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Prospects for the Use of By-Products of Oil and Wine Production in Bakery and Confectionery Technologies †

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Abstract: An influence of 10…20% of wheat germ meal (WGM) and 1…5% of rosehip meal (RM) on the quality indicators and nutritional value of rye-wheat bread was investigated. It was found that an addition of WGM in the entire range of dosages reduces the specific volume of the bread, and an addition of RM, on the contrary, increases this indicator. It is recommended to use 10% WGM with 5% RM to ensure the high quality and maximize the nutritional value of the rye-wheat bread. An impact of 15…25% of grape seed powder (GSP) on the quality indicators and nutritional value of butter biscuits was studied. It is recommended to add 20% GSP to obtain butter biscuits with improved quality and high content of biologically active compounds.

Keywords: wheat germ meal; rosehip meal; grape seed powder; bread; butter biscuits; nutritional value; dietary fiber; polyphenols

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1. Introduction

The use of secondary plant raw materials with high nutritional value in the bakery and confectionery technologies is an important area in the development of novel products, because it ensures maximum usage of the natural potential of the feedstock. The analysis of literature sources shows the effectiveness of the use for this purpose of grain, fruit and berry by-products], including products of processing of wine-grape pomace and by-products of oil production [1–7].

The defatted meals of wheat germ (WGM) and rosehip (RM), which are by-products of the low-temperature CO_2-extraction of the corresponding oils, are interesting for the development of healthy products as a source of dietary fiber, polyphenols, vitamins E, B_1, PP, minerals potassium, calcium, magnesium, etc. [8]. Rosehip meal also contains ascorbic acid, which is used in baking as an oxidant improver to strengthen gluten and improve the structural and mechanical properties of the dough [9,10].

The large quantities of grape pomace are accumulated in the process of making wine. Grape seed powders extracted from pomace of grape grown in southern regions of Ukraine are a rich source of health-promoting polyphenols such as hydroxybenzoic acids, stilbenes, flavonols, flavanols. They content dietary fiber, vitamins B_1, B_2, B_6, PP, minerals iron, calcium, potassium, magnesium as well.

The purpose of the present research is to determine the influence of defatted wheat germ meal, rosehip meal and grape seed powder on the quality and nutritional value of bakery and confectionery products. Wheat germ and rosehip meals added alone or in combination, were used in rye-wheat bread technology. Grape seed powder was chosen for butter biscuits technology.

2. Materials and Methods

2.1. Materials for Rye-Wheat Bread Making

Wheat germ meal (WGM) and rosehip meal (RM) were received from Scientific and Production LLC "Zhitomirbioproduct" (Ukraine). They are defatted dry powder by-products of the low-temperature CO_2-extraction of the wheat germ and rosehip oils. WGM and RM content 37.0 and 5.7 g/100 g of protein, 23.8 and 60.4 g/100 g of dietary fiber, 567.0 and 3850.0 mg GA/100 g DW of polyphenols, vitamins E (7.8 and 6.7 mg/100 g), B1 (2.1 and 1.2 mg/100 g), PP (2.4 and 1.8 mg/100 g), minerals potassium (1200.0 and 3543.0 mg/100 g), calcium (115.0 and 336.8 mg/100 g), magnesium (220.0 and 813.3 mg/100 g), etc. RM contains 47.0 mg/100 g of ascorbic acid [8].

Commercial first grade wheat flour, hulled rye flour, salt, pressed baking yeast, dry rye sourdough TM "Puratos Othello Norma" (Belgium) are also used for the study.

2.2. Materials for Butter Biscuits Making

Grape seed powder (GSP) was obtained from the grapeseed oilcake produced in LLC "Orion" TM "Oleo Vita" (Odesa, Ukraine). Considering the granulometric composition, grapeseed powder is fine-grained and homogenous: 80…82% of the fractional makeup consist of particles with dimensions between 20 and 30 mkm. GSP contents 11.8 g/100 g of protein, 8.26 g/100 g of fat, 51.3 g/100 g of dietary fiber, 3344 mg/100 g (routine equivalent) of polyphenols, vitamins B_1 (0.2 mg/100 g), B_2 (0.54 mg/100 g), B_6 (0.21 mg/100 g), B_{12} (5.67 mg/100 g), PP (3.33 mg/100 g), minerals iron (20.09 mg/100 g), calcium (388.89 mg/100 g), magnesium (387.74 mg/100 g), potassium (1544.44 mg/100 g), phosphorus (325.37 mg/100 g) etc.

Wheat flour of the highest grade, powdered sugar, butter and hen's eggsolution are used for the study as well.

2.3. Rye-Wheat Bread Making

The control bread formula consisted of rye flour (50 g), wheat flour (50 g), dry rye sourdough (2.5%, flour basis), salt (1.5%, flour basis), pressed yeast (2.0%, flour basis), and water (moisture content 47%). In experimental samples, 10…20% of the wheat germ meal or 2…6% of the rosehip meal or their combination was added instead of an equivalent amount of the rye and the wheat flour. Due to the high water absorption capacity of the additives (275 and 260%, respectively), the moisture content of the dough was increased by 1.0% relative to the control sample. The fermentation of all dough samples was carried out in a proofing cabinet for 90 min (W = 80 ± 5%, t = 30 ± 2 °C), after which the dough was divided into portions and formed, placed in the proofing cabinet (W = 80 ± 5%, t = 32 ± 2 °C) and baked at a temperature of 210 ± 10 °C within 25 ± 2 min using the steam. All breads were left at a room temperature for three hours to be cooled.

2.4. Butter Biscuits Making

The basic recipe for butter biscuits is: calculated based on 100 g of wheat flour, 24% powdered sugar, 78% butter, 6% hen's eggsolution. The technology of butter biscuits includes the following stages: preparing egg-sugar-butter emulsion; adding of wheat flour; kneading dough. In the experimental samples, 15…25% of grape seed powder was added instead of the equivalent amount of wheat flour.

3. Methods

Physical-chemical indicators of bread and butter biscuits quality, such as titratable acidity (bread only), wetting ability (biscuits only), moisture content and specific volume are determined by standard methods.

4. Statistical Analysis

The experimental data are processed statistically by the Fischer-Student method at a reliability level of 0.95 with the use of the MS Office 2016 application package version, including MS Excel 2016. Research results are calculated as an average of at least three replicates.

5. Results and Discussion

1. Determination of the influence of wheat germ and rosehip meal on the quality indicators and nutritive value of rye-wheat bread

The results of studies of physical and chemical indicators of bread quality are presented in Table 1.

Table 1. The effect of wheat germ meal (WGM) and rosehip meal (RM) on the total titratable acidity (TTA), specific volume and moisture content of rye-wheat bread.

Bread Sample s	Dosage of Additives (%, Flour Basis)	TTA	Specific Volume (cm^3/100 g)	Moisture (%)
Control	0	6.0	200	46.0
+WGM	10	6.5	185	46.7
	15	6.9	170	47.0
	20	7.3	150	47.6
+RM	1	6.4	215	46.4
	3	6.6	240	46.6
	5	7.4	255	47.0
+(WGM + RM)	10+5	7.6	195	47.7

It was found, that an addition of 10…20% of WGM and 1…5% of RM increases the humidity of the bread, which is caused by the significant content of hydrophilic dietary fiber in the both additives and protein in WGM. Their TTA also increases by 8.3…21.7% and 6.7…16.7%, respectively. However, meals have a different effect on the specific volume of the bread. In the case of an adding of the wheat germ meal, this indicator decreases by 7.5…25.0% compared to the sample without additives. It can be explained by the high activity of enzymatic processes, primarily proteolysis under the action of glutathione, which is contained in the wheat germ [9]. It makes the use of more than 10% of wheat germ in the technology of rye-wheat bread not appropriate. The introduction of RM, on the contrary, leads to an improvement in the specific volume of bread by 7.5…27.5% due to the strengthening of wheat flour gluten under the action of ascorbic acid, contained in the RM.

The combined use of meals in the experimental dosage (10%WGM + 5%RM) almost eliminates the negative impact of WGM on the specific volume of bread, bringing this indicator closer to control sample. Compared with sample with a separate application of 10.0% WGP the specific volume of this bread increases by 11.0%. In our opinion, it is associated with a decrease in an activity of proteolysis in the dough in the presence of RM.

The addition of both meals in selected dosages significantly increases the content of physiologically functional ingredients in bread (Table 2).

Table 2. The effect of wheat germ meal (WGM) and rosehip meal (RM) on the nutritive value of rye-wheat bread.

Nutrients	Control Sample	Bread with Additives (10% WGM +5% RM)
Protein, g	6.40	7.30
Fiber, g	5.20	8.90
Minerals, mg		

K	11.10	26.60
Ca	2.00	2.90
Mg	3.50	7.70
P	10.30	11.80
Fe	0.80	3.30
Vitamins, mg		
B_1	0.18	1.10
PP	0.90	1.10
E	1.30	1.60
Polyphenols, mg	90.00	221.50

Results presented in Table 2 show that the addition of 10% WGM along with 5% RM to rye-wheat dough resulted in increase in protein content by 14.1%, dietary fiber—by 71.2%. The content of potassium is 2.6 times, magnesium—2.0 times, iron—3.1 times, vitamin B_1—6.1 times, vitamins PP and E—22.0 and 23.0% higher in the experimental sample of bread than in the control. It was noted that due to the addition of meals, the content of polyphenols in bread increases by14.6 times.

2. Determination of the influence of grape seed powder on the quality indicators and nutritive value of butter biscuits

The results of the study of physical-chemical parameters of the quality of butter biscuits with grape seed powder are shown in Table 3.

Table 3. The effect of grape seed powder on the quality of butter biscuits.

Dosage of Powder (%, Flour Basis)	Wetting Ability, %	Specific Volume (cm^3/100 g)	Moisture (%)
0	150.0	178	5.5
15	148.0	176	5.5
20	146.0	172	5.6
25	137.0	165	5.7

It was found, that an addition of 15…20% of the powder reduces the specific volume of biscuits—by 1.1…3.4 % and the wetting ability—by 1.3…2.7%, an addition of 25% of GSP reduces the specific volume of biscuits by 7.3% and the wetting ability by 6.7% comparing to the control sample. So, an addition of the grape seed powder to the butter biscuit is advisable in an amount of up to 20% by the weight of the flour since an increase in an amount of powder up to 25% degrades the quality indices.

The addition of GSP increases the content of nutrients and biologically active ingredients in butter biscuits (Table 4).

Table 4. The effect of grape seed powder on the nutritive value of butter biscuits.

Nutrients	Control Sample	Butter Biscuits with 20% GSP
Protein, g	7.06	7.30
Fiber, g	0.06	6.24
Minerals, mg		
K	89.19	216.35
Ca	22.58	54.70
Mg	10.99	45.16
P	68.33	87.36
Fe	0.86	3.86
Vitamins, mg		
B_6	0.02	0.04

PP	0.84	1.74
Polyphenols, mg	00.00	647.35

Results presented in Table 4 show that the addition of 20% GSP to butter biscuits significantly increases the content of dietary fiber, potassium and calcium by 2.4 times, phosphorus—1.3 times, iron—4.5 times, vitamin B_6—1.5 times, vitamin PP—2.4 times. In addition, a sample of butter biscuits with GSP contains 647.35 mg of polyphenols while traditional biscuits are not.

6. Conclusions

The results of this study indicated that wheat germ meal and rosehip meal are promising additives for production of rye-wheat bread with the high content of protein, dietary fiber, vitamins, polyphenols and minerals. The introduction of more than 10% wheat germ meal leads to a significant deterioration in the specific volume of bread, probably due to active proteolysis in the dough. The introduction of rosehip meal in the entire dosage range improves the quality of the bread due to the strengthening of wheat gluten. To ensure high quality and maximize the nutritional value of rye-wheat bread, it is recommended to use 10% of wheat germ meal in complex with 5% rosehip meal.

Grape seed powder can be considered a promising additive in butter biscuits technology as a source of polyphenols, dietary fiber, vitamins and minerals. The addition of up to 20% of the powder improves the physical-chemical indicators, such as specific volume and wetting ability, as well as increases the nutritional value of butter biscuits.

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