preservative free.

https://www.schaer.com/it-it/prodotti/focaccia-con-rosmarino

a7. Product name: GLUTEN-FREE PIZZA BASE

Gluten-free pizza base, ready to fill and bake, recommended for people with celiac disease.

<table>
<tr><td> 
</td><td>Nutritional value

Per 100 g product:
Energetic value: 1231 kJ / 291 kcal
Fats: 3,5 g, of which saturated: 0,5 g
Carbohydrates: 60 g, of which sugars: 2,7 g
Fibers: 4,7 g
Proteins: 3 g
Salt: 1,3 g</td></tr>
<tr><td>Ingredients</td><td>Nutrition and health claims</td></tr>
<tr><td>maize starch, rice flour, sourdough (rice flour, water) 14%, water, potato starch, rice starch, maize flour, glucose syrup, yeast, thickener: hydroxypropyl methylcellulose; dextrose, extra virgin olive oil 1.6%, sunflower oil, vegetable fibre (psyllium), iodized salt (salt, potassium iodide), ethyl alcohol, soy protein, raising agents: glucono delta lactone, sodium bicarbonate; acidifiers: tartaric acid, citric acid</td><td>Gluten-Free product recommended for people with celiac disease;
Preservative free.</td></tr>
</table>

https://www.schaer.com/it-it/prodotti/pizza-base

a8. Product name: GLUTEN-FREE “PIADINA”

Gluten-free “piadina”, recommended for people with celiac disease. After heating in the pan, it is ready to be filled.

<table>
<tr><td> 
</td><td>Nutritional value

Per 100 g product:
Energetic value: 1426 kJ / 339 kcal
Fats: 10 g, of which saturated: 2 g
Carbohydrates: 56 g
of which sugars: 6,5 g
Fibers: 2,8 g
Proteins: 4,8 g
Salt: 1 g</td></tr>
</table>

Ingredients	Nutrition and health claims
rice flour, maize starch, water, glucose syrup, whole milk powder, extra virgin olive oil 4,2%, sunflower oil, buckwheat flour 3,9%, rice starch, thickener: guar gum, locust bean gum; soy protein, salt, chestnut flour, acidifier: tartaric acid; raising agents: gluconodeltalactone, sodium hydrogen carbonate.	Gluten-Free product recommended for people with celiac disease; Preservative free.

https://www.schaer.com/it-it/prodotti/piadina

a9. Product name: GLUTEN-FREE "CROISSANT"

Gluten-free "croissant", recommended for people with celiac disease.

 4	**Nutritional value** Per 100 g product: Energetic value: 1371 kJ/ 327 kcal Fats: 14 g, of which saturated: 6,8 g Carbohydrates: 45 g of which sugars: 6,2 g Fibers: 5,7 g Proteins: 3,4 g Salt: 1,3 g
Ingredients	**Nutrition and health claims**
deglutinated wheat starch, vegetable margarine [vegetable fats and oils in varying proportions (palm, palm kernel, coconut, rapeseed), water, salt, emulsifier: mono- and diglycerides of fatty acids; flavouring], water, egg, vegetable fibres (chicory, psyllium), dextrose, rice flour, egg white powder (egg), skimmed milk powder, raising agent: gluconodeltalactone, sodium bicarbonate; yeast , thickener: xathane gum; sugar, salt, emulsifier: mono- and diglycerides of fatty acids; natural flavouring.	Gluten-Free product recommended for people with celiac disease; Preservative free.

https://www.schaer.com/it-it/prodotti/croissant-la-francaise-frozen

High-fiber products with a low glycemic index, rich in fibers helps to reach the recommended daily intake of fibers to maintain a normal bowel activity within a varied diet. For review see Gobbetti et al. (2019).

a10. Product name: HIGH-FIBER/LOW GLYCEMIC INDEX RUSKS

High-fiber/low glycemic index rusks for breakfast or as a snack.

	Nutritional value
	Per 100 g product: Energetic value: 1694 kJ / 402 kcal Fats: 8,2 g, of which saturated: 3,9 g Carbohydrates: 69 g of which sugars: 2,5 g of which polyols: 5,3 g Fibers: 7 g Proteins: 12 g Salt: 0,88 g Polyphenols from *Vitis vinifera*: 80 mg
Ingredients	**Nutrition and health claims**
wheat flour, palm oil, sweetener: isomalt; inulin (2.5%), yeast, salt, emulsifier: soya lecithin; vitis vinifera seed dry extract 0.1%.	Rich in fibre. No hydrogenated fats. No added sugar. Naturally contains sugars.

https://www.giustofarma.com/prodotto/fette-biscottate/

Low-protein products are recommended for people suffering chronic kidney failure, a condition that leads to a gradual reduction of renal function. The disease complications can be avoided by following a low-protein diet.

a11. Product name: LOW-PROTEIN RUSKS

Low-protein rusks for breakfast or as a snack.

	Nutritional value
	Per 100 g product: Energetic value: 1762 kJ/19 kcal Fats: 10.2 g of which saturated: 5,1 g Carbohydrates: 76,7 g, of which sugars: 4,8 g Fibers: 8,2 g Proteins: 0,92 g Salt: 0,1 mg
Ingredients	**Nutrition and health claims**
Maize starch, potato starch, vegetable margarine (non hydrogenated palm and coconut fats and oils, water, emulsifier:	Low protein Rich in fibre No hydrogenated fats

mono- and diglycerides of fatty acids; salt), dextrose, thickener: locust bean gum; emulsifier: mono- and diglycerides of fatty acids; yeast, stabiliser: sorbitol syrup; green tea leaves dry extract (0,1%), flavouring.	Naturally lactose-free

https://www.giustofarma.com/prodotto/fette-biscottate-4/

a12. Product name: <u>LOW-PROTEIN PRE-COOKED PIZZA BASE</u>

Low-protein pre-cooked pizza base for people suffering chronic kidney failure.

	Nutritional value
	<u>Per 100 g product:</u> Energetic value: 1294 kJ/ 308 kcal Fats: 9,2 g of which saturated: 3,1 g Carbohydrates: 53,8 g, of which sugars: 2,7 g Fibers: 3,9 g Proteins: 0,73 g Salt: 1,6 g
Ingredients	**Nutrition and health claims**
Maize starch, water, vegetable margarine (hydrogenated and non-hydrogenated palm, rapeseed, sunflower and coconut oils, water, emulsifiers: mono- and diglycerides of fatty acids, soya lecithin; acidity regulator: citric acid; colouring: annatto), sunflower oil, sugar, glucose, yeast, maize flour, tapioca starch, salt, thickeners: guar gum, cellulose; humectant: sorbitol: annatto), sunflower oil, sugar, glucose, yeast, maize flour, tapioca starch, salt, thickeners: guar gum, cellulose; humectant: sorbitol; vinegar, preservative: calcium propionate; raising agent: sodium bicarbonate; emulsifier: soya lecithin.	Low protein Naturally lactose-free.

https://www.giustofarma.com/prodotto/fondo-precotto-per-pizza/

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CHAPTER 3.
NEWLY DEVELOPED FUNCTIONAL BAKERY PRODUCTS DEPENDING ON THE DIGESTIVE DISORDERS

3.1 Functional bakery products for digestive disorders

The diet of people with digestive diseases depends on the type of pathology developed. In this sense, digestive diseases can be classified into several categories (Figure 3.1).

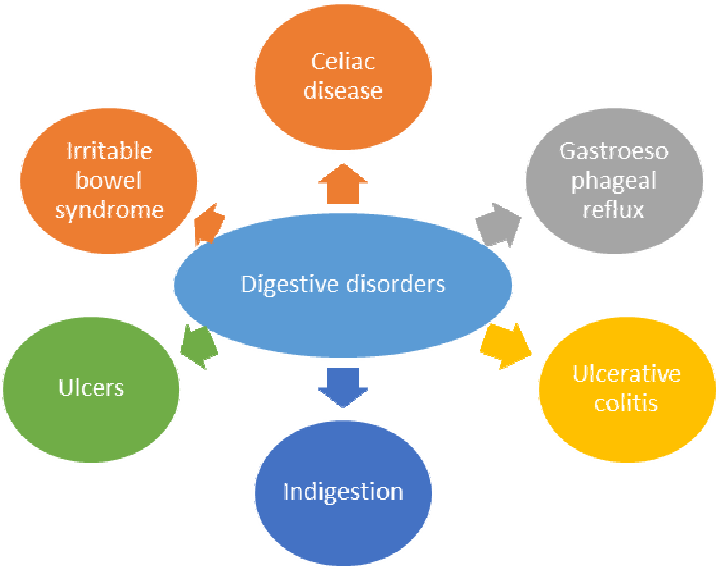

Figure 3.1. Digestive disorders

Functional bakery products for celiac disease

Celiac disease is the most common genetic disease in Europe. It is estimated that more than 1 million Europeans suffer from this condition. Epidemiological studies show that irritable bowel syndrome - celiac disease affects between 2% - 15% of the world's population, with variations depending on the area, more common in Europe and lower in the US and Asia.

Gluten is a mixture of proteins that ensures the elasticity of the dough and the maintenance of fermentation gases during the technological process of obtaining bread. The absence of gluten leads to a flattened product with low volume.

For people with **celiac disease**, gluten ingestion causes an abnormal immune response in the small intestine. This reaction not only destroys gluten, as if it is dangerous to the body, but also attacks the lining of the small intestinal mucosa. Inflammatory substances end up destroying the intestinal villi, which allow the nutrients absorption. Thus, despite a healthy diet, people with celiac disease

suffer from malnutrition. In addition to growth disorders, malnutrition, risk of osteoporosis, noncompliance to gluten-free diet can cause infertility, lymphoma and small bowel adenocarcinoma over time.
Unfortunately, there are many situations in which non-compliance of the regime can be fatal to the patient [www.fara-gluten.ro].
Injuries to the small intestine affect the normal absorption of nutrients, especially fats, calcium, iron and folate (malabsorption syndrome).
Celiac disease is also called celiac sprue, gluten sensitive enteropathy, gluten enteropathy or non-tropical sprue.
Although celiac disease cannot be prevented, a gluten-free diet can prevent the appearance and evolution of intestinal lesions.
A product is called gluten-free if its gluten content does not exceed 20 ppm or it is called gluten-reduced for products with a gluten content exceeding 100 ppm.
In allergen-free baking products the wheat and rye flour are replaced by soy, maize, rice and other grains flour.
In the manufacture of these products, it is important to achieve an appearance (i.e.: shape, volume and intestinal properties) similar to that of gluten-containing products.

Functional bakery products for gastroesophageal reflux disease

Although there are still a number of medical controversies about foods that cause symptoms of gastroesophageal reflux disease, many researchers agree that avoiding certain types of foods and beverages may help prevent indigestion, burning sensation in the chest and other symptoms.
Experts recommend avoiding high-fat foods: fried and fatty foods can decrease the pressure on the lower esophageal sphincter, can delay emptying of the stomach, exposing to an increased risk of symptoms.
Although fruits and vegetables are recommended in a healthy diet, some can cause or worsen the symptoms of gastroesophageal reflux.
These are: oranges, grapefruit, lemons, pineapple, tomatoes, tomato sauce and salsa derivatives, chili, pizza.
But there are some foods that help relieve the symptoms: yogurt and probiotics, due to the "friendly" bacteria in yogurt, helping the digestion process and providing protection against other harmful bacteria.
Fiber consumed in large quantities reduces by 20% the risk of reflux, although it is not yet known the exact way in which it influences the metabolism.
The recommended diet and the types of products for **gastroesophageal reflux** disease are presented in Table 3.1.

Table 3.1. *The recommended diet and the types of products for gastroesophageal reflux disease*

Products	Recipe	Observations
Whole-wheat products	60% wholemeal flour (wheat, rye or spelled) and up to 40% other wheat, rye or spelled meal.	The technology involves the use of sourdough or sourdough substitute
Bran bread	10 kg of bran made from cereals or the corresponding legumes per 100 kg of total flour	The starch content of the bran must not exceed 15% of the dry matter.
Graham bread	90% wheat Graham flour and up to 10% other wheat or rye meal (typically flour).	
Bread with high fiber content	10-20% apples, peas and oats as substitute of wheat flour	During the technology we should take into account that dietary fibers affect the water absorption capacity of the dough.
Bread with high vitamin content	small amount of vitamin	vitamins are unstable substances
low-fat pastries	pastries made of water-based and milk-based dough	

Functional bakery products for ulcerative colitis

The diet for ulcerative colitis should be based on a well-balanced diet rich in protein, complex carbohydrates and good fats, giving energy and maintaining good health.

It is recommended to include in the daily menu meat, fish, chicken and dairy products (for people who do not suffer from lactose intolerance), bread and cereals, fruits and vegetables, margarine and oils.

For vegetarians, dairy products and plant proteins (such as soy) can provide nutrients for the body.

Functional bakery products for indigestion

A high-fiber diet is often recommended for indigestion, especially if is accompanied by constipation. Another cause associated with indigestion is the consumption of foods rich in lipids. Lipids tend to slow down the functioning of the gastrointestinal muscles, while causing the contraction of the gallbladder. Therefore, it can also aggravate indigestion, even if it did not cause it, and therefore reducing the amount of fat ingested is the optimal solution.

Another dietary factor is fructose and related sugars, considered the cause of indigestion, because many people do not fully digest them and cannot absorb them before they reach the intestines.

Consequently, it is recommended to eliminate them from the diet, but they are quite widespread among fruits and vegetables and are found in high concentrations in many products sweetened with corn syrup, making exclusion more difficult.

Functional bakery products for ulcer disease

In the diet for people with ulcers, a fiber-based diet is recommended that is extremely important in maintaining the health of the gastrointestinal tract and can help in the recovery process of peptic ulcer. Some high-fiber foods (fresh fruits and vegetables, bread, tortillas or wholemeal rolls / oatmeal rolls, barley, popcorn with butter or other additives) are recommended for people with ulcers. Fruits and vegetables not only provide fiber, but are also important sources of vitamins, minerals and antioxidants that the body needs to fight ulcers. Some examples of foods rich in antioxidants are: blueberries, strawberries, pumpkin, peppers, dark green leafy vegetables (spinach and kale), sea vegetables (seaweed and kelp). Foods rich in antioxidants are recommended due to their high content of flavonoids, powerful antioxidants that help regulate *H. pylori* bacteria and can be found in: apples, celery, blueberries, onions, garlic, green tea.

The flouring products recommended in other digestive disorders disease are presented in the Table 3.2.

Table 3.2. *The recommended diet and the types of products for different digestive disorders*

Digestive disorders	Flouring products	Observations
➢ **Ulcerative colitis**	**Matzo**	The technology is a short-term process,

	thin, perforated bread dough made using only water and wheat flour	during which the goal is to avoid the occurrence of various fermentation and other processes in the dough. The whole technology takes 16-18 minutes. Baked at 220 °C for 2-3 minutes.
➢ **Indigestion**	**Pastries made from cereal grains of water-based and milk-based dough** (at least 3% skimmed milk powder) Characteristic products: Milky crescent, Kaiser Roll and challah	a loose structure
	Flouring products with artificial sweeteners sorbitol used for for reducing carbohydrate content	sugar substitutes, not participate in Maillard reactions and affect the caramelization (skin coloring) and flavor formation
	Flouring products with natural sweeteners: beet sugar (sucrose), fruit sugar (glucose), grape sugar (fructose), malt sugar (maltose), invert sugar (a mixture of glucose and fructose), milk sugar (lactose), and starch syrup and honey	
Ulcers	**white bread**	Baking technology using a sourdough
	semi-brown bread made from 85% half-white wheat bread flour and	the maximum salt 2.35%,

	15% light rye flour.	bread with a shiny, crunchy crust and a soft and elastic structure.
	high-fiber foods (fresh fruits and vegetables, bread, tortillas or wholemeal rolls / oatmeal rolls, barley, popcorn with butter or other additives)	
	low-fat biscuits	weaker structure due to its low gluten content
Irritable bowel syndrome	**diet rich in fiber**	

3.2 Newly developed functional bakery products produced in present depending on the digestive disorders

1. GLUTEN-FREE PREMIX BASED ON CORN AND RICE FLOUR WITH ADDED OF RAISINS AND FIGS

Raw materials: rice flour, maize flour, raisins and dehydrated figs (Alexa E., 2010b)

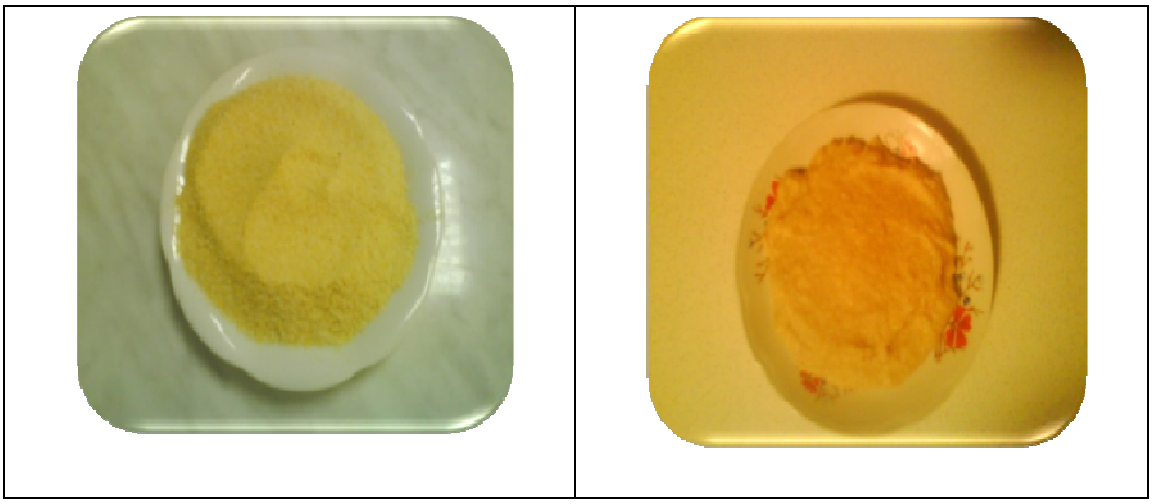

Figure 3.2. *Gluten-free premix (original photo)*

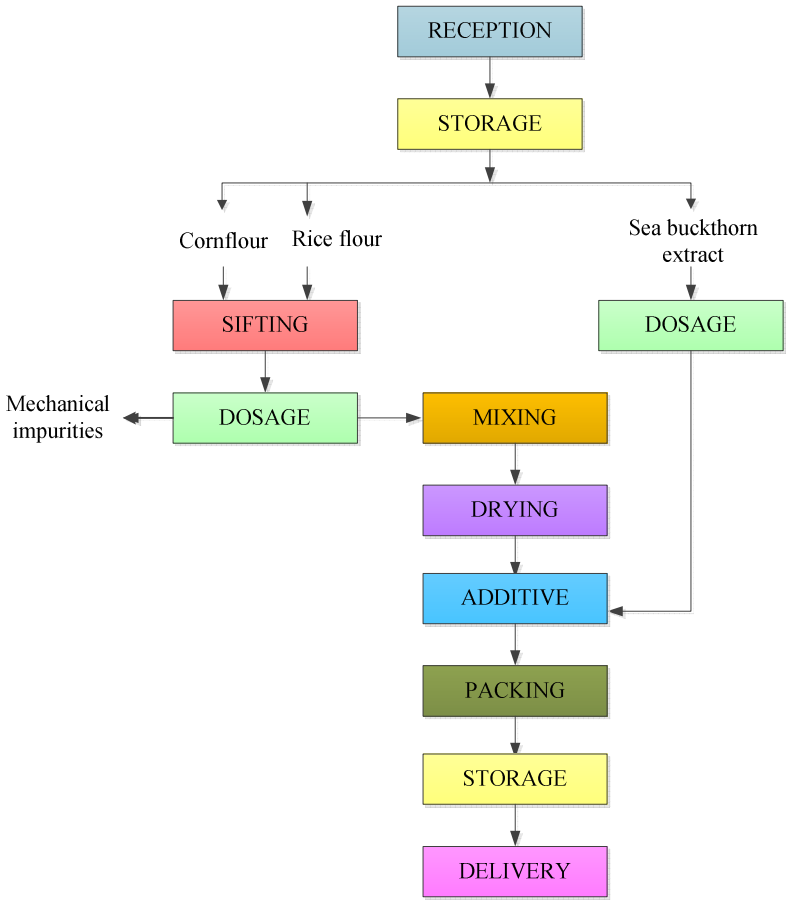

Figure 3.3. *Technological scheme for obtaining gluten-free premixes*

Technical specification – Gluten-free premix
Trade name: Gluten-free premix
Description: gluten-free premix with sea buckthorn extract
Weight: 500 g ± 5%.
Composition: cornmeal, rice flour, sea buckthorn extract.

Table 3.3. *Organoleptic properties (according to the manufacturer's technical specification)*

Properties	Admissibility conditions
Appearance	Uniform "gray"
Color	Yellow to orange-yellow
Taste	Normal, slightly sweet, neither bitter nor sour, no crackling due to mineral impurities (sand, ground, etc.)
Smell	Pleasant, specific to healthy flour, without the smell of mold, heat or other foreign matter.

Table 3.4. *Physico-chemical properties (according to the manufacturer's technical specifications)*

Properties		**Value**
Humidity (%)		16,5
Fineness	Residue on metal screen no. 22% maximum	-
	Residue on metal screen no. 24% maximum	2
	Passing through the metal sieve no. 34% maximum	10
	Passing through the metal sieve no. 55% maximum	-

Table 3.5. *Microbiological properties (according to the manufacturer's technical specifications)*

Properties	**Value**
Yeasts and molds, max./g	absent
E. coli, max./g	1
Salmonella, /25 g	absent
Coagulase-positive *Staphylococcus*, /25 g	absent
Bacillus cereus, max/g	1

Storage conditions: the storage of the finished products must be done in optimal conditions, which will ensure their quality until the introduction in the manufacturing process. The following factors are important for this purpose: air temperature and relative humidity and light. The optimal parameters are the temperature of 18-20ºC, the relative humidity of 65–70% and the lack of light.

Transport method: transport belts.

Shelf life is 3 months. The shelf life refers to the product stored and transported under the conditions provided by the manufacturer and is recorded from the date of packaging.

Consumer category: people with gluten intolerance (celiac disease).

Presentation: packed in paper bags weighing 500 or 1000 g. After filling, the bag is glued to the mouth and labeled.

Stability when using the product: the product kept under the prescribed conditions, has stability within the shelf life and above that, approx. 3 months.

Failure to comply with the recommended storage conditions will shorten the shelf life, as the product may become unstable (Alexa E., 2010a).

2. GLUTEN-FREE PASTA OBTAINED FROM RICE FLOUR

Figure 3.4. *Gluten-free pasta (original photo)*

Raw materials: rice flour, corn starch, eggs, water.
Technical specification – gluten-free pasta
Trade name: gluten-free pasta
Description: gluten-free pasta obtained from rice flour mixed with maize starch
Weight: 500 g ± 5%.
Composition: rice flour, corn starch, eggs, water

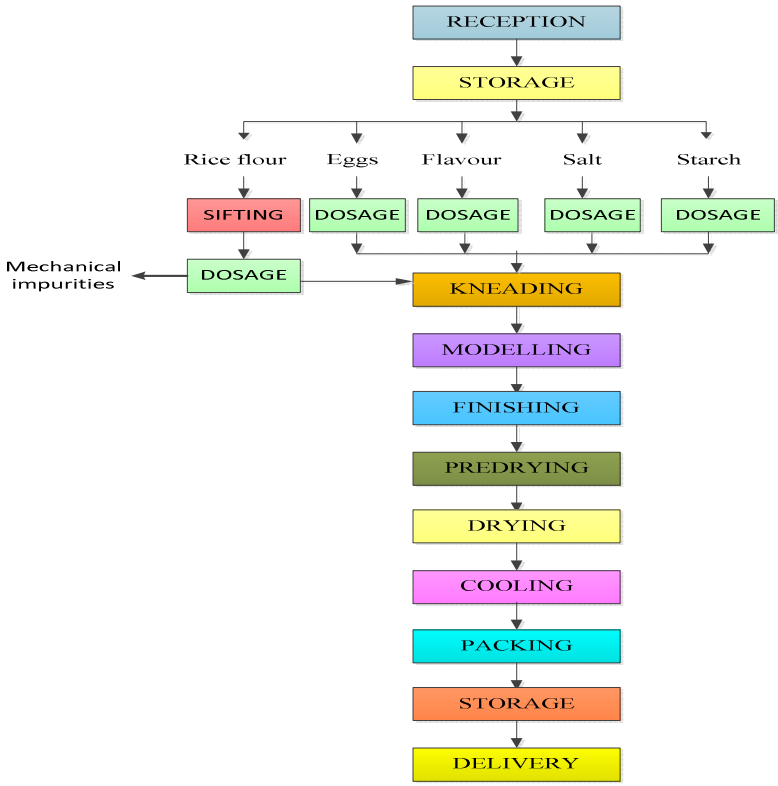

Figure 3.5. *Technological scheme for obtaining gluten-free pasta*

Table 3.6. *Organoleptic properties (according to the manufacturer's technical specification)*

Properties	Admissibility conditions
Appearance	Smooth surface, without traces of flour, matte / translucent, with a glassy appearance in section
Color	Uniform, yellowish white to yellow-orange
Taste	Normal, characteristic, neither bitter nor sour
Smell	Pleasant, specific, without the smell of mold, heat or other foreign smell.

Table 3.7. *Physico-chemical properties (according to the manufacturer's technical specifications)*

Properties	Value
Humidity (%)	7
Acidity, maximum degrees	4
Boiling volume increase, maximum %	250
Minimum bending load N (gf)	3,5 (350)

Table 3.8. *Microbiological properties (according to the manufacturer's technical specifications)*

Properties	Value
Yeasts and molds, max./g	absent
E. coli, max./g	1
Salmonella, /25 g	absent
Coagulase-positive *Staphylococcus*, /25 g	absent
Bacillus cereus, max/g	1

Storage conditions: the storage of finished products must be done in environments with relative air humidity of maximum 60–65% at a temperature of 10-20ºC, avoiding sudden temperature variations, which lead to condensation of water on the surface of the products.
Transport method: transport belts.

Shelf life is 12 months. The shelf life refers to the product stored and transported under the conditions provided by the manufacturer and is recorded from the date of packaging.
Consumer category: people with gluten intolerance (celiac disease).
Presentation: for pasta, a presentation packaging and a protective packaging against mechanical shocks are made, which can intervene during transport. The presentation packaging consists of: cardboard boxes; parchment paper, cellophane or plastic bags; bulk.
Packaging for mechanical protection is done by inserting boxes, envelopes, bags in wooden boxes and corrugated cardboard.
Stability when using the product: the product kept under the prescribed conditions, has stability within the shelf life and above that, approx. 12 months.
Failure to comply with the recommended storage conditions will shorten the shelf life, as the product may become unstable (Alexa E., 2010b).

3. GLUTEN-FREE BISCUITS OBTAINED FROM RICE FLOUR AND SEA BUCKTHORN EXTRACT

Raw materials: rice flour, walnut kernels, sea buckthorn extract, eggs, vegetable fat, aeration agents, sweeteners / sugar

Figure 3.6. *Gluten-free biscuits (original photo)*

Sea buckthorn (*Hippophae rhamnoides*) is a fruiting shrub that contains between 400-800 mg of vitamin C per 100 g of fresh juice. Other vitamins present in the fruit are A, B1, B2, B6, B9, E, K, P, F.
We also find cellulose, beta-carotene (in a net percentage higher than the carrot pulp), trace elements such as phosphorus, calcium, magnesium, potassium, iron and sodium, complex oils, etc. known as part of the spontaneous flora of Romania, which is used both in the food industry, in forestry, in pharmacy but also as an ornamental plant.
Sea buckthorn fruit contains twice as much vitamin C as rosehip and 10 times more than citrus fruits. In ripe fruit the content exceeds (Alexa E., 2010a).

Figure 3.7. *Sea buckthorn (Hippophae rhamnoides)*

Table 3.9. *Physical-chemical parameters of gluten-free products (Alexa E., 2010b)*

Physico-chemical parameters analyzed	Flour	Pasta	Biscuits
Humidity (%)	9,5	9,7	3, 6
Fats (%)	1,11	3,48	9,58
Proteins (%)	6,99	6,66	5,94
Ash (%)	0,8	0,9	1,37
Vitamin B1 (mg/100g)	0,210	0,110	0,322
Vitamin B2 (mg/100g)	0,122	0,120	0,151

The obtained gluten-free products were analyzed in terms of gluten content, all samples analyzed having a content below 20 ppm.

From the point of view of the physico-chemical properties, the gluten-free products obtained registered values that fall within the standards in force.

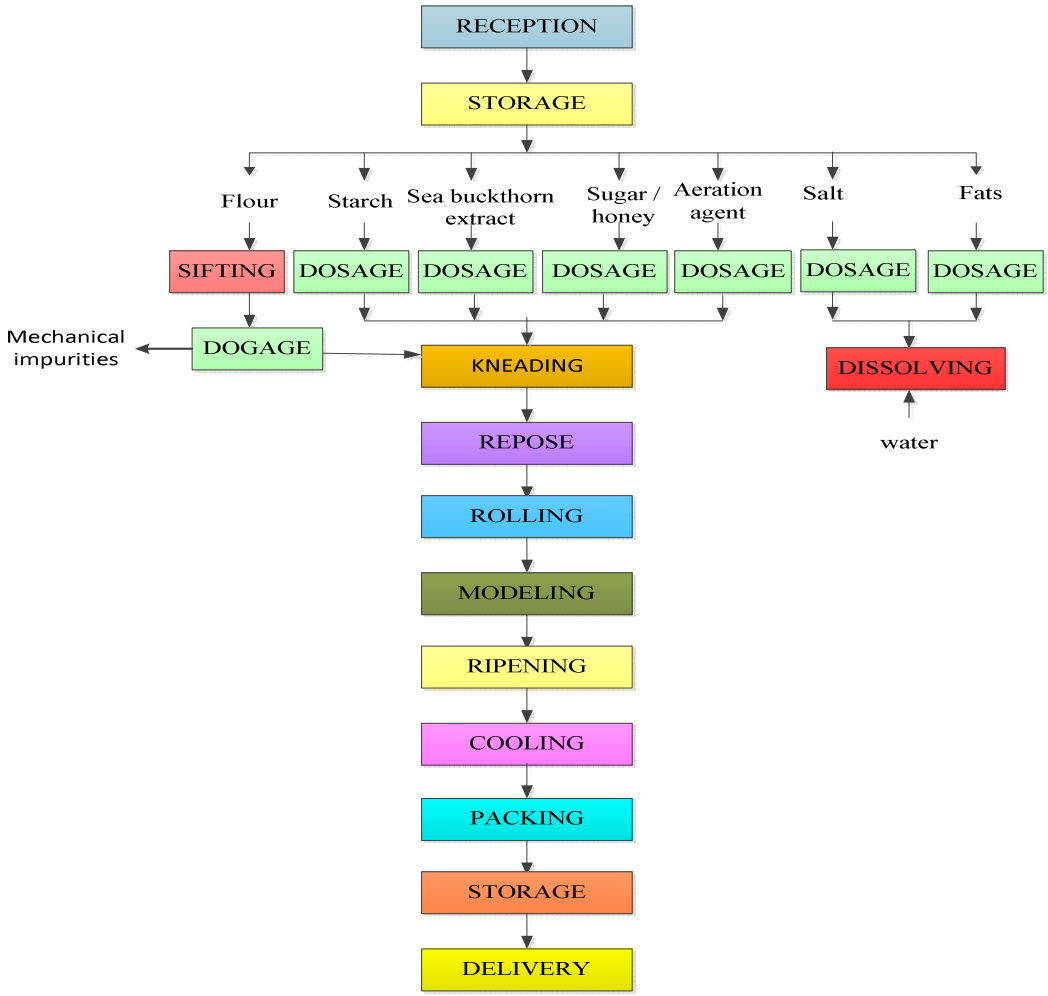

Figure 3.8. *Technological scheme for obtaining gluten-free biscuits*

Product description – gluten-free biscuits
Trade name: gluten-free biscuits
Description: gluten-free biscuits obtained from rice flour with added fruit
Weight: 5 g ± 5%.
Composition: rice flour, corn starch, aeration agents, sea buckthorn extract, ground walnut, eggs, sugar

Table 3.10. *Organoleptic properties (according to the manufacturer's technical specification)*

Properties	Admissibility conditions
Appearance	Round, flattened
Color	Diameter 5 cm
Taste	Pleasant, nuts
Smell	Pleasant, characteristic, suitable for sweet, without sour or

	bitter taste, without crackling due to mineral impurities (sand, ground, etc.)
	Pleasant, fruity, characteristic, without foreign odor (mold, rancid, stale, etc.)

Table 3.11. *Physico-chemical properties (according to the manufacturer's technical specifications)*

Properties	Value
Core moisture (%)	2,5
Proteins (%)	8,5
Fats (%)	15
Carbohydrates (%)	16
Gluten (%)	Absent
Energetic value, kJ/kg	1857
Acidity (degrees)	max. 6
Porosity (%)	min. 62 – 63
Salt content (%)	max. 1,4
Sugar content (%)	-
Fat content (%)	-

Table 3.12. *Microbiological properties (according to the manufacturer's technical specifications)*

Properties	Value
Yeasts and molds, max./g	100
E. coli, max./g	1

Salmonella, /25 g	absent
Coagulase-positive *Staphylococcus*, /25 g	absent
Bacillus cereus, max/g	1

Storage conditions: the biscuits must be kept in storage in such a way as to ensure that their taste, consistency, tenderness, color and shape are maintained. The following factors are important for this purpose: air temperature and relative humidity and light. The optimal parameters are the temperature of 18-20ºC, the relative humidity of 65 - 70% and the lack of light. Storage is done in packaging that protects them from light.

Method of transport: ripe products are collected using conveyor belts.

Shelf life is 6 months. The shelf life refers to the product stored and transported under the conditions provided by the manufacturer and is recorded from the date of packaging.
Consumer category: people with gluten intolerance (celiac disease).
Presentation: it is packed in bags, in cardboard boxes, or in a wrapper that is placed in cardboard boxes or wooden crates.
Stability when using the product: the product kept under the prescribed conditions, has stability within the shelf life and above that, approx. 6 months.

Failure to comply with the recommended storage conditions will shorten the shelf life, as the product may become unstable (Alexa E., 2010a).

4. GLUTEN FREE BREAD BASED ON RICE, MILLET, FLOUR AND MIX OF SEEDS

Product description: Gluten free bread based on rice flour, millet, flax and seed mix is an assortment of bread that is part of the range of gluten-free products, intended for people suffering from celiac disease, but also for those who want to adopt a healthy lifestyle.
Raw and auxiliary materials: Millet flour, rice flour, flax flour, xanthan gum, dry yeast, sea salt, cane sugar, olive oil, flax seeds, chia seeds, sunflower seeds.

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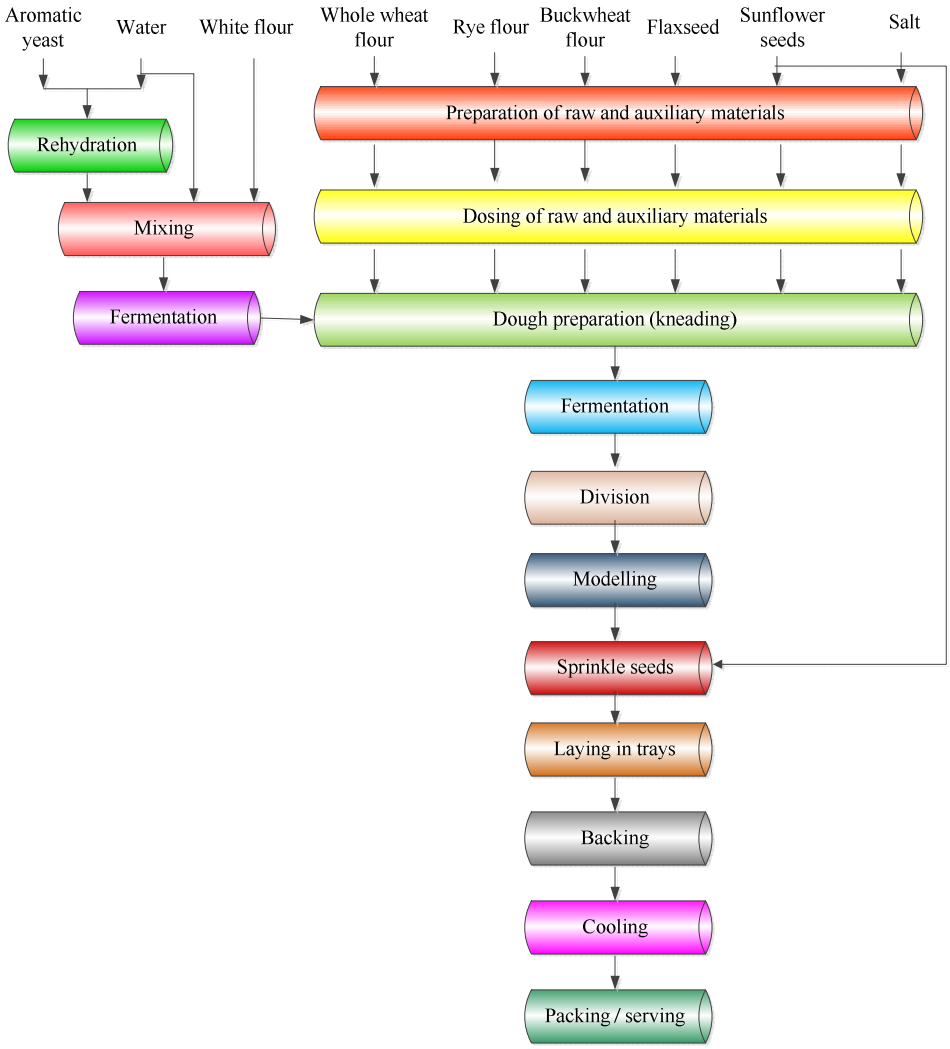

Figure 3.9. *Technological scheme for obtaining gluten-free bread*
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5. GLUTEN FREE MUFFINS WITH RICE FLOUR, ALMONDS AND BLUEBERRIES

Product description: Gluten free muffins with almond and blueberry flour are included in the wide range of products specially designed for people with gluten intolerance, for diabetics, but can be eaten just as well by all those who want to adopt a healthy and balanced diet from a nutritional point of view.

Raw and auxiliary materials: Almond flour, rice flour, blueberries, maple syrup, almond oil, eggs, baking powder, starch.

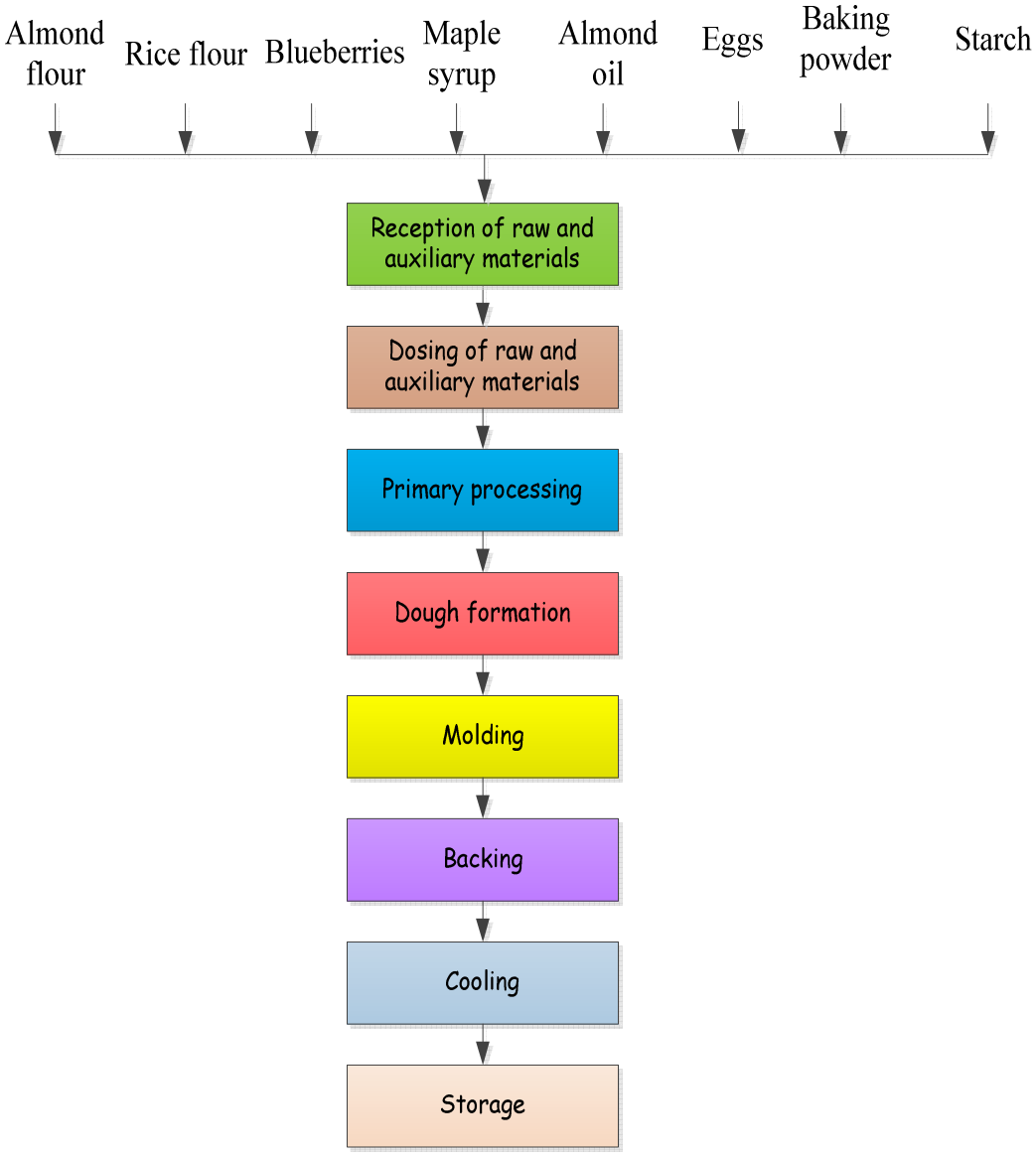

Figure 3.10. *Technological scheme for obtaining gluten free muffins with rice flour, almonds and blueberries*

Figure 3.11. *Gluten free muffins with rice flour, almonds and blueberries* (https://www.usab--tm.ro/utilizatori/tpa/file/student%20fest/2019/catalog%20student%20fest%202018%20final.pdf)

6. GLUTEN FREE MUFFINS WITH RICE AND QUINOA FLOUR, WITH ADDED SWEET POTATO, SPINACH AND BEET

Product description: Gluten free muffins made from rice and quinoa flour with the addition of sweet potato puree, spinach and beets are gluten-free pastries obtained from the desire to be consumed by as many people as possible: from people who are forced to excludes gluten from the diet and young children (who are more sensitive to food allergens), up to people who want to adopt a nutritionally balanced lifestyle.

Raw and auxiliary materials: rice flour, quinoa flour, coconut oil, agave syrup, eggs, baking powder, sweet potato puree, spinach puree, beet puree.

Figure 3.12. *Gluten free muffins with rice and quinoa flour, with addation of sweet potato, spinach and beet*

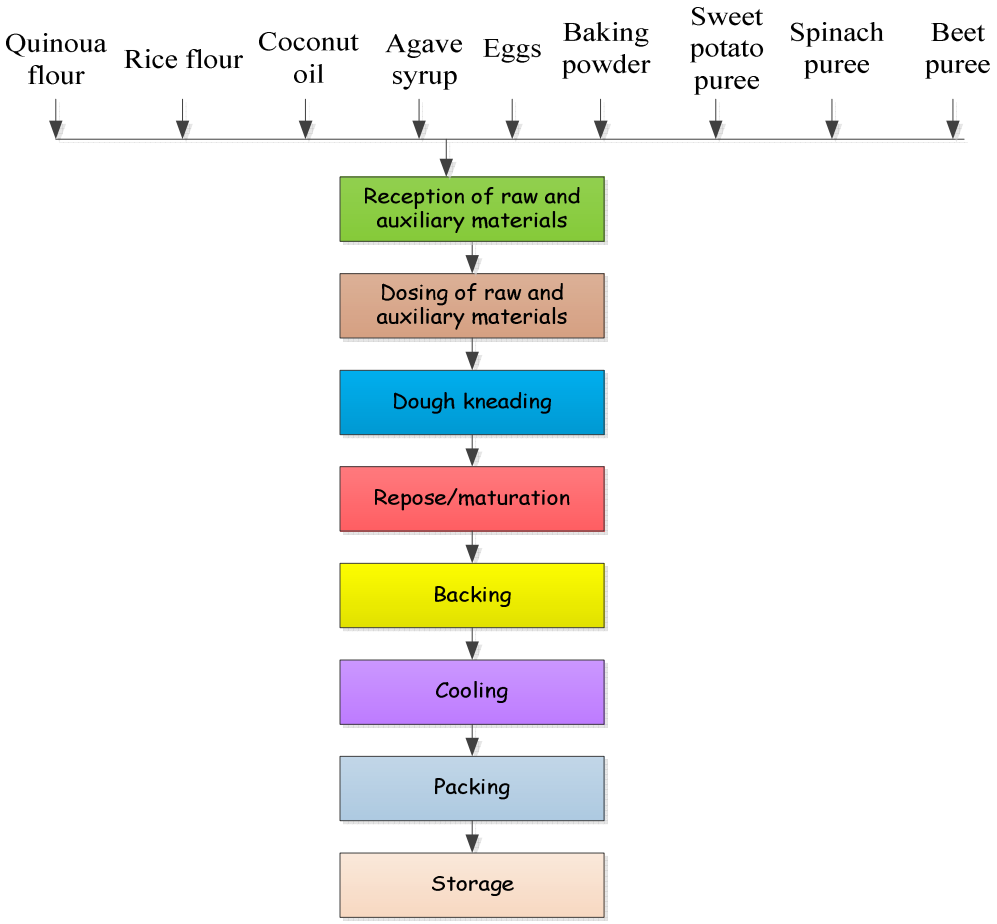

Figure 3.13. *Technological scheme for obtaining gluten free muffins with rice and quinoa flour, with addation of sweet potato, spinach and beet*
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7. GLUTEN FREE MUFFINS WITH CHESTNUT FLOUR, CONFIDED CURTAINS AND CHESTNUT PURE

Raw and auxiliary materials: chestnut flour, whole meal rice flour, coconut milk, egg, stevia extract, coconut flakes, candied currants, coconut oil, vanilla essence, baking powder, mascarpone, whipped cream, puree of chestnuts.

Wild chestnuts (*Aesculus hippocastanum*) contain vitamins C, K, vitamin B group, fats, starch, saponosides, triterpenes, bitter principles, tannins, albumin, flavonoids. They maintain the elasticity of blood vessels, have anti-inflammatory, vasodilating, anti-edematous, anticoagulant and fluidizing properties for the blood, hemostatic, decongestant, being a real remedy for increasing the tone of fragile capillaries.

Chestnut flour is an agglutinative flour with real medicinal properties, with miraculous effects on the circulatory system, vascular diseases. Chestnut flour contains fewer carbohydrates than wheat flour, has a lower caloric content than it and a high percentage of starch, so it can completely replace wheat flour in recipes.

Blackcurrants (*Ribes nigrum*) belong to the category of berries with a significant content of vitamin C (three to four times higher than oranges), antioxidants (twice as high as blueberries), plus twice the amount of potassium from bananas. They also contain vitamins A, B1, B2, B6, PP, trace elements such as calcium, phosphorus, zinc, beta-carotene, organic acids and volatile oils. The high fiber content regulates digestion and treats constipation, while preventing cardiovascular disease.

Nutrition facts (g/100 g product): Fats: 20.98 g Proteins: 15.72 g Ash: 2.86 g Total carbohydrates: 50.81 g Dietary fiber: 9.63 g Caloric value: 780 Kcal.

https://www.usab-tm.ro/utilizatori/tpa/file/student%20fest/2017/catalog%20student%20fest%202017.pdf

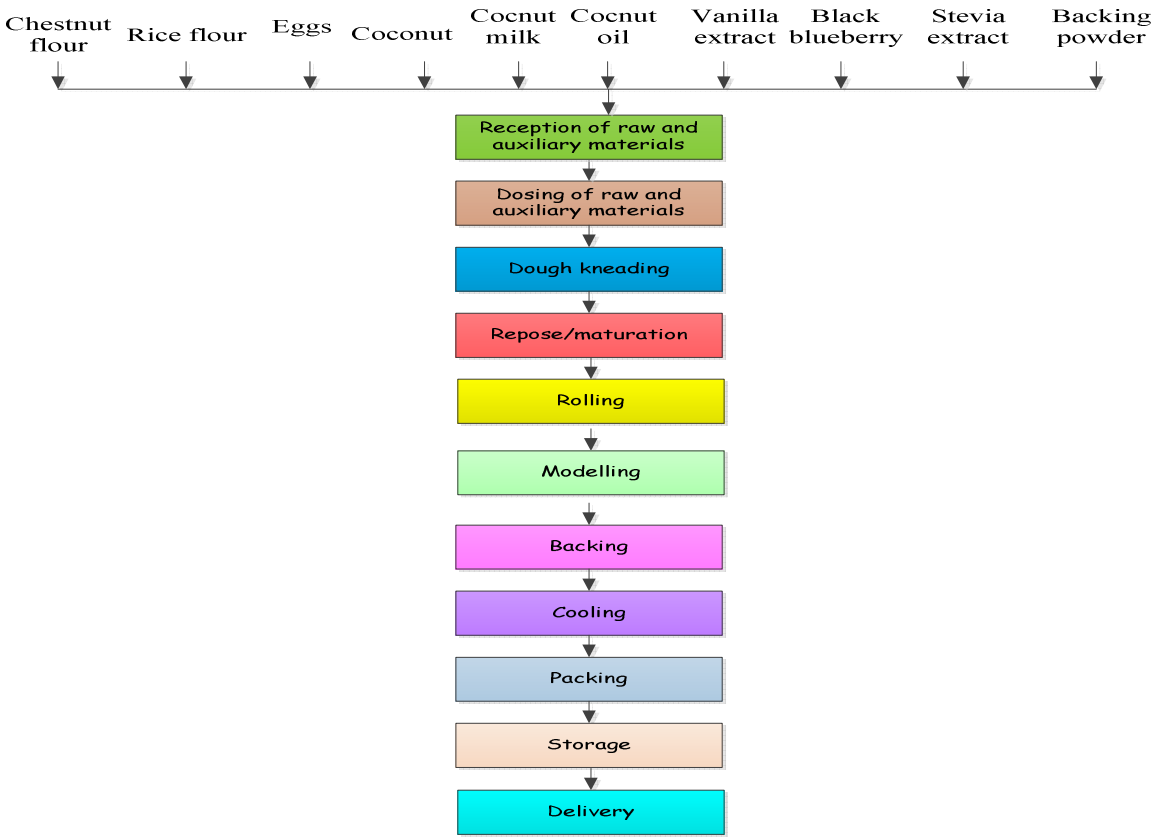

Figure 3.14. *Technological scheme for obtaining gluten free muffins with chestnut flour, confided curtains and chestnut pure*

8. GLUTEN-FREE BREAD WITH FLAX AND SESAME

Product description: Gluten-free bread with quinoa and tartar flour has superior nutritional qualities, and flax and sesame seeds increase the intake of minerals in the body.

Ingredients: quinoa flour, tartar flour, rice flour, flax and sesame seeds, tapioca and corn starch, xanthan gum, yeast, sunflower oil, himalaya salt, water.
http://noglutensugar.ro/produs/paine-fara-gluten-proaspata-cu-in-si-susan)

9. GLUTEN-FREE BREAD WITH FIBER

Product description: Gluten-free bread is rich in vegetable fiber due to the content of *Psyllium* bran, ground flax seeds, sesame seeds, rice flour and millet. Fiber reduces the risk of diabetes, heart disease and cancer. Fiber bread maintains the feeling of satiety for a longer period of time after meals, helping the intestinal transit, favorable in weight loss, relieves constipation.

Fiber supplements the amount of vitamins A, B, D, E, minerals Ca, Mg, Cu, Zn, Mn, folic acid, healthy fats.

Ingredients: rice flour, millet flour, ground flax seeds, sesame seeds, psyllium bran, yeast, sunflower oil, Himalayan salt, water.
http://noglutensugar.ro/produs/woo-single-4/)

10.GLUTEN-FREE FLOUR BREAD - with seeds

Product description:

Buckwheat flour, *Psyllium* bran, potato starch, rice leaven, salt, sunflower seeds, sesame, flax and pumpkin. We do not use baking powder, yeast, baking soda, loosens, substances that are usually used in gluten-free flour breads to make them rise or bind the dough.

Ingredients: whole rice leaven, whole buckwheat flour, potato starch, psyllium bran, salt, flax seeds, sunflower seeds, pumpkin seeds, white sesame seeds.
https://mamapan.ro/produs/paine-din-fainuri-fara-gluten/)

11.BREAD WITH RICE AND ALMOND FLOUR

Product description:

Almond flour bread is low in carbohydrates and rich in nutrients. The biggest benefit of this bread is that it contains a high dose of vitamin E, which is a powerful antioxidant. Almond flour is low in sugar and rich in protein, being much healthier than white flour bread.

Ingredients: wholemeal rice flour, almond flour, wholemeal rice leaven, potato starch, psyllium bran, 0.8% salt. https://mamapan.ro/produs/paine-cu-faina-de-orez-si-migdale/)

12.BREAD WITH RICE AND HEMP FLOUR

Bread with rice flour and hemp is a "medicine" bread used to treat various ailments or in very strict diets. It is a bread with a bitter taste due to hemp, but also moist inside.

Due to its analgesic properties, hemp can be administered in severe gastric disorders, gastric ulcers, respiratory diseases - asthma, emphysema or chronic bronchitis Ingredients: brown rice flour, brown rice leaven, hemp flour, potato starch, bran of psyllium, salt.

https://mamapan.ro/produs/paine-cu-faina-de-orez-si-canepa/)

13.GLUTEN-FREE CRISPY BREAD

Product description:

Gluten-free crispy bread is a bread substitute. Due to the high content of fiber, vitamins, minerals and other beneficial substances, it is ideal for diets or as part of a healthy lifestyle. This type of bread was originally made from wholemeal rye flour, salt and water

Ingredients: Potato starch, rice flour, amaranth flour, rapeseed oil, cane fiber, lactose-free skimmed milk powder, sugar syrup, sugar, dry rice yeast (rice flour, water), emulsifier: mono- and fatty acid diglycerides; yeast, table salt, thickener: guar gum; fennel, anise, cumin.

https://gymbeam.ro/paine-crocanta-fara-gluten-wasa.html?gclid=Cj0KCQjwtZH7BRDzARIsAGjbK2YbnVsx_ZI0kuo_upyhBguOgYH4J8_OlCeIZTHlQuf5Jp_lusllHRgaAjdbEALw_wcB#36169)

14.GLUTEN-FREE EXTRUDED BREAD WITH PUMPKIN

Ingredients: cornmeal (37%), pumpkin cream (18%), vegetable oil (palm, shea), whey powder, maltodextrin, millet (8%), cheese, buckwheat flour (1%), salt, soy lecithin.

http://noglutensugar.ro/produs/paine-extrudata-fara-gluten-cu-crema-de-dovleac-abonett-26g/)

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- *** https://www.usab--tm.ro/utilizatori/tpa/file/student%20fest/2019/catalog%20student%20fest%202018%20final.pdf)
- ***http://noglutensugar.ro/produs/paine-extrudata-fara-gluten-cu-crema-de-dovleac-abonett-26g/)
- ***http://noglutensugar.ro/produs/paine-fara-gluten-proaspata-cu-in-si-susan)
- ***http://noglutensugar.ro/produs/woo-single-4/)
- ***https://gymbeam.ro/paine-crocanta-fara-gluten-wasa.html?gclid=Cj0KCQjwtZH7BRDzARIsAGjbK2YbnVsx_ZI0kuo_upyhBguOgYH4J8_OlCeIZTHlQuf5Jp_lusllHRgaAjdbEALw_wcB#36169)
- ***https://mamapan.ro/produs/paine-cu-faina-de-orez-si-canepa/)
- ***https://mamapan.ro/produs/paine-cu-faina-de-orez-si-migdale/)
- ***https://mamapan.ro/produs/paine-din-fainuri-fara-gluten/)
- ***https://www.gustusor.ro/paine/p%C3%A2ine-%C8%9B%C4%83r%C4%83neasc%C4%83-f%C4%83r%C4%83-gluten.html)
- ***www.fara-gluten.ro
- ***https://ec.europa.eu/food/horizontal-topics/international-affairs/international-standards/codex-alimentarius_ro

CHAPTER 4.
MANUFACTURING TECHNOLOGY FOR BAKERY PRODUCTS WITH ADDED SOLUBLE FIBER

Most consumers see dietary fibre as being important, and the majority link specific health benefits to its consumption, but very few are actually consuming the recommended daily intake.
As an example, Western Europeans consume only **60-70%** of the recommendation.
A recent survey reported in the press showed that almost **80% of Britons** are unaware of the amount of dietary fibre they should consume in a day.
2010 Dietary Guidelines for Americans classified fibre as a nutrient of concern, with **<3% of all Americans** meeting recommended dietary intake goals.
In developing countries, social and economic progress and westernization of diets is contributing to consumption of high-energy dense food and **reduced consumption of grains, legumes and other sources of fibre.**

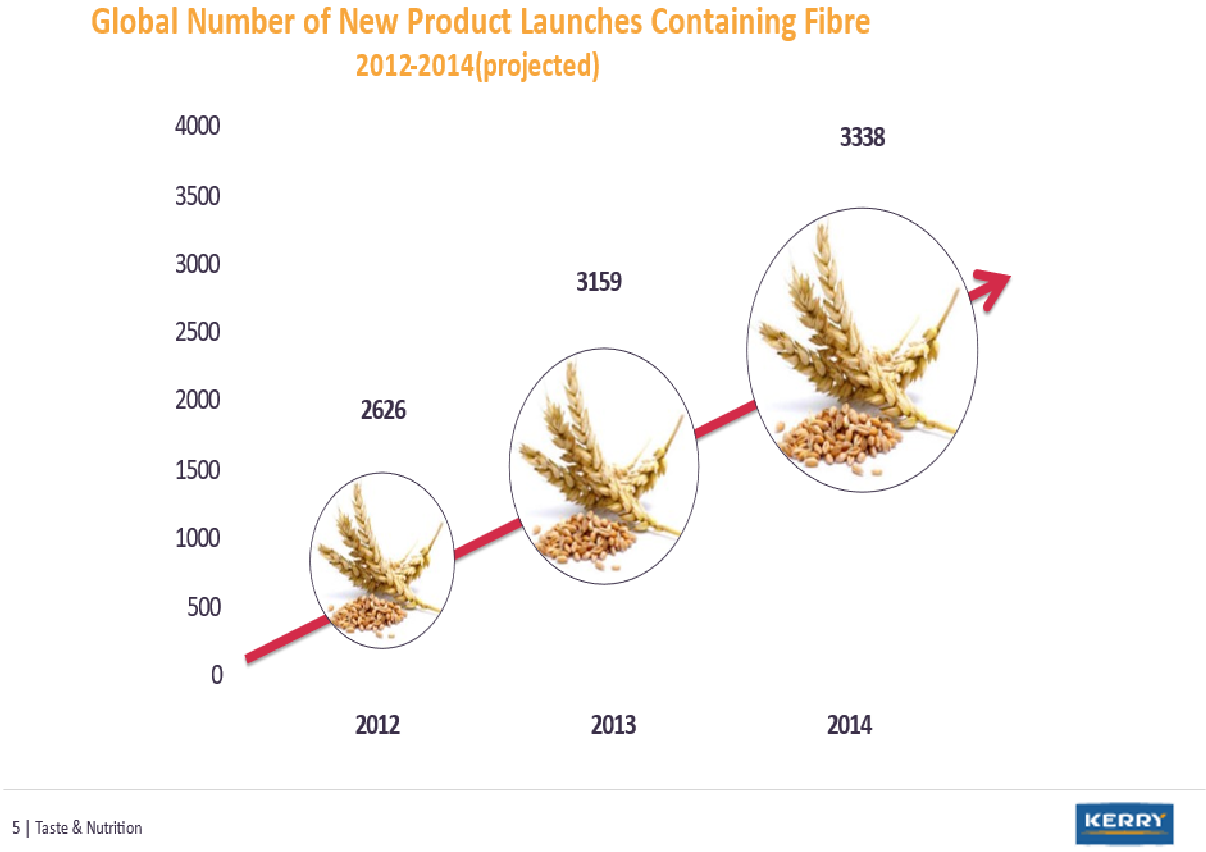

Figure 4.1. *Global Number of New Product Launches Containing Fibre 2012-2014(projected)*

4.1. Dietary fibers: description, health benefits, functionalities, and application in bakery

Dietary fiber is a term that is used for plant-based carbohydrates that, unlike other carbohydrates (e.g.: starch of sugars), are not digested in the small intestine but in the large intestine.
Dietary fibers refer to 'non-digestible soluble and insoluble carbohydrates (with 3 or more monomeric units), and lignin that are intrinsic and intact in plants; isolated or synthetic non-digestible carbohydrates determined by FDA to have physiological effects that are beneficial to human health (*Dietary Fibre*, 2020).
Dietary fibres are an important component of a healthy diet for humans.
Fibres are crucial for keeping the human body healthy and contribute to a reduced risk of chronic health diseases such as Type 2 diabetes, cardiovascular diseases and colon cancer (Slavin, 2013; Soliman, 2019).
According to (Boseley, 2019), the fibre intake worldwide is lower than the given recommendations.
The World Health Organization recommends at least 25-29 grams of fibre per day (Boseley, 2019).
The average fibre intake is around 20 grams per day.
Bakery products such as bread are consumed daily and therefore, they represent a convenient medium for delivering dietary fibre.
The main challenges with adding fibre in bread are the negative effects on the dough rheology, processability and final products quality (Foschia, Peressini, Sensidoni, & Brennan, 2013).
In particular, the addition of fibres weakens the dough, resulting in a decreased dough stability and resistance to extension.
This is mainly due to the dilution effect of fibres on gluten and fibre interruption on starch-gluten matrix.
Regarding bread quality, the addition of fibre can significantly affect the bread volume and firmness.
Also sensory properties of the bread can be significantly altered by the presence of high level of fibres in the formulation; therefore quality parameters such as texture, crust color, crumb color, taste, flavor, and overall acceptability can be compromised (Kohajdová, Karovičová, & Jurasová, 2012; Bhise, Kaur, & Aggarwal, 2013; Jingwen, Yonghui , Yong , Donghai , & Weiqun , 2021).
In Table 4.1, the impact of dietary fibers in products containing cereals has been summarized.

Table 4.1. *Summary of the main published results on the impact of insoluble and soluble dietary fibre in products containing cereals (Foschia, Peressini, Sensidoni, & Brennan, 2013)*

Article	Dietary Fiber (%)	Results
Bread (Almeida, Chang, & Steel, 2013)	Wheat bran (WB) Locust bean gum (LBG) Granular RS2-type corn resistant starch (RS) Combination of: 0-20% WB; 0-20% RS; 0-3% LBG	WB: reduced specific volume, crumb luminosity; increased high-speed mixing time, crumb chroma and crumb moisture content. Good results in the sensory evaluation. LBG: reduced crumb luminosity, increased crumb moisture content, but reduced high-speed mixing time. Good results in the sensory evaluation RS: increased high-speed mixing time; it was a more "inert" fibre in relation to bread quality characteristics. Good results in the sensory evaluation.
Bread (Peressini & Sensidoni, 2009)	Inulin ST; DP 10 Inulin HP; DP 23 Inulin HP-gel; DP 23 Substitution: 2.5, 5 and 7%	ST: lower changes in linear viscoelastic properties of dough; no negative effects on crumb hardness and volume of bread prepared with flour suitable for breadmaking. Addition of inulin ST over 5% caused sweet taste. HP: higher changes in linear viscoelastic properties. Breads with 5% inulin ST and HP: high sensory acceptance. Flour replacement at different levels by inulin change

		dough machinability, viscoelasticity and breadmaking performances.
Bread (A. Skendi, C.G. Biliaderis, Papageorgiou, & Izydorczyk, 2010)	Barley ß-glucans Substitution: 0.2, 0.6, 1.0 and 1.4%	Increase in the farinograph water absorption of the doughs with increasing fortification level. High molecular weight preparation had a greater impact. Breads containing barley ß -glucans showed lower moisture loss during storage than control. Increasing the ß -glucan content increased the number of gas cells but it produced a coarser and darker crumb structure with less rounded cells. The addition of ß -glucans decreased the firmness of bread during storage.
Cake (Gómez, Oliete, Rosell, Pando, & Fernández, 2008)	Chickpeaflour Substitution: 50 and 100%	At increasing substitution percentage decreased cake volume and symmetry, texture became firmer, more gummy and less cohesive. The changes are minimized if white chickpea flours are used instead of whole chickpea flours.
Cupcake (Lebesi & Tzia, 2011)	Wheat flour with dietary fibre (DF) from oat, wheat, maize, barley. Cereal bran (CB) from oat, rice and wheat. Substitution: 10, 20 and	DF addition improved cake volume, texture, sensory characteristics in contrast to CB, and prolonged the shelf-life. Wheat fibre and oat fibre up to 30%, improved quality characteristics of

	30%	cupcakes. CB yielded firm cakes that had low volume, low moisture, compact crumb texture, and low sensory acceptability.
Cake (Sudha, Baskaran, & Leelavathi, 2007)	Apple pomace blends Substitution: 10, 20 and 30%	At increasing level of substitution: water absorption, density and hardness mixing tolerance, index resistance to extension values increased significantly; the volume of the cakes, dough stability and extensibility values decreased. Apple pomace having high amount of TDF can function as a valuable source of dietary fibre in cake making.

Fibres can have multiple functions in bakery applications. Some fibres can provide creamy viscosity which can act as a partial fat replacer; this is useful for products with a higher amount of fat e.g. cakes and cookies. Other fibres can deliver a prebiotic effect, which have benefits for the human gastrointestinal health.

Common fibres that are used in bakery products can be divided into three categories. The first one is cereal and cereal by-products such as wheat, oat, barley and rice. The second one is non cereal sources, e.g. nuts, pea, orange, sugar beet, potato and apple. And the last category is commercial hydrocolloids which can be gums (guar gum, gum Arabic), cellulose, oligosaccharides (inulin, maltodextrins) (Foschia, Peressini, Sensidoni, & Brennan, 2013).

In the following paragraphs, a description of the most common and interesting fibers for the bakery sector have been reported.

Inulin

Inulin is widely used in the processed foods. It is mainly used as a fat or sugar replacer or to impart desirable characteristics. Inulin gives only 25–35% energy as compared to digestible carbohydrates (Shoaib, et al., 2016). This fiber can deliver different functionalities depending on its structure, which in turns is related to the type of source. Inulin can be highly branched or linear. In presence

of water, the highly branched inulin can develop a gel network able to alter the product texture and provide a fat-like mouthfeel. As a consequence, this type of inulin behaves as a hydrocolloids and is manly suitable for fat replacement in different food matrices (Paciulli, et al., 2020; Samakradhamrongthai, et al., 2021). Short-chain inulin molecules enhance flavours and sweetness. This is often used to partially replace sucrose. From bakery perspective, inulin has more properties besides the sugar-and fat replacer property. It will keep the baked products moist and fresh for a longer time and it improves crispiness. Inulin can be used in a range of 0.2%-5.0% without having adverse effects on gluten hydration and dough handling properties (BAKERpedia, 2020).

Citrus fibre

Citrus fibre can be obtained from different industrial sources and different kind of fruits. Fruits such as lemons, limes, oranges, grapefruits and pomelos. Fibres can be found in the peels and pulp of the fruits. One of the reasons why citrus fibre is getting more popular is because the availability of citrus. Citrus is the most abundant crop in the world. Global industrial waste may be more than 15x106 tons, as the amount of residue obtained from the fruit accounts for 50% of the original whole fruit mass. This causes a severe environmental problem (Marín, Soler-Rivas, Benavente-García, Castillo, & Pérez-Alvarez, 2007).

Looking at the functional and technological properties of citrus fibre, the main advantage of citrus fruits is the higher proportion of soluble dietary fibre in comparison to alternative sources (e.g. cereals). This soluble fibre is mainly pectin and cellulose. Depending on the source of the fibre, the ratio pectin/cellulose differs. Due to the presence of pectin, citrus fibre has another advantage namely it's gelling, thickening, stabilizing and water-binding (emulsifying) capabilities. It's in the food industry mainly used as fibre enricher, fat replacer and water binder.

Due to the emulsifying properties of citrus fibre, it can be a possible egg and oil replacer in baked foods.

Wheat fibre

Wheat fibre is sourced from the wheat plant and is an insoluble fibre. Benefits of this ingredient are the neutral taste and colour. Adding wheat fibre to products will improve the texture and stability of fibre enriched products. The fibres will not react with other ingredients, besides a special property of the fibre is the capillary which allows a temperature independent water binding and water retention (VITACEL Wheat Fibre Awarded with the ECARF Seal of Quality, 2007).

Soluble corn fibre

This fibre is sourced from corn and can be labelled as soluble corn fibre or as maltodextrin. Besides the prebiotic health benefits (Allgeyer, Miller, & Lee,

2010), soluble corn fibre can be combined easily with insoluble fibres. Products containing insoluble fibres do not always contain enough fibre to reach both claims, addition of soluble corn fibre can help with meeting the daily recommended amount and combine their nutritional benefits as well as to ensure taste and texture since insoluble fibres have organoleptic properties. Soluble corn fibre can act as a sugar replacer, it has a sweet taste and is a low-calorie fibre.

Acacia fiber

Acacia fiber is also well known as Acacia gum or gum Arabic. In the confectionary industry Acacia gum has been used as a stabilizer, emulsifier, binder, and thickening agent (Phillips, Ogasawara, & Ushida , 2008). It is a complex polysaccharide and so a soluble dietary fiber. It is a natural gum consisting of the hardened sap of two species of the Acacia tree: Acacia Senegal and Acacia Seyal. Senegal can be widely used across different applications; however, it is mostly used as an emulsifier. This is due to the structure of Acacia gum which consists of 3 components including major fraction of arabinogalactan, minor fraction of glycoprotein and complex fraction of arabinogalactan protein (Jin, et al., 2017). This last fraction makes the difference between the two species of Acacia gum. Arabinogalactan protein has a wattle blossom structure and is the effective component for emulsification properties. Acacia Senegal behaves more as an emulsifier than Acacia Seyal due to the higher content of arabinogalactan protein. Acacia Seyal is often used as a fiber and has a bulking property. Acacia fiber behaves like sugar in a system to retard crystallisation, making smaller crystalline structures and more of them. The sugars in acacia fiber are Arabinose, Rhamnose and Galactose and these are mostly complexed together into a highly branched carbohydrate structure.

Gum acacia is a clean label, natural, consumer-friendly ingredient with noteworthy sustainability benefits. Emulgold is produced using natural resin from the acacia tree from the Sahel region of Africa. Local farmers, who harvest the gum in a sustainable manner that does not damage tree formation, often do so as a form of secondary revenue, making it a critical income generator within vulnerable communities. Acacia is aligned to the importance consumers place on sustainable, naturally derived, clean ingredients that support farmers and growers.

One of Kerry's collections ingredients is Emulgold™ fibre. Emulgold™ is a selected acacia gum (Phillips, Ogasawara, & Ushida , 2008) coming from acacia trees that delivers several health benefits such as prebiotic and satiety effect, ability to reduce GI in the product, low caloric value and non-cariogenic consequences (Calame, Thomassen, Hull, Viebke, & Siemensma, 2011). For

these reasons, Emulgold™ has been identified as the right ingredient in order to fulfil consumer and manufactures demand for fiber enriched products.
The dietary fibers have been recognized as ingredients able to deliver several benefits for the human health. However, the worldwide fibre intake is lower than the given recommendations, which are at least 25-29 g of fibre per day.
Therefore, this presentation has been focused on fibre enrichment in baked goods (white tin bread, muffins and biscuits) in order to achieve the claim "high in fibre" (6 g/ 100 g in the final product). The dietary fibres taken under investigation for this project are inulin, soluble corn fibre, citrus fibre, wheat fibre and acacia fibre (Emulgold™, Kerry Ingredients, Ireland) and their impact on processing, dough/batter rheology and finished product quality (crumb texture, water activity, moisture content, specific volume, sensory) have been described.
The study showed that acacia fiber performed very well in white bread when some adjustment in the recipe and process have been applied. In particular, the reduction of water in the formulation, the extension of the mixing time gave a product comparable with the standard (no fiber added) in terms of dough handling, volume, texture and taste.
The bread was overall softer than Reference and maintained a moisty crumb over shelf-life. On the contrary, the crumb structure and texture were compromised when competitor fibres were added.
Acacia fiber had a negative impact on the batter and finished product of the muffin. However, corn fiber and inulin showed better performances during processing and in the finished product than acacia fibre in this project.
The addition of all the different fibers, considered in this project, in biscuit application resulted in a harder and crunchier biscuit.
To conclude the use of acacia fiber did not impact negatively the quality of white bread in terms of volume, crumb texture and sensory.
Among all the fibers tested, acacia fiber has been identified as the ideal ingredient to use for fiber enrichment in bread type applications. Acacia fiber had a negative impact on the muffin batter and finished product, while inulin and soluble corn fiber showed better performance and so might be preferred for this type of product.
The presence of acacia fiber, as well as the competitor, caused an evident increase of hardness and crunchiness in the biscuits; the only fiber that was performing slightly better was inulin.
However, the texture was not acceptable from a sensory point of view.
In general, this study seemed to indicate that soluble fibers are suitable for fiber enrichment in baked goods.

Overall, with addition of fibres to a product, adjustments needed to be made in the recipe and process to maintain dough or batter quality and the quality of the finished products. Due to the physical and chemical properties (molar weight, particle size, concentration, type of sugar), fibres might have an impact on the gluten development, dough stability, starch gelatinization and, as a consequence, on the finished product quality.
In bread bakery (white bread and burger bun application), the addition of acacia fibre showed the best performances due to the minimal impact on specific volume, crumb firmness, crumb structure and eating properties over shelf-life; however, in order to obtain a high in product quality, it is important to lower amount of water in the formulation, prolong the mixing time and/or apply acacia fibre as a solution.
While in fine bakery, particularly in muffin application, corn fibre and inulin showed better results than acacia fibre. Acacia fibre resulted in a higher viscous batter and underbaked muffin.
Despite the colour changes with soluble corn fibre or inulin, the crumb texture of the muffins were comparable to the reference; tehrefore, these two fibres could be considered suitable ingredients to use to deliver high in fiber claim in muffin application.
The addition of the fibres in biscuits did not affect the biscuit dough, however they did have an impact on the final baked quality of the biscuits; in particular, the hardness and crunchiness of the biscuits increased at a level that the product could not be considered acceptable.
However, only inulin gave a product that could be considered acceptable from the sensory panel. Based on this consideration, inulin might be preferred over the other types of fibers.

In general, looking at the two types of fibres (soluble and insoluble) that have been tested in this project, soluble fibres should be chosen as the most suitable for fibre enrichment in bakery products.

4.2. Application of acacia fiber (Emulgold™) in white tin bread

In this work, acacia fiber (Emulgold™) has been applied in white tin bread in order to achieve the claim “high in fibre” (6 g/ 100 g in the final product) and the impact on processing, dough rheology and finished product quality has been evaluated.

Materials and method

Mixing Properties

Mixing dough properties have been measured by Mixolab 2 (Chopin technologies, France; Figure 4.2).

The water absorption of the wheat flour as been compared to the dry blend "wheat flour + acacia fiber" thanks to the farinograph test carried out at 30 °C for 30 min.

Figure 4.2. *Mixolab 2, Chopin technologies*

Rheological analyses have been performed in triplicate.

White Bread formulation

In Table 4.2. has been reported white bread formulation for Reference and high in fibre (T1).

As reported in Table 4.2, the level of water has been decreased by 9.3% compared to reference.

This adjustment has been based on farinograph analysis (Mixolab 2, Chopin technologies, France;

Figure 4.2., where the water absorption has been evaluated.

The farinograph results showed that the water absorption (on 14% moisture flour basis) decreased from 54% to 49%.

The wheat flour (Meneba Kolibri, The Netherlands) contained 10.7% of protein, 2% of fiber and 15.5% moisture, while acacia fiber (Emulgold™, Kerry, Ireland) 1% of protein, 85% of fibre and 9% of moisture content. Netherlands).

Table 4.2: *Reference and high in fibre (T1) white bread formulations*

		Reference		T1	
Ingredients	**ppm**	**%**	**g**	**%**	**g**
Wheat flour		100	3100	100	3000
Water		57.00	1767	51.70	1551
Fresh Yeast		3.50	108.5	3.50	105
Salt		1.40	43.4	1.40	42
White Shortening		1.00	31	1.00	30
Ascorbic Acid	60		0.186		0.18
Enzymes	55		0.1705		0.1705
Calcium Propionate		0.4	12.4	0.4	12
Acacia fibre				8.15	244.5
TOTAL			**5063**		**4985**

In order to achieve the high in fiber claim: 8.15% acacia fiber (Emulgold™, Kerry ingredients, Ireland) has been added.

White tin bread production

All the ingredients were mixed in a spiral mixer (Kemper, Germany; Figure 4.4.a).

The Reference dough has been mixed for 9 min (mixing settings 500/1500), while T1 for 10 min and 45 s (mixing settings 500/2000).

The prolonged mixing step for T1 has been selected in order to allow the gluten development and has been carried out adding some ice during the mixing step in order to maintain the dough temperature in the range of 25-27 °C.

Once the dough was formed, it was rested for 5 min at room temperature covered with a cloth. After the resting step the dough quality (baker's touch), temperature and pH were measured.

Thereafter, dough was divided into pieces of 380 g and moulded through a round molder (Benier, The Netherlands; Figure 4.5) with a 5 min rest.

After the resting time, the round balls are moulded through a flatbed moulder system (Benier, The Netherlands; Figure 4.4.b).

Proofing step was carried out in a proofing cabinet (Wachtel Stamm Octopus) at 35 °C and 85% relative humidity for 60 min.

Loafs were baked in a deck oven (Wachtel with four trays) at 230 °C for 30 min with 3 s of steam at beginning of the baking. Baked loaves have been cooled down for 2 hours and packed in plastic zip lock bags.

Samples were stored for 12 days at room temperature. In Figure 4.3, the diagram of the white tin bread production.

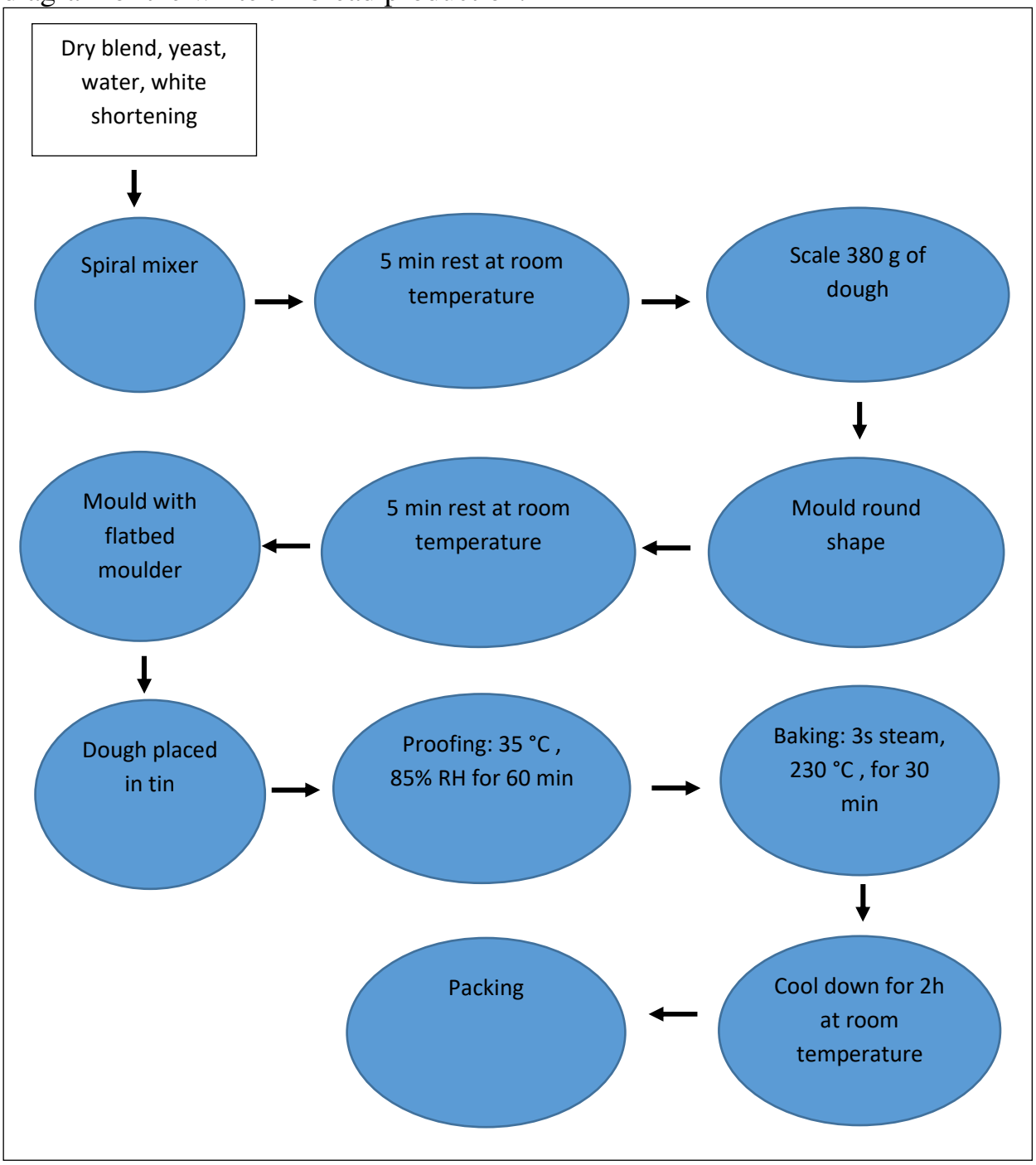

Figure 4.3. *White tin bread production*

a)

b

Figure 4.4. a*) spiral mixer (Kemper, Germany); b) flatbed moulder system (Benier, The Netherlands)*

Figure 4.5. *Round molder (Benier, The Netherlands)*

Bread quality measurements

To evaluate the quality of the baked products, several measurements has been carried out which includes water activity (mod. Aqualab CX-2, Decagon Devices Inc.™, Washington, USA) and moisture content (AACC Standard 44-154A) over shelf-life.

Crumb firmness and resilience (the capacity of the bread crumb to recover after been subjected to a compression force) have been measured by Texture Analyzer (TA.XT Plus, Stable Micro System, UK;

Figure 4.6.a) equipped with a 5 kg load cell.
Two slices of bread (12.5-mm-thick each slice) were subjected to a double compression with a 35 mm probe (Figure 4.6.b) at 1 mm/s to 50% of their original height with a gap of 30 seconds gap between the two compressions.
This analysis has been carried out over shelf-life (day+1, day+4, day+11). Analysis has been performed in triplicates.

Figure 4.6. *a) Texture Analyzer (TA.XT Plus, Stable Micro System, UK); b) 35 mm probe*

Sensory Evaluation
Sensory of white bread has been evaluated with the attributes which are shown in the template below:
Table 4.3.

Day+1	**Trial 1**													
	Insufficient				**Excessive**			**Insufficient**				**Excessive**		
	-3	-2	-1	0	1	2	3	-3	-2	-1	0	1	2	3
Softness to touch				0										
Crumb color				0										
Crumb porosity				0										
Resilience				0										
Sensory (Softness)				0										
Moistness				0										
Taste				0										
Aroma				0										
Aftertaste				0										
Cohesiveness				0										

For each attribute the Reference has been scored zero and T1 has been evaluated in comparison with Reference. The sensory evaluation has been carried out by 4 expert panelists.
Results and discussion
Dough evaluation The dough of Trial 1 was slightly less soft than reference. However, the differences were minimal and the processability of the dough of both samples were comparable.

Table 4.4. *Production parameters*

	Reference	**T1**
Baking time (min)	30	30
Proving time (min)	60	60
pH	6	5.8
Dough temperature (°C)	25	27

Bread quality

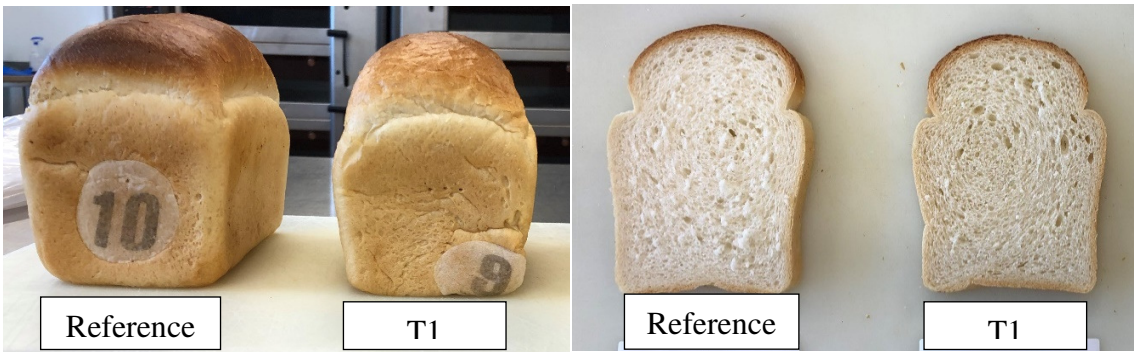

Figure 4.7*: Pictures of bread loaves and slices for Reference and T1 (high in fibre)*

As shown in Figure 4.6, Reference and T1 showed comparable volume and appearance, indicating that the presence of acacia fibre does not affect negatively these parameters.

Crumb Texture The texture has been analyzed over shelf-life on day +1, day+4 and day+11 in terms of resilience (%) and firmness (N). These results are shown below in Figure 4.8.

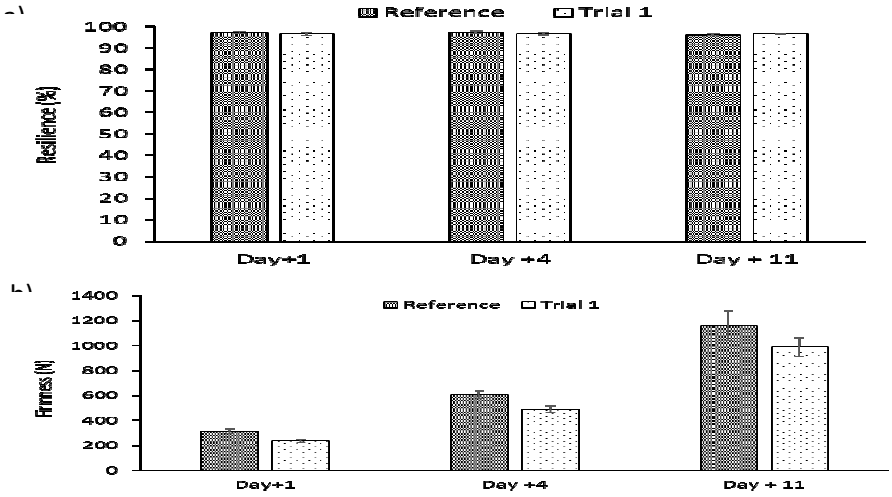

Figure 4.8. *Changes in a) crumb resilience (%) and b) firmness (N) of Reference and T1 over shelf-life.*

Figure 4.8 shows that reference and T1 were comparable in terms of resilience. The crumb firmness for T1 (high in fibre) was softer than Reference over shelf-life, probably due to less available water in the system that usually impact on the staling process over shelf-life. In general, a softer crumb is well perceived by the consumers.

Water activity and moisture content

Water activity and moisture content have been evaluated over shelf-life. As reported in Table 4, on day +4 the water activity (aw) was lower than reference; however, at the end of the shelf-life the two samples had comparable values. In addition, the moisture content of Reference (Table 4.5) has been higher than T1 all the shelf-life. This is ascribable to the different level of water in the formulations. However, the moistness perception of the reference slice of bread while eating has not been perceived so high as expected as described in the sensory results in the following paragraph.

Table 4.5: *Water activity and moisture content of the bread samples during shelf-life.*

	a_w		**Moisture (%)**	
	Day +4	**Day + 11**	**Day +4**	**Day + 11**
Reference	0.973	0.9536	34.19	32.67
T1	0.951	0.9501	31.98	27.48

Sensory evaluation

The Reference and T1 bread have been tasted on day +1 and the sensory results showed that the samples were comparable in terms of texture, appearance, taste and aftertaste. The only difference detected was the moistness perception, that was higher for T1 than reference.

Conclusion

In conclusion, the addition of acacia fibre in white bread application does not impact negatively the dough rheology, processability, texture, appearance and taste of the product.

However, it is important to apply some adjustments to the formulation (water content) and process (prolonged mixing time) in order to maintain the quality characteristics of the final product.

The total dietary fibre content in the bread samples have been evaluated using an enzymatic gravimetric method based on AOAC 991.43 (Lee, Prosky, & DeVries, 1992).

The results confirmed that the claim "high in fiber" has been achieved (Table 4.6).

Table 4.6. *Nutritional profile for Reference and T1 (high in fiber) breads.*

Nutritional (100g)	Energy (Kcal)	Fat (g)	Protein (g)	Carbohydrates (g)	Fibre (g)
Reference	258	1.6	8.0	50.6	1.6
High in fibre (Emulgold™)	247	1.5	7.8	52.9	6

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CHAPTER 5.

TECHNOLOGY FOR THE MANUFACTURE OF BAKERY PRODUCTS WITH THE ADDITION OF PROBIOTICS FOR THE REGULATION OF THE DIGESTIVE SYSTEM

Food, and in particular fermented food, can be a vehicle for living microorganisms, some of which may be potentially beneficial to human health. However, only characterised strains with a scientifically proven effect on health, can be defined 'probiotics', according to the guidelines provided by the International Scientific Association for Probiotics and Prebiotics.
Probiotics must be identified by genus, species and strain. Strain designation is important because different strains can have varying effects on human health, even if they are members of the same species.
The dose to be taken is also a key parameter and can vary depending on the strain, its viability and metabolic performances, as well as the condition of the person receiving it. The recomended dose should correspond to the level shown to be effective in a study (preferably *in vivo*) to confer a health benefit.

5.1. Probiotics used in baking: general, role, use

The largest segment in the functional food market is represented by foods containing probiotic microorganisms (Soares et al., 2019). Probiotics are defined as live organisms that confer health benefits to the host when administered in adequate amounts (FAO/WHO 2006). Nevertheless, these benefic effects are obtained only if the probiotic food is regularly consumed, and the food matrix contains a minimum amount of viable probiotic microorganisms. This means that probiotic microorganisms have to survive through the food processing and storage, and through the gastrointestinal tract (Soares et al., 2019).
Bread is staple food in many countries and represents one of the most important sources of complex carbohydrates, protein, minerals and vitamins. During the last decades the consumers' interest increased towards probiotic-enriched foods, including baked products. The role of food and microorganisms in the health of gastrointestinal system is deemed as a key factor in the production of functional food with probiotic bacteria (Hosseininezhad and Abedfar. 2018). The major difficulty in the development of this kind of products is related to using microorganisms able to survive during the cooking. The thermal treatments applied in baking can result in significant losses of microbial viability during the manufacture and storage of bread (Côté et al., 2013).
It is known that certain bacteria can survive bread-baking, leading to the well-known 'rope' defect, which is caused by the germination of bacterial spores

usually conveyed by flour or yeast formulations. Spore-forming bacilli possess improved ability to withstand high temperature processes, such as baking and boiling, compared to other probiotic bacterial strains. Thus, probiotic spore-forming bacilli represent the most suitable choice to design functional baked products. Although safety, efficacy and functionality of probiotics are strain dependent, the most investigated bacterial species to develop probiotic bread is *Bacillus coagulans*, previously identified as *Lactobacillus sporogenes. B. coagulans* is a non-pathogenic, Gram-positive and spore-forming bacterium, which is included in the list of Qualified Presumption of Safety (QPS) compiled by the European Food Safety Authority. Ameliorating and protective effects were attributed to *B. coagulans* strains towards the symptoms related to gastrointestinal disorders and rheumatoid arthritis, colitis, and viral infections of the respiratory tract (Fares et al., 2015).

The incorporation of probiotic during the dough production is challenging because of high baking temperature. Soares et al. 2019, investigated the viability of three microbial species claimed having probiotic properties in different food matrixes including bread. After bread cooking (20 min at 180°), *Bifidobacterium* and *Lactobacillus* species did not survive, whereas *B. coagulans* was viable at a cell density of ca. 6 log CFU/g in the baked matrix. *B. coagulans* remained stable also over the shelf life of bread (25 °C for 7 days). Then, the survival rates of microbial strains of *B. coagulans* exposed to simulated gastrointestinal fluids were determined. The viability of *B. coagulans* after the transit through the gastrointestinal solutions was around 91%. The study showed that the food fortification with probiotic *B. coagulans* strains may represent a feasible strategy for expanding the range of probiotic food, especially for baked ones.

Zhang et al. (2018) investigated various baking and storage conditions in order to ensure the highest surviving of a *Lactobacillus plantarum* strain. In fact, the viability of bacteria is affected by the heat exposure time and dehydration stress (Hansen and Riemannet, 1963). If the baking time is shortened by increasing the baking temperature or reducing the bread size, higher residual viability may be obtained after baking (Zhang et al., 2018). Bread samples with different sizes and baked at different temperatures showed a decrease of probiotic viability from 9 to 4~5 log cfu/g. Since the temperature and moisture profiles are different between bread crust and crumb, the survival behavior of *L. plantarum* during cooking varied between crust and crumb (Zhang et al., 2018). During storage, bacterial viability increased up to 8 and 6 log cfu/g in crust and crumb, respectively. The regrowth of probiotics was accompanied by a decrease of pH and total titratable acidity of bread. These results provided a valuable base for further modelling and optimization studies. The testing of other microorganisms

or different baking conditions could contribute to the development of probiotic bakery products (Zhang et al., 2018).
In the last years, several strategies were developed to overcome the losses of probiotic viability during food processing, product storage and distribution, and under gastrointestinal conditions (Bustos et al., 2013). Nowadays, microencapsulation of probiotics in biopolymers is the most common route for keeping alive probiotic bacteria in food systems (Burgain et al., 2011). Encapsulating lactobacilli in calcium alginate was showed to improve their survival up to 80–95 % (Krasaekoopt et al., 2013; Sheu and Marshall, 1993). Soukoulis et al. 2014 developed a single probiotic strain entrapped within an edible film consisting of selected biopolymers including proteins, polysaccharides, and prebiotics. The edible film was effective to preserve *Lactobacillus rhamnosus* cells for at least ten days under room temperature condition. *L. rhamnosus* is a well-known probiotic bacterium normally used in dairy products (Soukoulis et al., 2014). *L. rhamnosus* is not heat resistant but it can be applied to baked bread by using microencapsulation or spry-on technology (Côté et al., 2013). According to Soukoulis et al. 2014, the viability of *L. rhamnosus* on bread crust was higher for samples coated with sodium alginate-whey protein concentrate respect to samples with sodium alginate only. The same protective effect was observed after in-vitro digestion of bread crust. Thus, the design of film forming solution is effective strategy to preserve the viability of bacterial cells. The presence of whey proteins in the film forming solution reduced the viability losses of *L. rhamnosus* GG during the air-drying step (10 minutes at 60°C or 2 minutes 180°), as well as throughout the storage and the simulated *in-vitro* digestion. Apart from *L. rhamnosus*, other *Lactobacillus* species were tested to produce bread conveying probiotic cultures using microencapsulation technics. *L. acidophilus* entrapped within a starch-based edible coat at an initial concentration of 4.83 log cfu/g was shown to survive after cooking (Soares et al., 2019). The use of a coating with a double starch layer allowed better to preserve cells viability. The reduction in the microbial counts during the storage period was similar, independently of the coating layers (~1,22 log cfu/g) (Altamirano-Fortoul et al., 2012). The combination of microencapsulation with the addiction of prebiotic may improve the cells viability and the stability of capsules. According to the literature, several studies combined the microencapsulation with the addiction of inulin to develop a symbiotic bread. Seyedain-Ardabili et al. (2016) formulated a symbiotic bread enriched with 5% of inulin and probiotics encapsuled in edible coating starch. Under this condition, *Lactobacillus casei* was more resistant to the high temperatures than *Lactobacillus acidophilus*. Some reports are also available on the antidiabetic properties of symbiotic breads under *in vivo* studies

conditions (Sadat Ebrahimi et al., 2017; Bahmani et al., 2016). Thus, edible coatings could be used as vehicle for microorganisms to obtain functional baked goods, and starch solution is valid to protect microcapsules and bacterial cells during baking and storage time (Altamirano-Fortoul et al., 2012; Mansouripour et al., 2013).
Anyway, the viability registered for probiotic lactobacilli after baking was significantly lower than viability registered for other heat-resistance probiotics such as *B. coagulans* or *Bacillus subitlis.*
Further studies are needed to evaluate the survival of further probiotic species and strains under baking conditions, by using novel microencapsulation techniques and coating materials.
More investigations should be considered using consumer- and product-oriented tests, as well as *in vivo* test to confirm the healthy effect of probiotic bread (Zhang et al., 2018).

5.2 The role of the intestinal microbiota

Gut microbiota has a key immune function, maintaining intestinal epithelial integrity, inhibiting pathogens bacteria growth, and affecting the development, homeostasis and function of innate and adaptive immune cells.

Furthermore, intestinal microbes metabolize dietary components, converting them into harmful or beneficial metabolites, with consequences for human health. Conditions of microbial imbalance and specific genetic settings may contribute to the dysfunction of host metabolism and physiology, affecting the incidence and progression of several intestinal related disorders (De Angelis et al., 2019; Cristofori et al., 2018; Pecora et al., 2020).

According to the recent literature, changes in the composition and function of the gut microbiome are linked to chronic inflammatory diseases, like the celiac disease (Cristofori et al., 2018; Pecora et al., 2020).

While recognising that a gluten-free diet has an impact on the composition of the gut microbiota and is therefore a contributing driver, several studies support the hypothesis that the microbiota plays a role in the pathogenesis, clinical manifestation, and risk of developing coeliac disease (Fig. 5.1) (Cenit et al., 2015).
Cristofori et al., 2018; Pecora et al., 2020).

Although the published results may differ due to variation in microbiological methods, sample size, and patient characteristics, there is substantial agreement

on the imbalance between proinflammatory and anti-inflammatory species in individuals with celiac disease, with proinflammatory species being predominant (Cristofori et al., 2018).

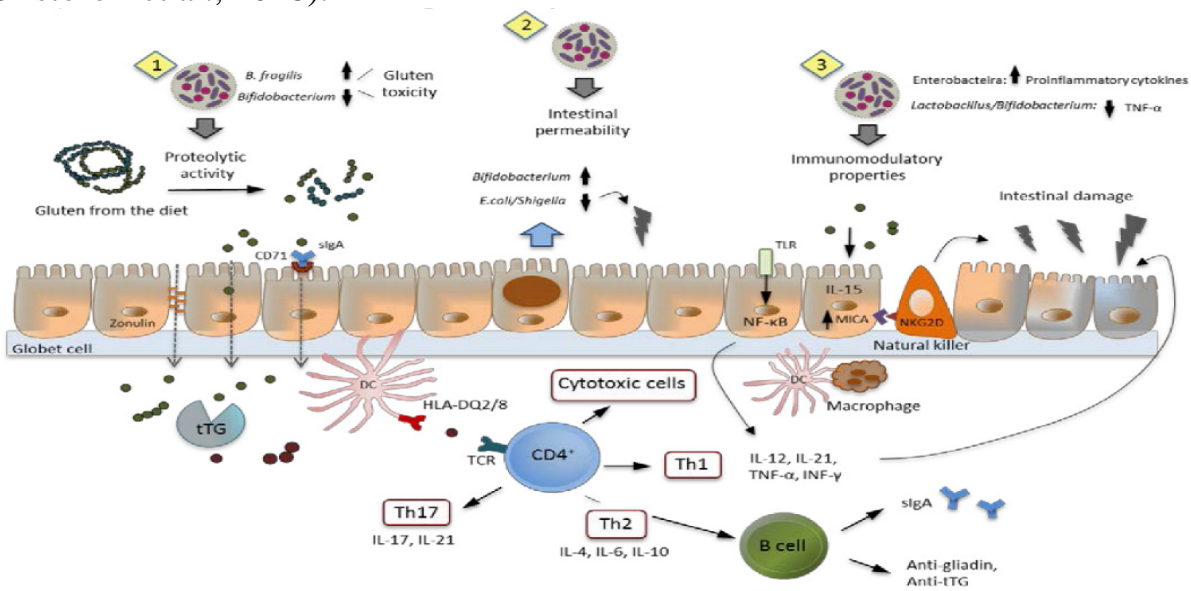

Fig. 5.1. *Microbiota and celiac disease: cause, consequence or co-evolution? (reproduced from Cenit et al., 2015 according to the Creative Commons Attribution License [CC BY 4.0]* [https://creativecommons.org/licenses/by/4.0/] which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited).

Several approaches targeting the microbiota have been developed aiming to ameliorate gluten-related disorders. These mainly include oral applications of selected protein/peptide hydrolases (e.g. glutinases) or bacteria (e.g. *Lactobacilli* and/or *Bifidobacterium spp*.). The latter approach also has a beneficial influence on the composition of the intestinal microbiota (De Angelis et al., 2021).

To obtain the digesting of gluten into non-toxic and non-immunogenic peptides/amino acids under human gastrointestinal conditions, De Angelis et al. (2021) assembled a microbial consortia, comprising *Bacillus* sp. and lactic acid bacteria, able to act in a complementary way with a mixture of commercial gluten-hydrolyzing enzymes and microbial cytoplasmic enzymes.

Using a large number of strains (504) previously isolated from the human intestine or food matrices, *ad-hoc* bacterial strains were selected based on resistence to gastrointestinal conditions and complementary peptidase activities (PepN, PepI, PepX, PepO, and PepP) which are potentially responsible for the hydrolysis of 33-mer and other gluten immunogenic epitopes (57–68 of α9-gliadin, 62–75 of A-gliadin, and 134–153 of γ-gliadin) (Fig. 5.2). Lactic acid bacteria and *Bacillus* strains selected by De Angelis et al. (2021) may also be

applicable in food biotechnologies to partially or totally hydrolyze gluten in cereal-based products.

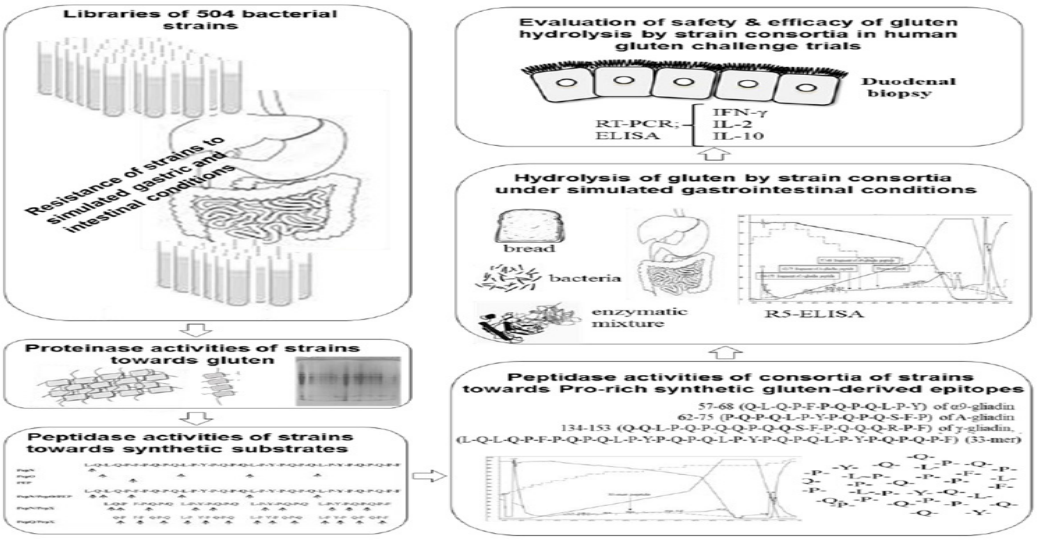

Fig. 5.2. Spore forming probiotics: protocols to select strains degrading gluten (modified from De Angelis et al., 2021 according to the Creative Commons Attribution License [CC BY 4.0] [http://creativecommons.org/licenses/by/4.0/] which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited)

5.3 Technology for the manufacture of bakery products with *Bacillus coagulans GBI-30*

Probiotics and introduction to GanedenBC^{30} *Bacillus coagulans GBI-30*

The most common worldwide infections are the ones affecting the respiratory and gastrointestinal tracts. Respiratory infections in children cause over 4 million deaths per year and 20-30% of hospitalization in the world (WHO, 2015). Upper-respiratory tract infections affect nose, sinuses, pharynx, and larynx, and encompass diagnoses such as common cold, sore throat, nasal obstruction, pharyngitis, laryngitis, and sinusitis (Simoes, et al., 2006). These types of infections are usually caused by some virus families such as the rhinovirus, parainfluenza, respiratory syncytial virus, adenovirus, human metapneumovirus, and bocavirus (Cotton, Innes, Jaspan, Madide, & Rabie, 2008).

Acute gastrointestinal infections is the second leading cause of death in children under the age of five years, particularly in developing nations, even though the cause is easily preventable and treatable (Sanyaolu, et al., 2020). The

introduction of antibiotics has reduced the acute symptoms and side effect caused by these types of infections. However, they have been associated with the development of antibiotic-resistant bacteria. For this reason, it has grown the interest to identify immunomodulatory agents. Probiotics are live bacteria defined as microorganisms that when ingested in a sufficient amount confer a health benefit upon the host and are known to interact with the immune system (Anaya-Loyola, et al., 2019). Oral consumption of probiotics can directly alter the gut microbiota by increasing the diversity and number of beneficial microbes, potentially leading to changes in microbiota-derived metabolite production. Probiotics can deliver several benefits to the human health:

- prevent and treat antibiotic-associated diarrhea and acute infections
- relieve symptoms of irritable bowel syndrome
- stimulate the immune response
- stabilize or maintain the gastrointestinal barrier function
- prevent pathogens to infect the mucosa
- treat atopic dermatitis in children

It is important that the selection process of probiotic strains meets both safety and functionality criteria, as well as those related to their technological usefulness as per WHO, FAO, and EFSA (The European Food Safety Authority) suggestions. The selection criteria of probiotic strain has been summarized in Table 5.1. (FAO, 2002; EFSA, 2005).

Table 5.1. *Selection criteria of probiotic strains (Markowiak & Śliżewska, 2017)*

Factor	**Required properties**
Safety	Human or animal origin Isolated from the gastrointestinal tract History of safe use Precise diagnostic identification (phenotype and genotype trials) Absence of data regarding an association with infective disease Absence of ability to cleave bile acid salts No adverse effects Absence of genes responsible for antibiotic resistance localised in non-stable elements
Functionality	Competitiveness with respect to the microbiota inhabiting the intestinal ecosystem Ability to survive and maintain the metabolic activity, and to grow in the target site

	Resistance to bile salts and enzymes Resistance to low pH in the stomach Antagonistic activity towards pathogens (e.g. *Salmonella* sp., *Listeria monocytogenes*, *Clostridium difficile*) Resistance to bacteriocins and acids produced by the endogenic intestinal microbiota Adherence and ability to colonise particular sites within the host organism, and an appropriate survival rate in the gastrointestinal system
Technological usability	Easy production and high biomass amount and high productivity of cultures Viability and stability of the desired properties of probiotic bacteria during the fixing process (freezing, freeze-drying), preparation and distribution of the probiotic products High storage survival rate in finished products (in aerobic and micro-aerophilic conditions) Guarantee of desired sensory properties of finished products (in the case of food industry) Resistance to bacteriophages

Probiotic characteristics are not associated with the genus or species of a microorganism, but with few and specially selected strains of particular species. The most widely recognised as probiotics and extensively studied for their immunomodulatory activities are *Bifidobacterium* and *Lactobacillus* (Hor, et al., 2018; Ranadheera, Naumovski, & Ajlouni, 2018; Anaya-Loyola, et al., 2019). Probiotic bacteria such as the *Lactobacillus* species are very sensitive to some environmental conditions such as low pH, which is present in the human stomach. In addition, the viability of these bacteria is affected by manufacturing methods as well as storage and shipping conditions (Ljungh & Wadstrom, 2006). Nevertheless, some strains of *Bacillus coagulans* are able to survive extreme conditions such as heat, acidity of the stomach and bile acids (Hyronimus, Le Marrec, Hadj Sassi, & Deschamps, 2000). Thanks to these characteristics, the strains have an increased chance of survival through the gastrointestinal tract (Adami & Cavazzoni, 1999). *B. coagulans*, when taken orally, has also shown beneficial effects on the intestinal environment, stool frequency and characteristics, and dermal attributes in animals and humans (Adami & Cavazzoni, 1999; Donskey, et al., 2001; Katsutoshi, et al., 2003).

GanedenBC^{30}

GanedenBC^{30} (*GBI-30, 6086*) is a strain of the gram positive, lactic acid producing spore-forming bacteria known as Bacillus *coagulans*. This strain of *B.*

coagulans can survive extreme conditions of heat and pressure during processing as well as the acidic environment of the human gastrointestinal tract, leading to a very high survival rate and germination in the lower intestinal tract. This prebiotic has been reported to enhance immunological response *in vitro* of healthy human adult cells to common viral causes of upper-respiratory tract infection (Kimmel, Keller, Farmer, & Warrino, 2010). Moreover, Kalman, et al., (2009) and Anaya-Loyola, et al., (2019) reported that GanedenBC^{30} reduced gastrointestinal tract infections symptoms in adults and children with post-prandial intestinal gas-related symptoms.

Due to the high resistance to adverse conditions, GanedenBC^{30} can survive most food manufacturing process; only few limitations apply as reported in Table 5.2.

Table 5.1. *Manufacture processes where GanedenBC^{30} can survive and where there are some limitations.*

High survival	Limitations
Powder blending	UHT/UP*
Baking	Retort
HTST Pasteurization	Hot, high moisture and long hold times
HPP Pasteurization	Shelf stable beverages*
Boiling	
Microwave	
Freezing	
Shelf Stable Products with water activity < 0.75	*Possible with available technologies

GandenBC^{30} in Bakery

In food application, GandenBC^{30}, which is in powder format, can be added directly to the dry mix (e.g. flour) without affecting the standard manufacture process.

In addition, no impact on dough rheology and final product quality such as texture, taste and appearance have been shown.

GandenBC^{30} can be easily applied in digestive biscuits; recipe of this type of product has been reported in .

Table 5.3. and manufacture flow chart.

Table 5.3. Digestive biscuit recipe

Ingredients	**%**
Wheat flour	47.38
Wholemeal wheat flour	13.42
Palm Fat	12.40
Sugar	10.00
Water	10.00
Invert Syrup	4.20
Sodium Bicarbonate	1.14
Ammonium Bicarbonate	0.50
Skimmed Milk Powder	0.45
Malic Acid Granulated	0.23
Salt	0.28

Total	100

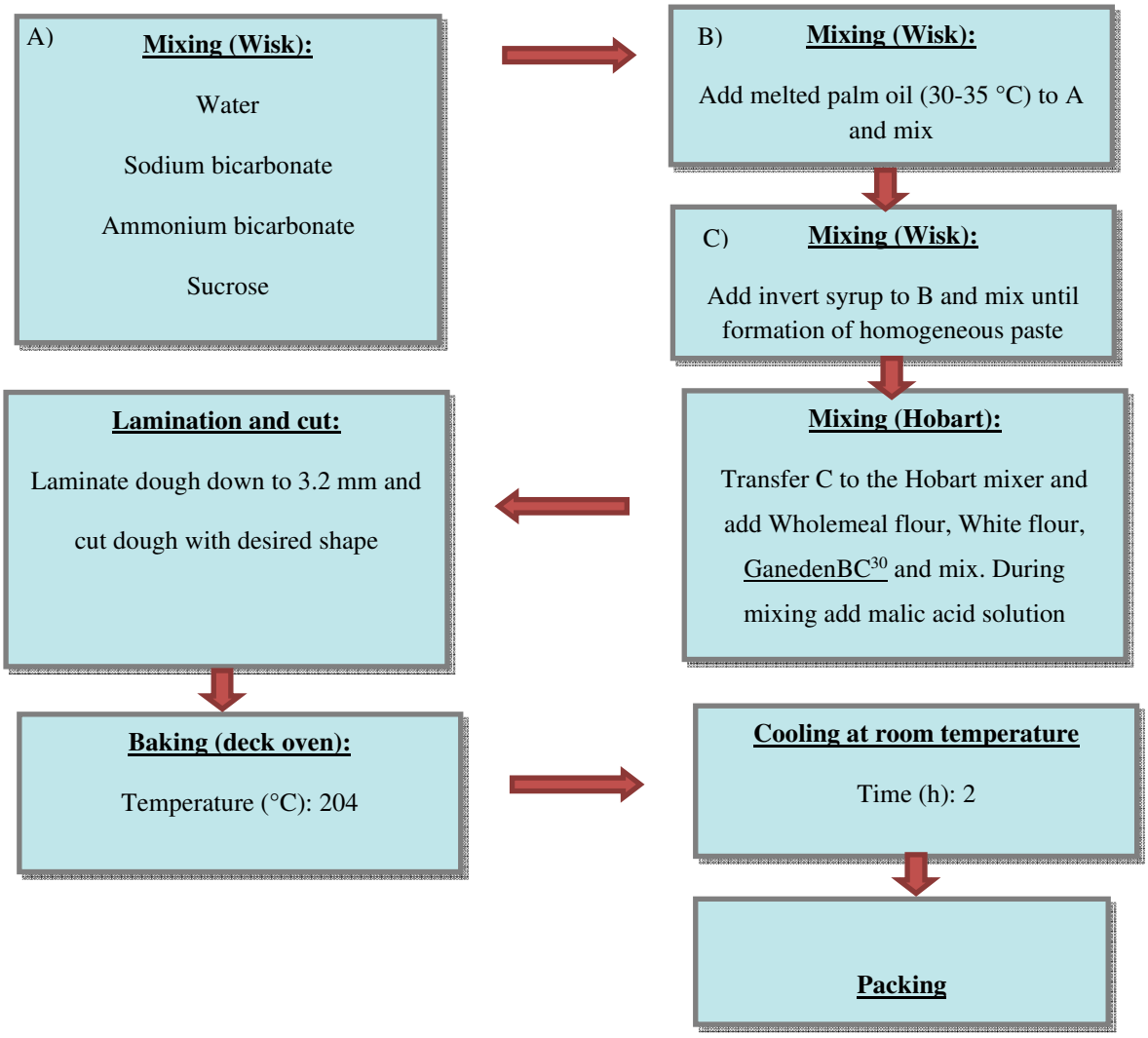

Figure 5.3. *Manufacture flow chart for laminated digestive biscuits*

From a regulatory point of view, GanedenBC^{30} has been worldwide approved; depending on the regional regulation, GandenBC^{30} can be claimed as culture (manly in Europe), probiotic or functional food and digestive/health claim can be stated in Oceania, North America and some countries of South and Central America.

Baked goods containing this culture are already available in the market as shown in Fig.5.4

Figure 5.4. *Baked goods containing GandenBC30 available in the US market*

Conclusions

Probiotics are living microorganisms that boost health when consumed in adequate amounts. There are many different types that can be obtained from foods or supplements. These microorganisms may help to cure various digestive problems, including antibiotic-associated diarrhea and Irritable Bowel Syndrome (IBS). However, the benefit of probiotic treatment for IBS still needs to be further investigated before the healthcare system can be confident to prescribe it on a routine basis. Some studies have indicated that certain gut bacteria may be able to help treat cognitive and neurological disorders, such as autism, Alzheimer's disease, and Parkinson's disease. In addition to their potential effects on weight loss, digestion, and neurological disorders, probiotics may improve heart health, immune function, and symptoms of depression and anxiety.

There is an increasing interest by consumers to purchase foods containing health-enhancing ingredients. Therefore, GanedenBC^{30} *Bacillus coagulans GBI-30, 6086* represents the prefect option to accomplish health and wellness goals. Its suitability for food applications is due to the superior viability compared to other probiotic strains. GanedenBC^{30} survives most manufacturing processes and against gastric acidity and bile salts. In addition, its safety is irrefutable (over 7

billion individual doses sold and not a single reported adverse reaction). Thanks to these characteristics and its long shelf-life (up to three years), this lactic acid producing spore-forming bacteria has been sold in more than 900 foods in over 38 countries.

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CHAPTER 6.

TECHNOLOGY FOR THE MANUFACTURE OF BAKERY PRODUCTS WITH LOW SUGAR AND FAT CONTENT

The two main sources of sugar in processed products on the market are sugar-sweetened beverages and sweet bakery products. Sugar reduction is challenging, especially in baked goods, since it interacts significantly with all ingredients. These interactions cause an increase in gelatinization temperature, a delay in gluten network development, an increase or decrease in yeast activity depending on the sugar concentration, as well as an enhancement of emulsification. Reflecting the molecular interactions on the product quality characteristics of different types of baked goods, sugar also contributes to browning reactions and extension of microbial shelf life. During cake preparation, sugar supports the batter aeration, which results in the typical soft cake crumb. Furthermore, it contributes to the spreading process of biscuits during baking and enhances surface cracking due to recrystallization. Sugar reduction requires the development of different strategies; the two best-known strategies are the replacement of added sugar by the combination of bulking agents and high-intensive sweeteners, or by sweet bulking ingredients, such as polyols (Sahin AW. 2019).

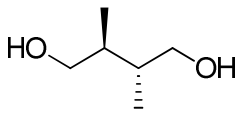
6.1. Sugars in bakery products

Sugar alcohols (polyols)

Polyols are sugar alcohols, which are either produced by chemical or biochemical reduction of sugars, or during fermentation using lactic acid bacteria or yeast. They may be categorized as monosaccharide-derived (erythritol, mannitol, sorbitol, and xylitol), disaccharide-derived (isomaltitol, lactitol, maltitol, and trehalose), and polysaccharide-derived (hydrogenated starch hydrolysates) compounds. Generally, polyols are lower in calories and known to reduced postprandial glycaemia, the blood glucose level after a meal, since they do not cause insulin response (Ghosh S. 2012, Livesey G. 2003). Sugar alcohols are considered as either generally recognized as safe (GRAS) or approved food additives by the FDA. Replacing sugar by polyols results in a decrease in sweetness as depending on the type, polyols have a sweetness between 30% and 90% relatively to sucrose. The use of sugar alcohols as sugar replacers in bakery products is a common practice, due mainly to their

modulating process properties, improving quality and health benefits. They are not only sweeteners with reduced-calorie, commonly used in combination with other sweeteners to achieve desirable taste and sweetness level, but also improvers for bread and other cereal foods to obtain a stable and strong network, retard staling, good taste and longer shelf-life (Ding S. 2021).
Mannitol, sorbitol, maltitol, erythritol, isomalt, xylitol and lactitol are considered as food additives and listed as a 'E' number in the list of ingredients (Regulation (EU) No 1129/2011). Among them, maltitol and sorbitol have potential as dough improver and antistaling agent in bread. Sugar alcohols are convenient for sucrose replacement since they can be added at an approximate 1:1 ratio to provide similar bulky capacity as sucrose.
Physicochemical and rheological properties of dough including swelling power, water absorption capacity, kneading torque, thermal attributes, gelatinization, retrogradation, and texture were significantly affected by the addition of sugar alcohols. The mechanisms of action in sugar alcohols' effect on dough properties are diverse. Sugar alcohols are capable of forming hydrogen bond between starch chains in the amorphous regions in starch granules, which would restrict starch swelling and thereby would stabilize these regions (Sun Q. 2014).

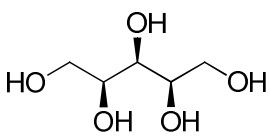
1. **Erythritol**



Erythritol (C4H10O4) (E968) is the sole non-caloric bulk sweetener. It is naturally occurring, and it can be made from corn using enzymes and fermentation. Erythritol is 60–70% as sweet as sucrose, it does not affect blood sugar or cause tooth decay. The caloric value of erythritol was estimated to be ≤0.4 kcal/g In combination with sucrose it can be used for a partial sugar replacement up to 75%. However, it deceases fragility and showed lower texture quality (Laguna L. 2013).

Erythritol is the only polyol, which is absorbed in the intestine, transported to the kidneys and excreted with urine. Compared to other polyols, the absorption of erythritol is more efficient, and its intake results in a less to no laxative effect (Oku T. 2007).

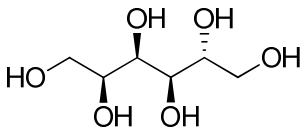
2. **Xylitol**



Xylitol (C5H12O5) (E967) is a colorless or white crystalline solid that is soluble in water. Xylitol occurs naturally in small amounts e.g. in plum, strawberry, cauliflower, and pumpkin (Ur-Rehman S. 2015). Industrial production starts with lignocellulosic biomass from which xylan is extracted; raw biomass materials include hardwoods, softwoods, and agricultural waste from processing maize, wheat, or rice. It is as sweet as sucrose.

The Farinograph and Extensograph tests have revealed that the addition of xylitol in a wheat dough lowered water absorption, significantly increased development, and stability time of dough. In the meanwhile, xylitol significantly enhanced stretching energy, extension degree and stretching resistance (Wang X. 2015). Adding xylitol could significantly reduce the peak viscosity, attenuation value, final viscosity, retrogradation value, and further effectively decreased the starch aging speed.

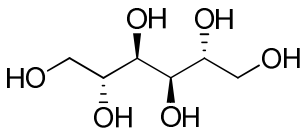
3. **Sorbitol**



Sorbitol (C6H14O6) (E420) can be obtained by reduction of glucose; in this way, the aldehyde group (–CHO) of glucose is converted to a primary alcohol group (–CH2OH). Sorbitol is mostly obtained from potato starch, but it is also found in nature, e.g. in apple, pear, peach, and prune.
In foods, it has the INS number and E number 420. Sorbitol is about 60% as sweet as sucrose.
Most bacteria cannot use sorbitol for energy, but it can be slowly fermented in the mouth by *Streptococcus mutans*, a bacterium that causes tooth decay (Kearsley MW. 2006).
Adding sorbitol into foods can prevent the drying of food and make food stay fresh and soft. Its application in bread cake has a significant effect.
Sorbitol could decrease the hardness, gumminess, chewiness and springiness of dough (Peng B. 2018).
It can prevent the denaturation of the carotenoids, edible fats and protein (Manisha G. 2012).
It had been observed that sorbitol increases the intestinal absorption of vitamin B12 in both man and animals and also iron absorption in man (Chow BF. 1958, Loria A. 1962).
People with untreated celiac disease often present sorbitol malabsorption, as a result of the small bowel damage.

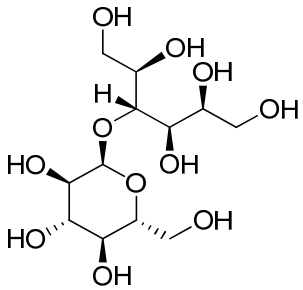
Ingesting large amounts of sorbitol can lead to abdominal pain, flatulence, and mild to severe diarrhea.

4. **Mannitol**



Mannitol (C6H14O6) (E421) is an isomer of sorbitol; the two sugar alcohols differ only in the orientation of the hydroxyl group on C-2 (Kearsley MW. 2006). It can be derived from mannose by reduction. Since mannitol is found in a wide variety of natural products, including almost all plants, it can be directly extracted from natural products, rather than chemical or biological syntheses. Mannitol concentrations of plant exudates can range from 20% in seaweeds to 90% in the plane tree (Platanus sp.). It is mainly used as a sweetener for people with diabetes, and coating for hard candies, dried fruits, and chewing gums. Moreover, it is often included as an ingredient in candies and chewing gum (Lawson P. 2007).
It has a very low hygroscopicity, it does not pick up water from the air until the humidity level is 98%. Mannitol is in the osmotic diuretic family of medications.

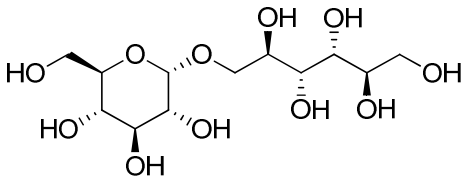
5. **Maltitol**



Maltitol (C12H24O11; 4-O-α-glucopyranosyl-D-sorbitol) (E965) is a hygroscopic non-reducing sugar and disaccharide polyol that is listed as an alternative sweetener to sugar because, except for browning, it possesses roughly 75–90% of sucrose's sweetness and has similar properties (Ding S. 2019). Of all polyols, maltitol has the closest solubility curve to that of sucrose and is freely soluble in water (Rozzi NL. 2007). Maltitol is less hygroscopic than sugar which results better shelf stability of those goods made with maltitol rather than sucrose when processed under given atmospheric/climate conditions. It is known under trade names such as Maltisorb, Maltisweet and Lesys.

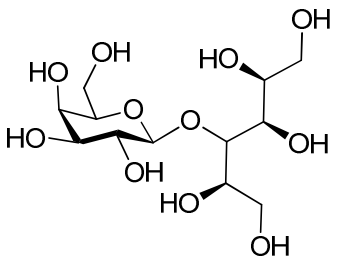
Maltitol occurs naturally in different fruits and vegetables. Small amounts of maltitol naturally exist in roasted malt and chicory leaves. Maltitol is commercially produced from the starch of cereals such as corn, wheat and potatoes (Saraiva A. 2020). Maltitol syrup, a hydrogenated starch hydrolysate, is created by hydrogenating corn syrup, a mixture of carbohydrates produced from the hydrolysis of starch. This product contains between 50% and 80% maltitol by weight. The remainder is mostly sorbitol, with a small quantity of other sugar-related substances.
In biscuits and cookies, maltitol has been evaluated as the most suitable sugar replacer among all polyols. Maltitol could decrease the hardness, gumminess, chewiness and springiness of dough (Ding S. 2019).
As with other sugar alcohols, maltitol is poorly absorbed in the small intestine, and has lower insulinaemic (35 vs. 45) and glycaemic indices (35 vs. 68), and a lower caloric value (2.4 vs. 4 kcal/g) and sweetening power (approx. 90%) than sucrose (Kearsley MW. 2012). It is not metabolized by oral bacteria, so it does not promote tooth decay (Moon HJ, 2010).

6. **Isomalt**



Isomalt (C12H24O11) (E953) is an equimolar mixture of two diastereomeric disaccharides, each composed of two sugars: glucose and mannitol (α-D-glucopyranosil-1,6-mannitol) and also glucose and sorbitol (α-D-glucopyranosil-1,6-sorbitol). Complete hydrolysis of isomalt yields glucose (50%), sorbitol (25%), and mannitol (25%) (Joint Expert Committee on Food Additives (JECFA)). It is odorless, crystalline and non-hygroscopic. The sweetening power of isomalt lies between 0.45 and 0.6. It has a pure sweet taste similar to sucrose without any aftertaste (Ghosh S. 2012).

7. **Lactitol**



Lactitol (C12H24O11, β-4′galactosylsorbitol) (E966) is an odorless, colorless, sweet, nonhygroscopic, and stable sugar alcohol. It is produced by catalytic hydrogenation of lactose. The relative sweetness of lactitol is 0.3–0.4 compared to sucrose. Its caloric value is estimated at 2–2.5 kcal g-1.
Lactitol has a clean sweet taste without an aftertaste. It is used in a variety of low food energy or low fat foods.
It is stable under both alkaline and acid conditions and at high temperatures likely to be encountered during food processing.
High stability makes it popular for baking. It is used in sugar-free candies, cookies (biscuits), chocolate, and ice cream, with a sweetness of 30–40% that of sucrose (Gränzle MG. 2011).

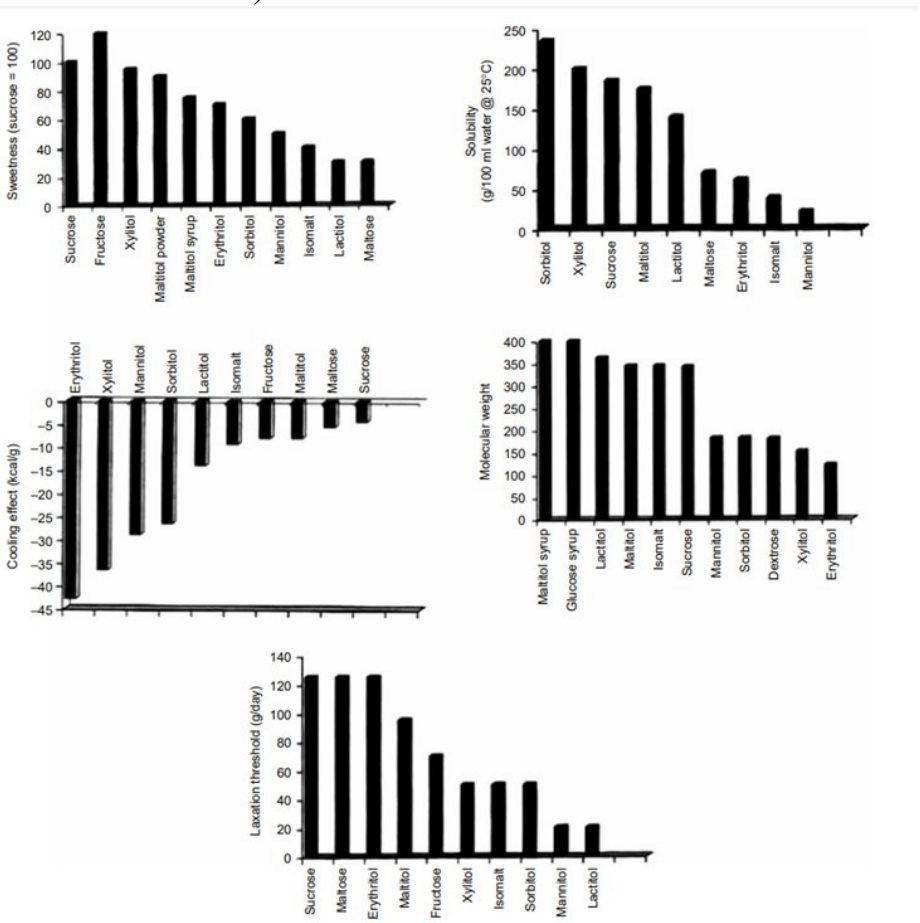


Figure 6.1. *Properties of polyols (Kearsley MW. 2006)*

6.2. Fats used in the manufacture of bakery products

Fat is a type of nutrient; high in calories but a necessary part of human diet. The beneficial or detrimental effects of dietary fats on human health and well-being largely depend on their fatty acid composition. Generally, patients have to avoid

or reduce saturated fats (usually from meat and dairy) and trans fat (in processed foods, margarines, and shortenings). Consumption of foods, rich in unsaturated fatty acids is proposed. The primary source of the main unsaturated fatty acid, α-linolenic acid (ALA, ω-3), is plants, concentrated mainly in some seeds and nuts and in some vegetable oils. Flaxseed, chia seeds, and walnut seed oils are known to be good sources of ALA, whereas sunflower, corn, and soybean oils are rich in linoleic acid (LA, ω-6). EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) can be synthesized in the human body by using ALA as a precursor. However, bioconversion of ALA to EPA and DHA is limited; thus, adequate dietary intake of long chain ω-3s is required. Olive oil is a good source of oleic acid (OA) and LA. OA is monounsaturated fatty acid and makes up approximately 55-85% of olive oil while the polyunsaturated LA makes up about 9% (Shahidi F. 2018).

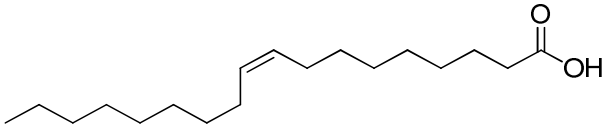
Margarine is produced by the hydrogenation of vegetable oils, often the mainly unsaturated sunflower and rapeseed oils. The fatty acid composition of margarines and fat spreads can vary considerably. Spreads have a similar composition to margarine but are usually lower in fat. In this case, water is used to bulk out these spreads. Reduced fat spreads can be used for baking. Nowadays, the amount of ω-3 fatty acids present (as ALA) in margarines and fat spreads are increased by manufacturers (Lunn J. 2006).

The use of lipidic substitutes (often containing ω-3) in functional bakery products involves modifying the ratio SFA:MUFA:PUFA (SFA = saturated fatty acid; MUFA = monounsaturated fatty acid; PUFA = polyunsaturated fatty acid). Sunseed oil, commonly utilized in sponges and muffins, has a 10%:29%:61% ratio, whereas that of margarine in cookies and croissants is 50%:33%:17% (Doménech-Asensi G. 2016).

The change in the lipidic profile of bakery products using seed oils can be a good strategy to increase their nutritional profile. However, the addition of seed oils rich in PUFA (e.g. in case of flax (Linum usitatissimum)], gave rise to high oxidation ratios during the storage of sponges.

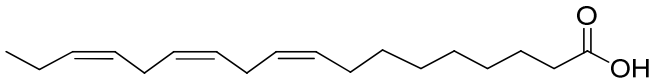
Chia seeds (Salvia hispanica L.) with a high oil content (30%–40%), mainly ω-3 (linolenic acid, 54%–67%) and ω-6 (linoleic acid, 12%–21%), as well as in protein (15%–25%) and fiber (18%–30%), improve the nutritional profile of bakery products (Peris M. 2019).

1. **Oleic acid**



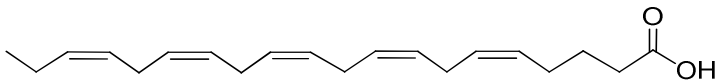
Oleic acid is the most common fatty acid in nature, occurring in various animal and vegetable fats and oils. It is an odorless, colorless or yellowish oil. Oleic acid is classified as a monounsaturated ω-9 fatty acid, abbreviated with a lipid number of 18:1 cis-9. It fatty acid in nature. Triglycerides of oleic acid comprise the majority of olive oil (about 70%), and 20–80% of sunflower oil.
Monounsaturated fat consumption has been associated with decreased low-density lipoprotein (LDL) cholesterol, and possibly with increased high-density lipoprotein (HDL) cholesterol. Oleic acid may be responsible for the hypotensive (blood pressure reducing) effects of olive oil that is considered a health benefit (Teres S. 2008). It was found that diets enriched in oleic acid are beneficial for regulating body weight (Tutunchi H. 2020). The FDA has approved a health claim on reduced risk of coronary heart disease for high oleic (> 70% oleic acid) oils (Nutrition).

2. **α-Linolenic acid**

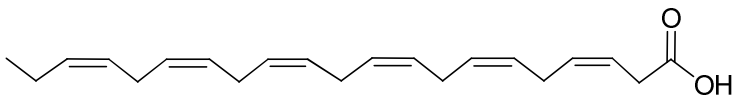


α-Linolenic acid (ALA) is an ω-3, polyunsaturated, essential fatty acid, it can only be obtained by humans through their diets. It is abbreviated with a lipid number of 18:1 cis-9. ALA is found in many seeds and oils, including flaxseed, walnuts, chia, hemp, and many common vegetable oils. α-Linolenic acid is relatively more susceptible to oxidation and will become rancid more quickly than many other oils.
Based on a systematic review and meta-analysis, higher ALA consumption is associated with a moderately lower risk of cardiovascular disease (Pan A. 2012). In the body, ALA is metabolized to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Dietary ALA intake can improve lipid profiles by decreasing triglycerides, total cholesterol, high-density lipoprotein and low-density lipoprotein cholesterol (Yue H. 2020). Moreover, ALA intake is associated with a reduced risk of mortality from all causes, cardiovascular disease and coronary heart disease but a slightly higher risk of cancer mortality (Naghshi S. 2021).

3. **Eicosapentaenoic acid and docosahexaenoic acid**



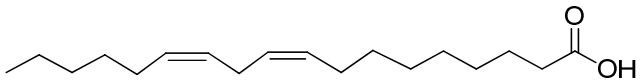
eicosapentaenoic acid



docosahexaenic acid

Besides ALA, the other two main important ω-3 LCPUFAs (long chain polyunsaturated fatty acid) are the longer chain variants: eicosapentaenoic acid (EPA, 20:5) and docosahexaenoic acid (DHA, 22:6), with a backbone of 20 and 22 carbon atoms and five and six double bonds, respectively. EPA and DHA are found in high concentrations in oily fish, such as salmon, mackerel, anchovy, and other marine sources. ALA can be converted into EPA and DHA by the human body, but the rate of conversion has been limited for DHA. It has been suggested that there may be a higher conversion rate of ALA into EPA and DHA during pregnancy (Williams CM. 2006).
As Western diets consist primarily of ω-6 PUFAs, which is derived mainly from refined cooking oils (e.g. sunflower and corn), the conversion of ALA to EPA is restricted. With the LA conversion to AA, a larger amount of AA can lead to higher production of eicosanoids, thereby changing the physiological state of the body to one that is prothrombotic and proaggregatory (Simopoulos 2008). It is therefore critical to maintain a proper ω-3:ω-6 balance, as these eicosanoids have an antagonistic function depending on their precursors. A ratio of 1:4 between ω-3 and ω-6 is recommended for prevention of CVD. The current ratio of ω-3:ω-6 in Western diets is estimated to be between 1:15 and 1:16.7 (He 2009).

4. **Linoleic acid**



Linoleic acid (LA) is a polyunsaturated, essential fatty acid denoted as 18:2 (ω -6) or 18:2 cis-9,12. Linoleic acid is a precursor to arachidonic acid (AA) with elongation and saturation. AA is the precursor to some prostaglandins, leukotrienes (LTA, LTB, LTC), and thromboxane (TXA). LA is converted by various lipoxygenases, cyclooxygenases, cytochrome P450 enzymes.
Consumption of linoleic acid has been associated with lowering the risk of cardiovascular disease and premature death (Li J. 2020).

Nutritional optimization of high in fat and high sugar baked goods: challenges and strategies

In the last decades, the developed countries across the world have seen an increased incidence of obesity and overweight across the population (World Health Organization, 2017; Swinburn, et al., 2011). Overweight and obesity are major risk factors for several chronic diseases, including cardiovascular diseases, which are the leading causes of death worldwide (Whitelaw, O'Kane, Wales, & Barth, 2001). Being overweight can also lead to musculoskeletal disorders and to diabetes. In addition, numerous cancers have been associated with excessive accumulation of body fat (Formica, et al., 2020). The risk of these noncommunicable diseases increases even when a person is only slightly overweight and grows more serious as the body mass index (BMI) climbs.
Obesity is a condition driven by both genetic and environmental risk factors. However, several studies have identified further causes such as the reduction in daily physical activity and increased access to highly palatable and varied food items high in fat and sugar (Leigh, Lee, & Morris, 2018; Johnson, et al., 2007).
For these reasons, many countries have put in place some measures in order to urge the food manufactures to improve the nutritional profile of the items; this should help people to have higher availability of healthier foods. For instance, governments introduced a sugar tax, that varies between countries, on sugar-rich food and/or beverages (Jou & Techakehakij, 2012). More recently, UK government has announced the intention to ban promotions of products high in fat, sugar and salt (HFSS) by location and price through legislation and consult on how this policy should be implemented (Public Health England, 2020).
Fine bakery products, such as muffins, pound cake and biscuits, are high in sugar (contribution of up to 30-40%) and fat (Sahin, Zannini, Coffey, & Arendt, 2019; Van der Sman & Renzetti, 2020). However, the reformulation of fine bakery products with a substantial sugar and fat reduction is very challenging due to the multiple functionalities that sugar delivers, next to simply providing sweetness and flavour (Pareyt & Delcour, 2008; Wilderjans, Luyts, Brijs, & Delcour, 2013). Therefore, it is important to understand the interactions of the sugar with the ingredients present in the formulation of baked goods and the effects on the final product quality.

Function of sugar and fat in different fine bakery products

In bakery products such as cakes, muffins and biscuits the sugar and the fat play important functionalities throughout the different process stages, from mixing to baking and cooling of the final product (Wilderjans, Luyts, Brijs, & Delcour, 2013).
In general, the high sugar and fat level in these type of products obstacles in the development of the gluten network during the mixing step (Clemens, et al.,

2016). In addition, it has been demonstrated that the presence of fat and sugar influence the starch hydration and gelatinizing. The presence of sugar in a starch solution decreases the degree of starch hydration and swelling, due to the high affinity of sugar to water (Struck, Jaros, Brennan, & Rohm, 2014). Consequently, higher temperatures are required to achieve starch gelatinization. Sugar functionality in cakes becomes particularly apparent during the baking process. In fact, biopolymer phase transitions such as starch gelatinization and protein denaturation are affected by sugar content and type, which will determine the resulting structure and texture of cake (Struck, Gundel, Zahn, & Rohm, 2016) (Renzetti and Jurgens, 2016). In addition, the sugar influences the color of the products, aroma and shelf-life (Sahin, Zannini, Coffey, & Arendt, 2019).

In general, fat is the third larger ingredient in the dough after the flour and sugar. The fat or oil present in a baked product disrupts the protein and starch structure, avoiding the gluten and starch particles to adhere to each other. Thanks to this, the bakery products show the typical tender and well aerated texture. Consequently, the main functionalities delivered in baked goods by the fat are: texture, flavor, mouth feel, lubrication, incorporation of air and extended shelf-life (Ghotra, Dyal, & Narine, 2002).

Strategies to replace sugar and fat in baked goods

The most common ingredients utilized for replacing the sugar are long chain polysaccharides, such as starches, polydextrose, maltodextrin, hydrocolloids as well as dietary fibres. They can also be applied in combination, in order to achieve the desired texture, volume and batter or dough rheology. In Table 6.1. the effects of the most common bulking agents used as sugar replacers in fine bakery products are reported.

Table 6.1. *Most common bulking agents applied as sugar replacers and their effects on product quality (Sahin, Zannini, Coffey, & Arendt, 2019)*

Bulking agents	Product Application	Effect on the product	Reference
Polydextrose	High ratio cake Chiffon cake Pound cake Muffin	Contributes to browning, lowers specific volume, increases mean air bubble size in cake batter, decreases	(Hicsasmaz, Yazgan, Bozoglu, & Katnas, 2003; Martínez-Cervera, Sanz, Salvador, & Fiszman, 2012; Zoulias,

	Cookies	viscosity and viscoelasticity of batter, decreases structure setting temperature, increases cookie brittleness	Oreopoulou, & Kounalaki, 2002)
Oligofructose	Sponge cake Short dough biscuits	Contributes to browning, maintains specific volume, increases cake crumb firmness, decreases biscuit snap force, decreases biscuit dough hardness	(Ronda, Gomez, Blanco, & Caballero, 2005; Gallagher, O'Brien, Scannell, & Arendt, 2003)
Maltodextrin	Biscuits	Contributes to biscuit spreading, contributes to browning	(Pourmohammadi, Habibi Najafi, Majzoobi, Koocheki, & Farahnaki, 2017)

However, these functional ingredients are not able to deliver the sweetness perception of the sugar. High-intensive or artificial sweeteners are non-nutritive ingredients which bind on the taste receptors on the tongue sending the brain the signal of sweetness (Mooradian, Smith, & Tokuda, 2017). Most of the artificial sweeteners have zero calories or very low and might be considered to improve the sweetness perception when reducing sugar in the formulation. Nevertheless, these ingredients are allowed as food additives in fine bakery products only for special nutritional uses (Regulation (EU) No, 1129/2011, 2011).

Another well-known category of ingredients that can replace sugars is polyols, which can be produced by chemical or biochemical reduction of sugars, or during fermentation using lactic acid bacteria or yeast. Polyols are among the most consumed sugar substitutes, mainly due to their low caloric value, lack of cariogenic properties and no interference in insulin levels (Livesey, 2003). They can function as bulking agents and perform a sweetening activity. Despite the several benefits mentioned, polyols can have laxative effects in the human gut

when consumed in high amounts (Buttriss, 2017). The polyols such as mannitol, sorbitol, maltitol, erythritol, isomalt, xylitol and lactitol are considered as food additives and listed as a "E" number in the list of ingredients (Regulation (EU) No 1129/2011, 2011). Furthermore, they are only allowed to be added as sweeteners in products which are either 'energy-reduced' or have 'no additional sugar' (Regulation (EU) No, 1129/2011, 2011). In addition, if the food contains a level of polyols above 10%, the statement "excessive consumption may produce laxative effects" must be declared on the product label.

Regarding fat reduction, long chain polysaccharides, such as starches, maltodextrin, hydrocolloids as well as dietary fibers can be applied for replacing part of the fat present in the formulation. In addition, the utilization of emulsifiers should be considered since they can help to soften the crumb structure and improve the volume in cake type products and support the spread of the biscuit during the baking step. Several authors analysed the effects of partial fat replacement in biscuits and cakes with carbohydrate-based fat mimics (Table 6.2.).

Table 6.2. *Most common fat replacer applied in fine bakery products and their effects on product quality*

Fat mimetic	Product Application	Effect on the product	Reference
Polydextrose	Biscuits	Good dough rheology and texture quality obtained when combined with glycerol mono stearate and guar gum or with resistant starch	(Aggarwal, Sabikhi, & Kumar, 2016; Sudha, Srivastava, Vetrimani, & Leelavathi, 2007; Moriano, Cappa, & Alamprese, 2018)
Inulin Modified mungbean starch	Cake	Batters with low apparent viscosity, volume loss, higher crumb porosity; volume and hardness of the cakes increased with an increase in the level of modified starch	(Rodríguez-García, Salvador, & Hernando; Punia, Siroha, Sandhu, & Kaur, 2019)

Fats provide our body with calories, energy and the structure of the membranes, building materials for hormones and vitamins. Excessive intake will accumulate in our body that can lead to obesity and its complications.
To prevent this, today's fashionable fat-reduced products have appeared. In the baking industry, the manufacture of these kinds of products is still in the experimental stage.
The experiments use low-fat margarine, usually with 40-60 % fat content.
Low-fat content is a particular problem in manufacturing of shortbreads and puff pastries, where fat plays a significant role in shaping the structure.
In conventional manufacturing technology, the fat forms a hydrophobic coating on the flour granules, thus forming the characteristic structure of said products, but during fat content reducing this is only partially achieved.
For these products, the use of fats with a favourable fatty acid composition may be a solution, as the consumption of unsaturated fatty acids has favourable physiological effects.
Carbohydrate-reduced products are favoured primarily by consumers with carbohydrate metabolism disadvantages, but dieters also prefer.
A carbohydrate-reduced product is considered to be a baking product if, given the original product, the food contains at least 30% less carbohydrate.
In practice, this is achieved by increasing the protein content or using artificial or natural sweeteners.
The replacement with sweeteners is the most often used method in practise because reducing the sugar content significantly affects the taste of the product, but these substances significantly reduce this effect.
However, the modifications must take into account that sugar has a technofunctional effect, so reducing its quantity will have a negative effect on the water absorption capacity of the dough and the intensity of Maillard reactions on the surface of the product.

In selecting the appropriate sweetener, in addition to the above, their sweetening ability, heat sensitivity and, in the case of intense sweeteners, their ADI must be taken into account.

6.3. Technology for the manufacture of low-sugar bakery products

1. Partial replacement of sugar by honey

Honey is the oldest known sweetener suitable for human consumption and, due to its high carbohydrate content, it also provides significant energy (1385KJ/100g).
Long-life cakes made from honey dough are called gingerbread.
Technology:

- Preparing the basic honey pasta
- Making the basic sugary dough
- Mixing the honey and sugar dough
- Shaping the dough
- Baking
- Cooling

Table 6. 3.

Honey/sugar ratio Ingredients (kg)	100% sugar	75% sugar: 25% honey	50% sugar: 50% honey	25% sugar: 75% honey	100% honey
Flour	0,1	0,1	0,1	0,1	0,1
Sugar	0,1	0,75	0,5	0,25	-
Honey	-	0,25	0,5	0,75	0,1
Loosening agent (alkali)	0,0015	0,0015	0,0015	0,0015	0,0015
Flavouring (mixed spices)	0,0015	0,0015	0,0015	0,0015	0,0015

2. Sugar substitution

Presentation of sponge cake production technology

Sponge cake (sponge cake pudding): a dough made from wheat flour, sugar and eggs, leavened with egg white foam.

It can be round or square, cut into sheets, and flavoured with a variety of additional ingredients. (Hungarian Food Guide 2013)

Sponge cake is very easy to make, but it is also a type of dough that requires a lot of attention. A basic mistake is to make a dough that collapses and does not have a light consistency. The method of preparation of the bakery product will be discussed in the following lines. The most important ingredient in this bakery product is the egg. The secret of sponge cake is the light consistency of the foam, which is obtained by the air that is introduced into the dough. This process takes place when the egg whites are beaten into stiff peaks and when the yolks are mixed with the whites. When beating the egg whites, care must be taken not to incorporate any egg yolks. The egg yolks should always be added to the beaten egg whites while mixing them with the sugar until homogeneous.

The lightness of the dough is enhanced by the flour. This is measured out during the preparation. It is measured out very accurately using a balance.

The flour is then sieved to remove foreign matter and make it more homogeneous. The sifting process introduces air between the flour particles, which plays an important role in increasing the volume of the sponge cake during baking. Finally, the flour is carefully added to the protein mixture, taking care not to allow air to escape from the dough.
Stir the whole dough in a semi-circular arc clockwise. Then place the finished dough on a baking tray lined with baking paper, place in a preheated oven and bake.

Table 6.4

Ingredients	**Erythritol sponge cake**	**Xylitol sponge cake**	**Stevia sponge cake**
Flour (g)	80 g	80 g	80 g
Egg (piece)	6	6	6
Sweetener (g)	120 g	80 g	0,27 g

Figure 6.2. *Erytritol sponge cake*

Figure 6.3. *Xylitol sponge cake*

Figure 6.4. *Stevia sponge cake*

6.4. Technology for the manufacture of low-fat bakery products

In the baking industry, several types of fat are used to make different products.

Egg-enriched products are made with 11% margarine per kilogram of flour, according to the Hungarian standard.
Control product

Table 6.5. *Material Calculated on total flour %*

BL55 flour	100
Yeast	5
Salt	1
Sugar	10
Margarine	11
Milk powder	3
Eggs	1,5
Additive	0,5

Figure 6.5.

Production technology for fine plaited cakes

This type of product is characterised by the fact that they are of different weights but similar composition and are made from dough prepared using the same dough method as in the production of egg-enriched brioche.
The fine scones are made in 0,25 kg, 0,50 kg and 1,00 kg units using 4 or 6 twigs and different spinning techniques.
This subheading also includes festive cakes made up of two or more twigs of braided strands placed one on top of the other.

A fine plaited loaf weighing 0,25 kg is made from 4 branches of 280 g of dough by plain plaiting.
Fine plaited cakes of 0,50 kg and 1,00 kg can be made with 4 or 6 branches using the plain or window plaiting technique.
The 0,50 kg loaf is made from a total dough weight of 560 g and the 1 kg loaf from a total dough weight of 560 g.
The pieces of dough, formed using the appropriate spinning technique, are risen and baked on a baking tray.

Table 6.6. *Fat content reduced to 8 %; Material Calculated on total flour %*

BL55 flour	100
Yeast	5
Salt	1
Sugar	10
Margarine	8
Milk powder	3
Eggs	1,5
Additive	0,5

Technology:
Preparation of raw materials:
- sifting, weighing and mixing flour
- weighing, dissolving and filtering salt
- measuring, weighing, measuring, weighing, weighing, weighing
- adjusting and measuring the temperature of water

Figure 6.6.

Preparing the dough:

Measuring the raw materials into the kneading machine, then the kneading machine mixes the dough.

- Adding water during kneading
- Kneading time: 10 minutes
- dough temperature: 26-28 °C

Dough processing:

The dough is removed from the kneading bowl, given up, rested and then shaped.

- dispatch weight: 2,10 kg
- resting time: 15 minutes
- stretching, dividing the dough with a dividing machine
- rest for about 10 minutes
- shaping the divided dough into lengths
- spinning the dough sticks into a 4-strand loaf

Rising:

Brush the surface of the kneaded scones with egg wash and place them in the properly rolled out mould. Place the moulds on plates and then on a baking trolley.

- on a baking trolley in a baking chamber
- rising time: 70 minutes
- temperature: 30-35 °C
- humidity: 80-100 %.

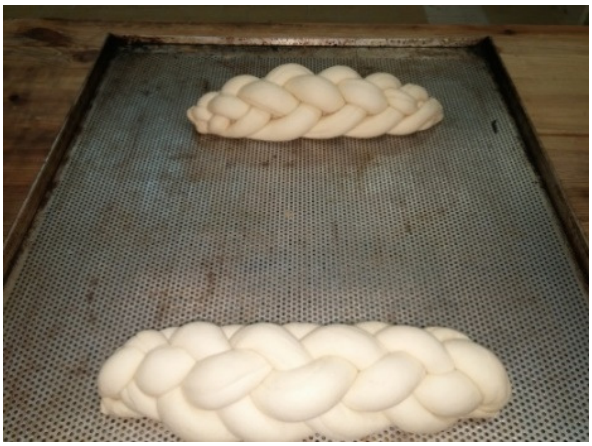


Figure 6.7.

Baking:

The baking trolley is placed in a properly heated rotary oven. No steam is required, as the surface has already been treated.

- oven temperature: 200 °C
- baking time: 17 minutes

Figure 6.8.

Replacing fat with oil

Wafer products

Technology:

Preparation of suspensions:

The liquid intermediate, wafer suspension, is a heterogeneous dispersion system, the dispersion medium is water, the solid particles of flour are suspended in an aqueous solution of the raw materials. When the flour particles are mixed with water, they swell strongly, but since the water is present in excess and separates the individual flour particles from each other, the swollen flour particles do not come into contact with each other and a coherent flour skeleton cannot form. The temperature of the prepared suspension is 18-20°C. In view of the

technological conditions of wafer production, the viscosity of the liquid suspension must be of great importance for pump transport and uniform dosing. The viscosity of a suspension prepared using flour of the same concentration and temperature can vary over a wide range. The viscosity is determined primarily by the protein content of the flour and its swelling capacity. A constant viscosity can be achieved by adjusting the water content of the suspension to the different flour types and qualities. T paddle or turbo mixers are used to produce liquid wafer suspensions. In addition to intermittent mixers, continuous vibratory mixers have recently become more common. Experiments with continuous mixers show that combining mechanical and vibratory mixing is preferable. Vibratory mixing allows the different components to be well distributed and at the same time prevents the different materials from sticking to the mixing blades.

Screening:

It is extremely important to filter the wafer suspension before it enters the baking chamber to ensure accurate dosing. This operation should not be omitted from any technology; it is a prerequisite for good quality and the continuous operation of the wafer production line.

Frying waffles:

The shape of the wafer layer is formed in a mould of the appropriate shape in the baking equipment. The suspension is pumped through the pipe system to the dosing tank. The dosing is done by an automatic feeder. Two simultaneous processes, drying and baking, are typical of the heat-solidification of thin wafers. The water transfer process is characterised by a decreasing speed phase. This is explained by the fact that the suspension with a high water content heats up suddenly on direct contact with the baking tray and that there is an intense heat exchange in the contact layer, which only decreases during the subsequent vapour formation. It follows that, in view of the intense heat transfer, the heating is greater in the first stage of the operation. The water bound by absorption is removed in the second half of the baking operation, so the temperature of the baking sheets must be reduced at this stage.

During the baking process, the temperature difference between the outer and inner layers of the wafers tends to decrease, reaching a minimum at the end of the process. The temperature of the wafer suspension during baking can be varied significantly by changing the temperature of the baking surface.

Experience has shown that, with one-sided heat transfer, wafers of optimum quality can be produced in about two minutes (at a temperature of about 170°C) with continuous operation.

With double-sided heat transfer, both sides of the wafer sheet will have approximately the same water content at the end of the operation, so that the

wafer sheets do not deform during storage, which is an inherent feature of single-sided heat transfer. A further advantage of two-sided heat transfer is that the baking time is reduced by about 10%.
Ingredients: Control product
Flour (BL-55): 1 kg
Powdered sugar: 0,5 kg
Margarine: 0,45 kg
Milk: 1 l

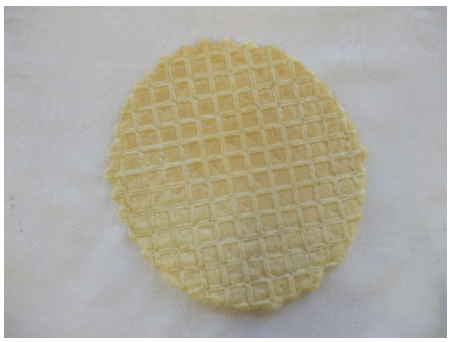


Figure 6.9.

Before baking, the dough is light yellow in colour, shiny on the surface, slightly runny, sticky and dense. It bakes in 2-2,5 minutes. After baking, it is uniformly golden brown in colour. It crumbles easily, is crispy and has a delicate sweet taste typical of the product. Does not stick to the baking tray during baking.
Made with 100% Olive oil
Flour (BL-55): 1 kg
Powdered sugar: 0,5 kg
Olive oil: 0,45 kg
Milk: 1 l +
It is darker in colour, has a glossy surface, and forms a fluid and homogeneous dough. It takes less time to bake and burns faster. Same colour as the control, with an oily feel.

Technology to improve sweetness perception in sugar reduced bakery products: Tastesense ™

TastesenseTM (Kerry Ingredients, Ireland) is based on fruit and vegetable extracts and it interacts with the taste receptors of the mouth modifying the overall taste perception.
TastesenseTM allows to reduce sugar up to 30% without compromising the taste and it also improves mouthfeel and flavour impact in products with reduced sweetness.

The effect is larger in combination with a high intensity sweetener like sucralose and it can also be labelled like natural flavouring.
When reducing sugar in a baked product, it is essential in the formulation the utilization of a bulking agent that can replace the sugar functionalities (texture, volume, batter viscosity, colour, etc.) as reported in the previous paragraphs. TastesenseTM combined with the right bulking agent, helps to bring back the sweetness perception. As an example, in the Table 9, the standard muffin recipe and the 30% sugar reduced version have been reported. In this case, the bulking agent applied is wheat starch.

Table 6.7. *Muffin recipe: Reference vs 30% sugar reduced*

Ingredients	Reference	30% Sugar Reduced
Soft Wheat Flour	22,5	22,5
Sugar	24,50	16,5
Whey powder	1,32	1,32
Baking Powder	0,88	0,88
Salt	0,36	0,36
Wheat gluten	0,36	0,36
Dextrose	0,18	0,18
Distilled Monoglycerides (E471)	0,36	0,36
Liquid Egg	18,9	18,9
Vegetable Oil	18,4	18,4
Water	12,1	12,1
Wheat Starch		7,9
Tastesense™		**0,1**
TOT	100	100

Processing Instructions:

1. Combine all ingredients together in the mixing bowl
2. Mix with paddle for 3 minutes on speed 1
3. Scale 100 g into muffin cases
4. Bake at 180 °C for 32 minutes

As shown form Table 6.7., sugar has been replaced by wheat starch and Tastesense™, without requiring any further modification neither in the formulation nor in the processing manufacture.

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