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THE INFLUENCE OF PROTEINS ON THE TECHNOLOGICAL PROCESS OF MAKING BREAD WITH FRUCTOSE

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Abstract: *The article discusses the necessity of enriching products by proteins for patients suffering from diabetes. The influence of casein, egg albumin and whey protein on microbial and structural and mechanical processes in the dough and on the quality of the finished bread for diabetics was studied. The aim of our research was to determine the influence of animal proteins on the technological process of making bread with fructose. The studies included recommendations on nutrition for patients with diabetes. As indicators of the technological process there were investigated gas producing, gas holding ability of dough and its viscosity as well as the quantity and quality of gluten, quality of finished products. It has been established that it is technologically advisable to enrich bakery products for people with diabetes by fructose and by studied animal proteins due to their high biological value.*

Keywords: *bread, diabetes, casein, egg albumin, whey protein.*

1. Introduction

Nowadays the actual problem is diabetes mellitus because there are millions of people who suffer from this disease. However, published data do not reflect the true dissemination of the disease. It is believed that for each registered person there are 2 - 2.5 undiagnosed patients [1].
A key role in maintaining patients'health with diabetes plays nutrition. One of the main food products is bread, but there are a few types of bread for diabetics enriched by nutrients with a low glycemic index. According to the WHO Expert Committee patients with diabetes need products with the low contents of easily digestible carbohydrates, i.e. which contain ingredients with a low glycemic index, and especially sugar free or with reduced sugar content. Scientists found appropriate to replace sugar by fructose when producing bread, because the monosaccharide fructose is sweeter than sucrose 1.5-1.7 (1.5 – 1.7) times, it does not require insulin for assimilation, does not affect significantly blood sugar level. The glycemic index of fructose is 20 whereas sucrose - 70 [2].
Traditional breads, especially from top-grade flour are characterized by low nutritional value, including restricted anabolic protein targets due to low content of lysine and threonine [3].
It is known that bread from top-grade flour is a product with a low content of complete protein; its limited amino acid is lysine. The variety of bread commercially available is quite wide, but there is limited number of bakery products for special purposes, enriched by proteins. When there is a growing prevalence of diabetes this problem is particularly acute because such patients should have complete proteins in daily diet [4]. Therefore, the actual problem is the increase in the biological value of bakery products especially because of this disease [5].

This problem can be solved by using natural raw materials that contain a number of biologically active substances. Leading scientists conducted research in this field, but data on the impact of proteins on bread manufacturing process and the quality of finished products with fructose have not been found yet.

As it is known, the works of many researchers are focused on studying the possibility of using these natural raw materials in end products of processing sunflower, beans, and a variety of non-traditional supplements for enrichment bread by protein [6]. A number of studies are devoted to such sources of protein like soya, pea, and lupine [7], [8].

Raw vegetables are effective in terms of protein enrichment, but in most cases their use is limited because of the negative impact on the manufacturing process and products' quality. Almost all protein sources of enrichment impair the structural and mechanical properties of dough, bread volume and porosity. Its main reason is considered to be technological incompatibility of proteins from different materials [9]. It is believed that proteins of bread enrichers interact with gluten proteins and seal their structure due to the formation of new disulphide bonds (-S-S-).

An important role in a balanced diet belongs to animal proteins, because they are the most valuable ones due to the balance of amino acid composition [10].

Native scientists conducted research concerning the enrichment of bread by these proteins to improve the biological value of bakery products [11], [12], [13].

Foreign scientists found that the best sources of enrichment by animal protein are eggs and milk proteins. Their assimilation reaches 96 - 98% [14], [15].

Therefore, the aim was to investigate the effect of animal protein such as egg albumin, casein and whey protein on the technological process of making bread with fructose for people who suffer from diabetes.

2. Materials and methods

The influence of egg albumin, casein and whey protein on the technological process of making bread from top-grade flour containing fructose 5% to the weight of flour has been researched. Proteins were dosed in an amount that satisfies 20, 30 and 40% of the daily dose of protein when consuming 277 grams of bread.

The effect of supplements on yeast microflora, structural and mechanical properties of dough and the quality of finished products have been investigated.

As indicators of the technological process there were investigated gas producing, gas holding ability of dough, its viscosity, quantity and quality of gluten [16], [17]. The indicators of the quality of finished products were: specific volume, porosity, shape stability and acidity of bread. Control - a sample with fructose without addition of protein enrichers.

3. Results and discussion

As a result of the experiments it has been found that the reduction of dedicated carbon dioxide during the fermentation of dough when adding proteins is explained by decrease of gas producing ability (Table 1).

It has been found that in compounds with casein (20%) gas producing ability of dough deteriorated by 7.1% as compared with Control, with albumin (20%) – by 6.1%, with whey protein (20%) – by 9.3%. While adding 30% of casein gassing deteriorated by 8.2% compared with Control, albumin (30%) – by 7.2%, whey protein (30%) – and by 11.1% respectively.

Table 1.

The influence of proteins on gas producing ability of dough

Holders of protein	Number of enrichers, % to provide the daily protein intake	The total gas production in dough, [cm^3, CO_2]
Control	0	1368
Casein	20	1271
	30	1256
	40	1232
Egg albumin	20	1277
	30	1263
	40	1237
Whey protein	20	1244
	30	1220
	40	1204

While enriching by casein (40%) the studied indicator declined by 9.9% as compared with Control, with albumin (40%) – by 9.0%, with whey protein (40%) – by 12.2% respectively. The addition of animal proteins to the dough affects adversely the fermentation activity of yeast. It can be explained by high protein buffering, thus creating unfavorable pH of dough for fermentative hydrolysis of starch and accumulation of maltose, which is a reason of reducing the intensity of fermentation.

In the case of enrichment products by proteins the important factors are structural and mechanical properties of dough (SMP). SMVP are characterized primarily by the quantity and quality of gluten. The determination was conducted after softening the dough for 20 minutes at 30˚C for swelling of proteins. The impact of added proteins for this indicator is given in Table 2.

Table 2.

The influence of proteins on gluten properties

Holders of protein	Number of enrichers, % to provide the daily protein intake	Wet gluten, [%]	Dry gluten, [%]	Value IDK, units of instrument	Hydratation ability, [%]	Extensibility %, [cm]
Control	0	25.52	9.55	73.7	168.1	15.4
Casein	20	23.5	8.70	70.3	170.5	15.1
	30	21.5	8.03	63.5	168.1	14.9
	40	21.1	7.72	56.7	163.6	14.8
Egg albumin	20	23.2	8.70	72.0	168.5	15.5
	30	23.1	8.63	67.2	167.8	15.3
	40	22.8	8.61	63.1	165.2	15.0
Whey protein	20	19.04	7.1	52.1	168.0	15.1
	30	18.4	6.8	36.4	161.7	14.9
	40	not washed				

Thus, the trend of reducing wet gluten when adding proteins is traced, namely in samples with albumin (20%, 30%, 40%) the quantity of wet gluten decreased by 7.8

- 17.2% compared with Control; with casein – by 9.1 - 10.3%; with whey protein (20% and 30%) – by 25.4 - 27.9%.
When adding 40% of whey protein gluten was not washed.
Reduction in the quantity of gluten can be explained by the fact that milk proteins are not involved in the formation of gluten and form complexes that affect dough viscosity. When adding albumin the percent of reduction is the least and whey protein – is the highest. However, gluten is highlighted by indicator IDK.
Visco-elastic properties of dough were determined by its specific volume (Figure 1).

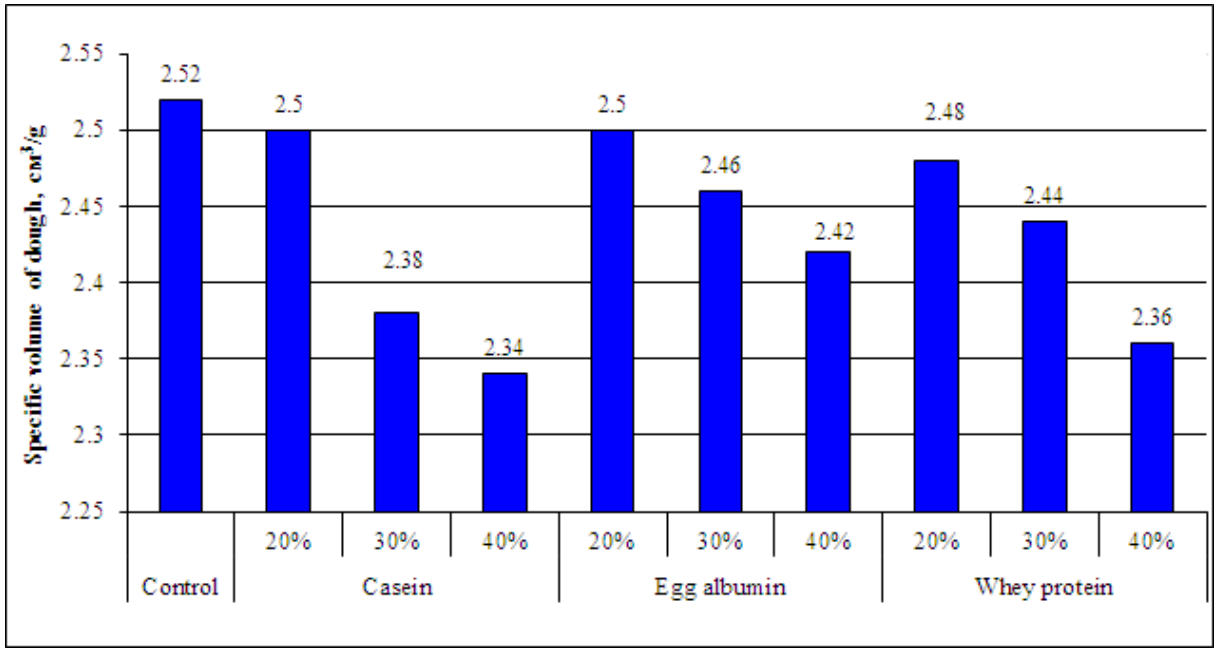

Figure 1. Gas holding ability of dough.

It has been established that the addition of proteins in dough reduces gas holding capacity, in particular casein by 0.8 - 7.1% depending on the dosage, egg albumin – by 0.8 - 3.9%, whey protein – by 1.6 - 6.3 %, apparently due to the negative influence of proteins on fibrinous frame, resulting in the deterioration of CO_2 holding.
Elastic properties of dough were determined by spreading the dough balls (Table 3).

Table 3.

Shape holding ability of dough

Holders of protein	Number of enrichers, % to provide the daily protein intake	Spreading dough balls, [mm]
Control	0	94
Casein	20	112
	30	120
	40	130
Egg albumin	20	106
	30	118
	40	132
Whey protein	20	118
	30	122
	40	126

When adding proteins to the dough, a trend of spreading and increasing especially with whey protein was observed. It is explained by the decrease in dough viscosity: whey protein reduces the water absorbing capacity of dough by dehydrating action of milk sugar - lactose. Dilution is observed mostly with increasing of dosage of protein in the recipe.

There have been studied the indicators of bread when adding sources of protein. The results are shown in the Table 4.

Table 4.

The influence of proteins on the quality of finished products

Holders of protein	Number of enrichers, % to provide the daily protein intake	Indicators			
		Specific volume [cm^3/100 g]	Shape stability, [H/D]	Porosity, [%]	End acidity, hail
Control	0	337	0.42	76	2.0
Casein	20	311	0.41	71	2.1
	30	299	0.39	71	2.1
	40	285	0.38	72	2.3
Egg albumin	20	309	0.39	71	2.2
	30	296	0.35	72	2.3
	40	281	0.33	72	2.5
Whey protein	20	301	0.37	70	2.2
	30	288	0.36	71	2.2
	40	262	0.30	71	2.6

When increasing the dosage of proteins the specific volume of bread, shape stability and porosity decrease.

4. Conclusion

As a result of studies on the impact of animal proteins on the technological process of making bread it has been found that enrichment of diabetic bakery products by fructose and by protein reduces fermentation activity of yeast microflora and affects adversely the structural and mechanical properties of dough, including reducing the intensity of flatulence, gas producing, gas holding ability, quantity of gluten in dough. However, it is strengthened. But due to the valuable amino acid composition of studied proteins they are considered to be advisable to be used in order to provide patients suffering from diabetes with complete proteins. To ensure the quality of diabetic bakery products enriched by animal proteins there should be applied technological measures to increase the intensity of fermentation and improve the structural and mechanical properties of dough.

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