



WHEAT FIBRE IMPACT ON FLOUR QUALITY OF CONFECTIONERY PRODUCTS

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Abstract: *The article reviews the current state and prospects of the development of products enriched by dietary fibres, including wheat fibre, and their importance to the public. The importance of the dietary fibres for people suffering from diabetes and cardiovascular disease is emphasized. The features of the chemical and fractional composition of wheat fibre are described. The impact of wheat fibre and emulsifier mixture on wheat flour gluten complex is determined. The influence of wheat fibre and emulsifier mixture on physical and chemical indicators of the quality of the biscuit semi-finished product is studied.*

Keywords: *dietary fibres, biscuit semi-finished products, emulsifier, gluten.*

1. Introduction

Flour confectionery products are among the most popular and affordable food products in the world, their consumption possesses the first place in all population groups. However, they have high calorie content and contain many easily digestible carbohydrates, which are starch and sucrose, and unbalanced nutrient composition, as this product has a small amount of biologically active substances. An issue of the enrichment of flour confectionery products with physiologically functional food ingredients is important as it reduces the risk of the most common “diseases of civilization” (cardiovascular, cancer, diabetes, and obesity).

A solution to this problem is to create functional food products, because their segment is almost empty in the market of Ukraine today. It will provide an opportunity to the enterprises of confectionery industry, including the units

of restaurant business, to use a wide range of the flour confectionery products enriched by biologically active substances in their manufacture [1].

Biscuit semi-finished products are primary or component part of many flour confectionery products. Biscuit dough is a thermodynamically unstable foam-like food system; a stability of this system has technological importance in its production. The introduction of the flour confectionery products of new generation is due to their enrichment with vital and biologically active substances: dietary fibres, unsaturated fatty acids, macro- and micronutrients.

Dietary fibres are among the most important physiologically functional ingredients that can ensure a real correction of the food products towards improving their health benefits.

There is credible evidence of the link between dietary fibres consumption and cholesterol decrease that is a risk factor for cardiovascular disease. A sufficient

amount of the soluble dietary fibres in the diet reduces the risk of atherosclerosis and coronary heart disease. Low consumption of the dietary fibres is related to the fact that the products enriched with them are often less attractive to taste than refined [2].

Choosing an appropriate type of the fibres with different properties, according to specific tasks, enables to develop the products with their high content without compromising organoleptic properties of the latter.

Proper selection of the fibres provides certain technological and economic advantages. In accordance with the recommendations of the World Health Organization, the product, 100 grams of which contain 3 grams of the dietary fibres, is a source of this functional ingredient, and with the content of 6 grams of the dietary fibres per 100 grams of the product – enriched with the dietary fibres [3].

However, with the introduction of the dietary fibres in the food system, including flour confectionery products, many technical problems appear. The introduction of the dietary fibres influences on taste, smell, colour, texture, and volume indicators. The level of these indicators change largely depends on the source of the dietary fibres and their technological properties.

The analysis of the literature shows that the use of the dietary fibres in the manufacture of the flour confectionery products is poorly studied [4, 5].

However, conducted research concerning the use of different types of the dietary fibres in the manufacture of the flour confectionery products, including biscuit semi-finished products, does not reflect a full picture of their impact on physical and chemical processes occurred in the production; as well as the change of the structural and mechanical properties of the

dough and baked semi-finished products.

We use a secondary plant material such as wheat fibre produced by Vitatsel (Germany) as enriching supplements [6]. It contains a significant amount of the dietary fibres, thus, it is important to study its chemical composition and functional-technological properties.

2. Materials and methods

The aim is to study the prospects of using the product of wheat processing – wheat fibre (WF) in the technology of the biscuit semi-finished product.

The objective of the work is to determine the general chemical and fractional composition of the wheat fibre and its polysaccharide complexes as well as the impact on the quantity and quality of gluten wheat flour and indicators of the quality of the biscuit semi-finished product.

The protein content is determined by the modified Kjeldahl's method, ash – by wet ashing method with the use of the accelerator, mass fraction of fat – by the refractometric method. The quantitative determination of cellulose is determined by the nitrogen-alcoholic method (Kiurshner's method), pectin substances – by the calcium-pectin method, lignin – by the method of Vilshtetter Tsehmeister, the total hemicellulose content – according to the technique [7], the content of their separate fractions – using the technique [7], the mass fraction of starch – by the volumetric method. Quality indicators of the finished product – porosity, specific volume, ratio of lifting and baking loss are described by the generally accepted methods.

3. Results and discussion

Using experimental and literature data, a comparative evaluation of the content of

the nutrient and bioactive substances of wheat fibre, wheat bran and extra wheat

flour is performed, which is presented in Table 1.

Table 1
The Content of nutrients and bioactive substances in the raw materials studied, g/100g

Main components, g/100 g	Extra Wheat Flour	Wheat bran	Wheat fibre
Proteins	10.3±0.3	14.6±0.2	0.1±0.1
Fats	1.1±0.1	5.5±0.2	0.1±0.1
Carbohydrates, including	73.6±2.0	63.1±2.0	95.4±2.5
- mono and disaccharides	1.6±0.1	4.6±0.1	0.1±0.1
- starch	68.5±2.0	20.6±1.0	0.1±0.1
- dietary fibres	3.5±0.2	37.9±1.0	95.2±2.0
Ash	0.5±0.1	1.8±0.1	1.0±0.1
Energy value, kcal	342.0	165.0	4.0

The research results in Table 1 show that WF yields to extra wheat flour and wheat bran with protein and fat content because its composition contains only traces of them. At the same time the content of DF in WF is 95.4g/100 g that is 28 times larger than their content in extra wheat flour and 2.5 times than in wheat bran. A significant number of DF can reduce the percentage dosage of WF to flour weight in the FCP technology to ensure physiologically

desired concentration of DF. Another significant advantage of WF is its low energy value – only 4.0 kcal / 100 g – that can also reduce the caloric content of the finished product as a result.

The direction of physiological effect of DF, their technological features depend on the content and value of the individual components of DF. Thus, DF content in the raw materials is investigated by fractions (Table 2).

Table 2
The Content of the Dietary Fibres and Their Individual Components in the Studied Raw Materials. g/100 g

The name of the raw materials	Polysaccharides				
	Cellulose	Hemi-cellulose	Pectin substances	Lignin	Together
Extra Wheat Flour	0.6±0.1	2.5±0.1	0.3±0.1	0.1±0.1	3.5±0.1
Wheat bran	17.3±0.3	13.7±0.2	3.1±0.1	3.8±0.1	37.9±0.3
Wheat fibre	53.6±1.0	24.1±0.5	10.1±0.3	7.4±0.3	95.2±1.0

Cellulose is the main component of the cell walls of the plants and has high water absorbing ability, which as a result has a positive effect on the human gastrointestinal tract. The experimental data, presented in Table 2, show that this polysaccharide is a basis of the dietary fibres of WF – 53.6 g / 100 g of the raw materials. Its content compared to wheat flour and wheat bran is 90 and 3 times larger respectively, due to the peculiarities of the WF technology.

Hemicelluloses are characterized by a high hydrophilic nature. The binding process of water with xylan, which is a chemical component of hemicelluloses, is similar to the processes of starch swelling, but they do not undergo retrogradation. Hemicelluloses in the composition with FCP are able to slow down the process of hardening but do not have a significant impact on increasing their capacity and output. Table 2 shows that WF contains a significant amount of

hemicellulose, namely 24.1 g / 100 g that is 9.6 and 1.8 times larger than their content in wheat flour and wheat bran, apparently due to the differences in the chemical composition of the studied raw materials [8].

The study of the fraction composition of

WF hemicelluloses shows (tab. 3) that hemicelluloses of the group “B” (water-insoluble) constitute their basis, the content of which is higher compared to hemicelluloses of the group “A” (water-soluble fraction) in average 1.2 ... 2.0 times respectively.

Table 3

Hemicellulose Fractional Composition of Wheat Fibre, g / 100 g

Hemicellulose fraction	Product containing DF		
	Extra Wheat Flour	Wheat bran	Wheat fibre
Group „A”	1.1±0.1	7.3±0.2	7.8±0.2
Group „B”	1.4±0.1	6.4±0.2	16.3±0.3

Pectin substances have complex forming properties that determine their participation in the metabolic processes and the ability to rid from the human body of heavy metals and radionuclides. There is evidence that pectin substances influence on the course of biochemical and microbiological processes in the dough; change the rheological properties

of the semi-finished products and structural and mechanical properties of the finished products. The degree of this impact depends on the ratio of water-soluble and insoluble pectin components. Therefore, the study of the fractional composition of the pectin substances in the raw materials is conducted (tab. 4).

Table 4

Pectin Substances Fractional Composition in the Studied Raw Materials, g / 100 g

Fraction	Extra Wheat Flour	Wheat bran	Wheat fibre
Water-soluble pectin	0.08±0.01	1.1±0.1	3.8±0.1
Protopectin	0.22±0.01	2.0±0.2	6.3±0.2
The amount of pectin substances	0.30±0.01	3.1±0.2	10.1±0.3

Research results of the fractional composition of the pectin substances in the raw materials (tab. 4) indicate that their main proportion is protopectin. The content of this component in wheat fibre is 1,7 times larger compared to the content of water-soluble fraction of these substances.

Thus, the results that determine the chemical composition of WF show that it has a high content of bioactive substances, especially dietary fibres, which are mainly represented by cellulose and hemicellulose complex [9].

To investigate the WF impact on structural and physical properties of the dough, modelling experiments are conducted to determine the quantity and quality of gluten, namely elasticity, extensibility, ability, and hydration. The indicators of the quality of gluten depend not only on the parameters of technological process of the dough, but also on the composition and properties of its prescription components. The technology of the biscuit products provides the use of wheat flour with low gluten; otherwise, semi-finished products

have a small volume and low porosity due to a significant resistance of the strong gluten to the expansion of the air bubbles with temperature increasing. The use of the wheat fibre enables to prevent it, as this raw material does not form a fibre. In this regard, the impact of the wheat fibre on the quality of gluten dough is determined (tab. 5).

The necessity to investigate the impact of the studied products on the content and quality indicators of gluten is due to the peculiarities of their chemical composition, high degree of their

dispersion. It is possible that fine grinding of the product leads not only to the changes in the quantitative and qualitative content of its individual components, enzyme activity, degree of digestibility, changes of the mechanism of its influence on the dough biopolymers. Wheat fibre is added to the dough in quantities of 25, 30 and 35% instead of wheat flour. The amount of wheat fibre adding is established at the rate of 25% of the daily need of the dietary fibres.

Table 5

Wheat Fibre Impact on the Quality Indicators of Gluten

Flour mixture	The content of wet gluten, %	The content of dry gluten, %	Quality indicators of gluten		
			Extensibility, cm	Elasticity, units IDG	The hydration ability, %
Extra wheat flour	28.5±1.1	9.5±0.5	19.0±1.1	81.6±2.2	188.5±3.1
Extra wheat flour, wheat fibre, 25%	26.7±1.0	9.0±0.5	17.0±0.9	66.9±2.1	184.1±3.3
Extra wheat flour, wheat fibre, 30%	25.5±0.8	8.4±0.4	16.0±0.8	64.6±2.1	181.3±2.8
Extra wheat flour, wheat fibre, 35%	24.2±0.7	7.8±0.3	13.0±0.5	62.8±2.0	176.8±2.5

The research results show (tab. 5) that WF introduction causes the decrease of the amount of wet and dry gluten. Thus, the use of 25 ... 35% WF the content of wet gluten decreases by 22.3 ... 53.4% and dry gluten – 5.2 ... 12.6% respectively.

Increasing the dosage of all supplements in the studied range, gluten strengthens. It becomes more resilient and has a lower extensibility. Strengthening performance of the additives is associated with high hydrophilic ability of the constituents of their polysaccharide complexes that have a significant dehydrating impact on the dough biopolymers. It is evidenced by lowering hydration ability of dough gluten with this raw material, namely 2.3 ... 6.2% by adding WF compared to hydration of gluten washed from the dough without it. It should be noted that the formation of

strong gluten frame might cause an excessive compaction of the dough structure due to a significant resistance of the elastic gluten to the expansion of the air bubbles with temperature increase during baking and getting not enough aerated crumb of the baked biscuit semi-finished products and reduce their volume and porosity [10].

Table 4 shows that the introduction of the wheat fibre strengthens gluten, which is a negative factor in relation to the biscuit dough, so it is appropriate to provide the introduction of the surface-active agents (surfactants) that enable to weaken it and thus contribute to obtaining finished products with greater porosity and specific volume.

Surfactants are chemical compounds that concentrating on the interface cause the

reduction of the surface tension. The most common surfactants that gained their recognition in the FCP technology are non-ionic. They are generally compatible with other classes of surfactants, added to the raw materials in small quantities and are relatively inexpensive. Non-ionic surfactants enable to form an even thin-walled structure of the FCP crumb able to be kept fresh for a long time and to create a weakening effect on dough gluten.

Non-ionic surfactants are offered to use as surfactants for the biscuit semi-finished product that are a mixture of the emulsifiers «Grindsted Cake» produced by

Danisco (Denmark) [11]. It consists of propylene glycol ester and fatty acids (E 477), mono- and diglycerides of fatty acids (E 471), lactic acid stearate sodium (E 481). The addition of «Grindsted Cake» improves the overrun of the liquid biscuit dough and increased volume of the finished product, and provides an even structure.

The next stage of the research is to determine the impact of WF with adding the mixture of the emulsifiers «Grindsted Cake» on the quality of gluten of extra wheat flour (tab. 6).

Table 6
Impact of the Emulsifier «Grindsted Cake» on the Quality Indicators of Gluten

Flour mixture	Extensibility, cm	Elasticity, units IDG
Extra wheat flour	19±1.0	81.6±3.0
Extra wheat flour, wheat fibre, 30%	16±0.6	64.6±2.0
Extra wheat flour, wheat fibre, 30%+ «Grindsted Cake»	19.5±0.8	83.7±1.4

Table 6 shows that the included emulsifier enables to weaken gluten, improve its elasticity and extensibility. Therefore, we can predict that the finished products with added «Grindsted Cake» will have larger volume, better porosity and structure.

To determine the WF impact on the

indicators of the quality of the biscuit semi-finished product, baking tests are carried out with the replacement of the WF flour in the amount of 25, 30 and 35% and their quality indicators are determined, in particular – their specific volume, porosity, lifting and baking loss coefficient (tab. 7).

Table 7
Quality Indicators of the Biscuit Semi-Finished Product with Adding Wheat Fibre

Indicators	Control	With the replacement of 25%	With the replacement of 30%	With the replacement of 35%
Specific volume, cm ³ / g	2.46±0.2	2.43±0.2	2.36±0.2	2.31±0.3
Porosity, %	68.80±1.4	67.30±1.2	65.6±1.3	63.20±1.1
Lifting coefficient, units	1.83±0.2	1.81±0.1	1.76±0.1	1.71±0.2
Baking loss, %	9.90±0.4	9.10±0.3	8.40±0.2	7.90±0.1

Table 7 shows that the addition of WF degrades the quality of the baked semi-finished products for all indicators except baking loss whose value increases with

increasing the dosage of WF, apparently due to its high water absorbing and water retaining ability.

Based on the data obtained above on

weakening the gluten of wheat flour when adding «Grindsted Cake» emulsifier (tab. 6) it is decided to determine its impact on

the quality of the biscuit semi-finished product with wheat fibre addition (tab. 8).

Table 8

Quality indicators of the biscuit semi-finished product with wheat fibre addition and mixture of «Grindsted Cake» emulsifiers

Indicators	Control	With the replacement of 25%	With the replacement of 30%	With the replacement of 35%
Specific volume, cm ³ / g	2.46 ±0.2	2.58 ±0.2	2.51 ±0.2	2.43 ±0.1
Porosity, %	68.80 ±1.2	73.20 ±1.4	71.40 ±1.1	67.30 ±1.0
Lifting coefficient, units	1.83 ±0.1	1.92 ±0.2	1.88 ±0.1	1.79 ±0.1
Baking loss, %	9.90±0.2	9.10 ±0.3	8.40 ±0.2	7.90 ±0.2

Table 8 shows that the addition of «Grindsted Cake» leads to the increase of porosity, specific volume and lifting coefficient of the finished product with the addition of wheat fibre, thus, enabling to approach the quality indicators of the biscuit semi-finished product to the quality indicators of control. Specifically, the specific volume of the finished product increases by 2%, porosity by 3.7% and lifting coefficient by 2.7% respectively for the sample with the replacement of wheat flour into wheat fibre in the amount of 30%. Thus, it can be concluded that the addition of the «Grindsted Cake» emulsifier is appropriate to improve the quality of the biscuit semi-finished products with wheat fibre addition.

4. Conclusion

Thus, wheat fibre addition is a promising source for the enrichment of the flour used in confectionery products with dietary fibres, because its composition contains large amounts of cellulose, hemicellulose, lignin and pectin substances. The determined results of the fractional composition of WF indicate that dietary fibres are largely represented by cellulose and hemicellulose complex. Quite low energy value of the raw materials reduces

the energy value of the final product.

It is investigated that WF has a strengthening impact on flour gluten. It becomes more resilient and has lower extensibility. Reinforcing effect of WF can be associated with high hydrophilic ability of its polysaccharide component systems. It is determined that the introduction of WF together with a mixture of the emulsifiers «Grindsted Cake» in the dough increases flexibility and extensibility of flour gluten that affects positively the quality of the finished products. During baking tests of the biscuit semi-finished products with the replacement of wheat flour into WF in the amount of 25 ... 35% and addition of a mixture of the emulsifiers «Grindsted Cake», it is determined that the quality indicators, including porosity, specific volume and lifting coefficient, are improved in comparison with the indicators of control. Thus, WF can be recommended to use in the flour confectionery products technology as a source of functional ingredients.

5. References

- [1]. DOROHOVICH V. V., The use of carrot juice with biscuits developed functionality, Products and Ingredients, Vol. 8, 22-23 (2013).

- [2]. SHENDEROV B. A., Current state and prospects of development of the concept of "Functional food", *Food Industry*, Vol. 5, 4-7 (2003).
- [3]. MARINA N. V., NOVOSELOVA G. N., SHAVNIN S. A. Products with increased biological value out of non-traditional plant raw materials, *News of the Samara Scientific Center of the Russian Academy of Sciences*, Vol. 12, 1(8), 2079-2082 (2010).
- [4]. BRENNAN C.S. Evaluation of starch degradation and textural characteristics of dietary fiber enriched biscuits, *International Journal of Food Properties*, Vol. 7, 3, 647-657 (2004).
- [5]. ARSENEV L.Y., DOTSENKO V. F., Concentrates nutritive fibers, *Bakery and confectionery industry Ukraine*, Vol. 12, 109, 49-51 (2013).
- [6]. Conclusion sanitary and epidemiological expertise № 05.03.02-03/11418 from 18.02.2014.
- [7]. CONSTANDACHE M., The influence of fortification of bread with exogenous proteins on the protein digestibility, *Journal of Agroalimentary Processes and Technologies*, Vol. 8, 2, 461-466 (2007).
- [8]. OCHEME O., CHINMA C. Effects of soaking and germination on some physicochemical properties of millet flour for porridge production, *Journal of Food Technology*. Vol. 6. № 5. P. 185-188 (2008).
- [9]. HIDVEGI M., LASZTITY R. Phytic acid content of cereals and legumes and interaction with proteins, *Periodica Polytechnica. Ser.Chem.Eng.*, Vol. 46. № 1–2. P. 59–64 (2002).
- [10]. DROBOT V.I., ARSENYEVA L.Yu., BILYK O.A. etc. Laboratory workshop on technology of bakery and macaroni production. Kyiv: Center of educational literature, 341 (2006).
- [11]. Conclusion sanitary and epidemiological expertise № 05.03.02-03/84115 from 17.09.2013.