

BUTTER BISCUIT WITH INCREASED BIOLOGICAL VALUE

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Abstract.

Introduction. It is proposed to use hull-less oat malt flour in confectionery products in order to increase their bioavailability.

Materials and methods. Amino acid composition, total amount of sugars and lipid composition of oat malt and malt flour have been determined using standard techniques.

Results. The effects of oat malt flour on physicochemical, structural and mechanical properties of dough and quality of butter biscuits have been determined. The chemical composition of oat malt of hull-less oats has been identified. The innovative production technology of biscuits having increased biological value has been scientifically substantiated. Academic novelty of this research consists in that the changes of amino acid and lipid composition of oat malt flour after the germination process have been first investigated, as well as the effect of oat malt flour on protein and starchy components of wheat flour and on the structural - mechanical properties of butter biscuit dough. The results of this study can be used in confectionery industry for butter biscuits production in order to improve the biological value of butter biscuits.

Keywords: biscuit, hull-less, oat, malt, flour, dough.

I. Introduction

The use of new types of non-traditional materials is one of the priorities in the development of innovative production technologies of confectionery exhibiting high nutritional and biological value. The by-products of grain malt are classified as plant raw materials with high content of biologically active substances. The sprouted grains contain the entire set of ingredients necessary for a balanced diet: low molecular weight proteins, amino acids, easily digested carbohydrates, food fibers, polyunsaturated fatty acids, minerals, vitamins and polyphenol compounds [1]. The scientists of National University of Food Technologies developed the modes of obtaining fermented and unfermented malts from different grain varieties. The available technologies ensure high content of vitamins, minerals, plant enzymes and plant hormones [2]. Malts of different cereals (wheat, oats, corn, barley) contain biologically active compounds in different proportions. Oat malt, compared with other cereal malts, contains the greatest amount of amino acids being the regulators of metabolic processes in the human body [3]. Therefore, it was oat malt flour which was used when developing a new product line of butter biscuits.

II. Materials and Methods

Investigation, presented in this paper, aimed at studying physico-chemical and technological properties of hull-less oats malt flour and its effect

on the structural and mechanical properties of dough as well as the quality of butter shortbread biscuits aiming to create a new range of products with a high biological value. Unfermented oat malt flour obtained from the hull-less oat and its influence on the formation of the dough for butter shortbread biscuit were determined as the target of research. Studies were performed using standard methods of analysis [5].

Digestible carbohydrates were measured by paper chromatography using chromatography paper Filtak № 1 with the upward flow of solvent.

Amino acid content was measured by amino acid analyzer T 339.

Fatty acid composition of oat malt flour made of hull-less oats was measured by gas liquid chromatography.

The enzymatic activity of oat malt and the amount of reducing sugars was determined.

The effect of oat malt on quantity and quality of gluten was examined by applying IDK – 3 instrument.

The effect of oat malt flour on the formation of dough was determined by applying Brabender farinograph.

The effect of oat malt on flour slurry viscosity was evaluated by using Brabender ASG amylograph.

Changes in structural and mechanical properties of oat malt butter biscuits dough were rated by applying "Structurometr" instrument.

III. Results and Discussion

Research results show that oat malt contains 18 amino acids, including valine, leucine, isoleucine, lysine, threonine, phenylalanine, arginine, aspartic and glutamic acids, serine, proline, glycine, alanine and tyrosine. The ratio of essential amino acids to the total number of amino acids is 34% (Table 1).

Table 1. *The amino acid composition of hull-less oat malt, mg/100 g*

Amino acids	General amino acids	Free amino acids
Lysine	754	8
Histidine	390	6
Arginine	1230	17
GABA	10	4
Aspartic acid	1110	21
Threonine	628	7
Serine	816	10
Glutamic acid	3569	73
Proline	887	12
Glycine	802	5
Alanine	874	16
Cysteine	459	1
Valine	907	9
Methionine	227	2
Isoleucine	602	5
Leucine	1337	10
Tyrosine	596	3
Phenylalanine	891	9
Total:	16090	220
Including essential amino acids mg %	534634	5123

From technological point of view, the content of sugars is an important aspect if using malt flour of various crops. These sugars are accumulated during germination by enzymatic hydrolysis of polysaccharides. It has been found that the saccharification time of oat malt flour is 15 minutes and the amount of reducing sugars, 11,7% (Table 2).

Table 2. *The sugar content in hull-less oat malt, average %*

Fructose	2,8
Glucose	3,5
Maltose	1,2
Sucrose	3,0
Glucoside	1,2
Total amount of sugars:	11,7

Due to biological value, it is highly important to define the fatty acid composition of oat malt flour. The investigation of fatty acid composition proved that the hull-less oats malt flour contains a large amount of polyunsaturated fatty acids, such as linolic (36,7%), linolenic (34,4%) and oleic acids. The ratio of polyunsaturated fatty acids to the total number of amino acids is up to 72% (Table 3).

Table 3. *Lipid acid composition of oat malt*

Polyunsaturated fatty acids	C, %	Unsaturated fatty acids	C, %
Oleic (C ₁₈)	36,7	Palmitic (C ₁₆)	22,8
Linolic (C ₁₈)	34,4	Stearic (C ₁₈)	1,41
Linolenic (C ₁₈)	1,1	Myristic (C ₁₄)	0,41

In order to determine the optimal dosage of oat malt flour in the production of butter shortbread biscuits, the research of the effect of malt on the organoleptic, physico-chemical, structural and mechanical properties of semi-finished and finished products has been conducted.

Organoleptic quality evaluation of the biscuits was performed by the following differential parameters: taste, aroma, shape, surface condition and cut-away view. When treating oat malt flour in a formula in an amount of up to 50%, butter biscuits were characterized as having delectable taste and flavor as well as uniform porous structure. By expert evaluations it was found that, when treating oat malt flour in a formula in an amount of up to 30%, butter biscuits have the best organoleptic characteristics.

One of the basic processes of butter biscuit production is the preparation of the dough. The flour with an average gluten quality is commonly used for kneading: the dough contains a substantial amount of sugar and fat, which limit the swelling of flour gluten. The studies of oat malt influence on the process of dough formation have been conducted in order to determine the optimal amount of new material and to form dough having specific structural and mechanical properties [6].

While investigating the influence of oat malt flour on the quality of gluten complex, it was found that there was an increase in gluten extensibility and reduction of its elasticity when adding malt flour to the wheat one.

When analyzing farinograms of dough with different content of malt flour, it was specified that its elastic properties were reduced and its plastic properties were increased. This is due to the high activity of proteolytic enzymes of oat malt, conducive to the hydrolysis of flour proteins and dough structure plastification. By increasing the

amount of malt flour, the maximum dough consistency, water absorption capacity and the dough-development time were reducing (Table 4).

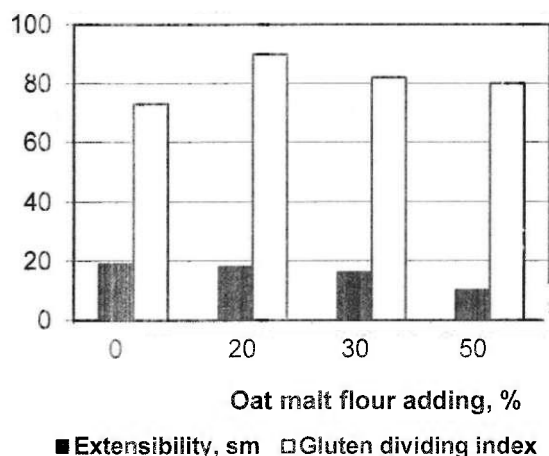


Fig. 1. The effect of oat malt flour adding to wheat flour on the gluten quality

Results show that the addition of oat malt plastifies the semifinished dough and reduces the

amount of fat in butter biscuit formulations.

Table 4. Farinogram characteristics of wheat flour dough with the addition of oat malt flour (OMF)

Name of the indicator	Value of the indicator		
	Wheat flour Control	OMF 20%	OMF 30%
Maximum dough consistency $\alpha_{max} O\Phi$	565	500	544
Water absorption capacity, %	59	49.1	54.8
Time of dough formation β , minutes	1.7	1.0	1.5
Rarefaction of $O\Phi$	98	140	112
Stability, minutes	2.4	0.8	1.5

Researches conducted at Brabender ASG amylograph suggest that the addition of malt flour significantly alters the maximum viscosity of flour suspension (Table 5).

Table 5. The amylograph measures of oat malt effect on the viscosity of flour suspension

№	The composition of flour suspension	The maximum viscosity of the suspension, measurement units of the instrument	The temperature of gelatinization, °C
1	Wheat flour, top-grade + water	650	68
2	Wheat flour 70% + oat malt flour 30% + water	120	66
3	Wheat flour 50% + oat malt flour 50% + water	80	67.5

These processes are explained by the fact that the strengthening of hydrolytic activity of amylolytic enzymes is realized simultaneously with temperature lift, when adding the malt. Amylolysis is most rapid when adding malt flour in an amount of 50%. These processes affect the change of rheological properties of dough and the structural properties of the finished products. Furthermore, addition of malt flour contributes to the accumulation of glucose and maltose, which enables to reduce the sugar content in the products.

In order to determine the effect of new raw material on the butter biscuit dough structure, a change of limit shear stress, depending on the dosage of malt flour, was identified (Table 6). It was found that the addition of 30% oat malt flour reduces the critical shear stress of biscuit dough by a factor of 1.7. These data correlate with the farinogram measurements of the dough. It was concluded that it is necessary to reduce the amount of fat in the dough formulation in order to increase

the shape retention of dough pieces.

Table 6. The change of limit shear stress of butter biscuit dough, depending on the dosage of malt flour

Oat malt flour dosage, % to the weight of flour	Control	Adding 30% of oat malt flour
Critical shear stress after the dough formation	17,0	9,8
Critical shear stress after the 30 minutes dough proving, kPa	24,0	10,9

A formulation of butter biscuit with a sugar content reduced up to 25% and with a fat content reduced up to 15% has been developed under the conducted investigations. The new technology is patented in Ukraine [(2012), Oatmeal cookies, Patent of Ukraine 72044].

IV. Conclusions

The results of conducted experimental studies have demonstrated the expediency of oat malt flour application aiming to improve the organoleptic quality of butter biscuit and to increase its biological value. The adding of oat malt to the wheat flour in the recipes of butter biscuits allows decreasing the amount of sugar and fat and reducing its caloric content.

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