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Increasing economic efficiency of flour production from grain of the main cereal crops by extrusion method

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Abstract. The paper deals with the issues of improving the economic efficiency of grain processing enterprises through the introduction of the developed technologies of extrusion and flour production from extruded grains of the main cereal crops. The comparison of the output norms in the processing of grain from the main cereal crops on the existing and developed technologies was carried out. The calculations of the flour production efficiency showed that the processing of wheat will increase the volume of marketable products by 10.0 %, barley – by 14.8 %, oat – by 22.3 %, in this regard, the profitability of production of new high-yield types of flour will increase: wheat by 15 %, barley – by 29.3 %, oat – by 45.6%. Crops have a higher economic effect in the production of extruded flour due to the low cost of raw materials and a decrease in technological waste.

1. Introduction

Enrichment of mass consumption products with various physiologically valuable components to give them additional useful properties is one of the perspective directions of food technology improvement [1]. The biological value of higher grade flour is not very large; there is a shortage of essential amino acids, macro-and microelements (calcium, iodine, iron, etc.), vitamin B. During processing, the grain is deprived of all five protein shells, which contain about 70% of vitamins and minerals, i.e. in white crumbly flour remains almost pure starch. Vitamins B_1, B_2 and folic acid in the higher grade flour are three times less than in the flour of coarse grinding, vitamin E is generally absent. Magnesium is 5-6 times less; phosphorus and calcium are 3 times less [2].

To solve this problem in recent years, the ways of creating special foods are studied necessary to maintain the vital functions of the human body and protect it from many diseases associated with environmental degradation (diseases of the immune and cardiovascular systems, respiratory tract, cancer and premature aging). Replacement of a part in flour varietal by flour from the extruded grain at production of bread, bakery and flour confectionery give the chance to expand the product range of a functional orientation [3].

The extrusion process of various products is studied by both local and foreign scientists. According to Abeykoon, Chamil & Kelly, Adrian L. & Brown, Elaine C. & Vera-Soroche, and others "extrusion is one of the fundamental methods of production in the polymer processing industry and is used in the production of a large number of goods in various industries" [4].

In their scientific work such authors as Coimbra, Michelle Cardoso & Duque, Aleta & Saéz, Felicia & Manzanares and others, consider the application of the extruding method with the alkaline pre-

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treatment for the production of sugar from biomass wheat straw to optimize the enzymatic dosage, as the production of enzymes is costly [5]. Despite the presence of studies about extrusion issues by foreign authors, the use of extrusion in grain processing is poorly reflected, which determines the actuality of the study of this issue.

2. Research method

The efficiency of grain processing is estimated by a number of technical and economic indicators of the processing plant, the main ones are the output volume of finished products, reducing waste and losses, increasing the quality of flour products [6].

The technologies of extrusion and flour production from extruded grain developed in the course of scientific research allow increasing the output of finished products in flour production. And thereby they allow increasing its economic efficiency. The proposed technology and optimal extrusion modes of the main cereal crops (temperature and time) were studied by the authors earlier [3].

Table 1 presents a comparative assessment of the output norms in the grain processing of the main cereal crops on the existing and developed technologies.

Table 1. Norms of output in the processing of wheat, barley and oat.

Name of product	Existing technology		Proposed technology	
	%	ton	%	ton
Wheat				
Wheat flour	77.5	2974.3	96.0	3684.3
Fodder flour and bran	18.0	690.8	1.4	53.7
Fodder grain product	2.9	111.3	0.0	0.0
Waste and mechanical losses	0.3	11.5	0.3	11.5
Shrinkage	1.3	49.9	2.3	88.3
Total	100.0	3837.8	100.0	3837.8
Barley				
Barley flour	68.0	2609.7	91.0	3492.4
Fodder flour and bran	21.0	805.9	3.0	115.1
Fodder grain product	6.0	230.3	0.0	0.0
Waste and mechanical losses	3.7	142.0	2.7	103.7
Shrinkage	1.3	49.9	3.3	126.6
Total	100.0	3837.8	100.0	3837.8
Oat				
Oat flour	64.0	2456.2	90.0	3454.0
Fodder flour and bran	25.1	963.3	3.7	142.0
Fodder grain product	5.6	214.9	0.0	0.0
Waste and mechanical losses	4.0	153.5	3.0	115.1
Shrinkage	1.3	49.9	3.3	126.6
Total	100.0	3837.8	100.0	3837.8

According to the results, the proposed technology allows obtaining flour from extruded wheat grain with an output of 96%, flouring from extruded barley grain – 91 %, flour from extruded oat grain – 90 %, this indicator is higher than using the existing technology.

In the traditional technology of grain processing bran and flour containing high-protein components are used for the production of animal feed. Extrusion processing of grain crops ensures the inclusion and preservation of vitamins, minerals and proteins in the new types of flour. Analysis of the data in table 1 showed that the main reserves for increasing the output of finished products with the proposed technologies are reducing the waste of flour production. The proposed technology for grain processing of the main cereal crops can increase the flour output by reducing the amount of waste, bran and mechanical losses in the processing of grain: wheat flour by 18.5 %, barley – by 23%; oat – by 26 %.

3. Results

An important factor in the development strategy of the grain processing industry is to increase the output of high-yield products. Tables 2 - 4 present the calculations of the standard cost estimate of wheat, barley and oat flour on existing and proposed technologies and the calculation of the economic effect of the introduction of new technology.

Table 2. The calculation of the standard cost estimate for wheat flour and the efficiency of its production

Calculation section	Existing technology			Proposed technology		
	Value		Cost structure, %	Value		Cost structure, %
	total, thousand rub	per 1 ton, rub		total, thousand rub	per 1 ton, rub	
Material costs – total including:	45556.1	12063.4	83.8	48983.6	13104.2	81.3
-raw and materials	39898.4	10565.2	73.4	40439.9	10818.6	67.1
-heat energy and electricity	5657.7	1498.2	10.4	8495.7	2272.8	14.1
-water supply for technological needs	0	0.0	0.0	48.03	12.8	0.1
Return waste	8021.0	2124.0	14.7	537.0	143.7	0.9
Amortization	2241.6	593.6	4.1	3867.02	1034.5	6.4
The payroll with deductions on social needs	5850.0	1549.1	10.,8	5850.0	1565.0	9.7
Commercial and other expenses	695.5	184.2	1.3	996.1	266.5	1.7
Total cost of product	62364.1	16514.2	100.0	60233.7	16113.9	100.0
Cost of 1 ton of flour, rub		18371.0			16203.0	
Commodity products, thousand rub		67502.0			74223.0	
Profit, thousand rub		5137.8			13989.3	
Profitability, %		8.2			23.2	
Net profit, thousand rub		3085.7			8393.6	

Table 3. The calculation of the standard cost estimate for barley flour and the efficiency of its production.

Calculation section	Existing technology			Proposed technology		
	Value		Cost structure, %	Value		Cost structure, %
	total	per 1 ton, rub		total	per 1 ton, rub	
Material costs – total including:	37880488	10389.9	66.5	41481660	11498.7	77.7
-raw and materials	32222775	8838.1	56.5	32937924	9130.4	61.7
-heat energy and electricity	5657713	1551.8	10.0	8495703	2355.0	15.9
-water supply for technological needs	0	0.0		48033	13.3	0.1
Return waste	10362000	2842.1	18.2	1151000	319.1	2.2
Amortization	2241571	614.8	3.9	3867021	1071.9	7.2
The payroll with deductions on social needs	5850000	1604.5	10.2	5850000	1621.,6	11.0
Commercial and other expenses	695469	190.8	1.2	996090	276.1	1.9
Total cost of product	57029528	15642.1	100.0	53345771	14787.5	100.0
Cost of 1 ton of flour, rub		17882.3			14945.2	
Commodity products, thousand rub		67775.4			77983.8	

Calculation section	Existing technology			Proposed technology		
	Value		Cost structure, %	Value		Cost structure, %
	total	per 1 ton, rub		total	per 1 ton, rub	
Profit, thousand rub		10745.8			25338.3	
Profitability, %		18.8			48.1	
Net profit, thousand rub		6447.5			15202.9	

Table 4. The calculation of the standard cost estimate for oat flour and the efficiency of its production.

Calculation section	Existing technology			Proposed technology		
	Value		Cost structure, %	Value		Cost structure, %
	total	per 1 ton, rub		total	per 1 ton, rub	
Material costs – total including:	30204588	8310.7	59,5	33822694	9405.6	73.6
-raw and materials	24546875	6754.0	48,3	25414894	7067.5	55.3
-heat energy and electricity	5657713	1556.7	11,1	8355800	2323.6	18.2
-water supply for technological needs	0	0.0	0,0	52000	14.5	0.1
Return waste	11782000	3241.8	23,2	1420000	394.9	3.1
Amortization	2241571	616.8	4,4	3867021	1075.4	8.4
The payroll with deductions on social needs	5850000	1609.6	11,5	5850000	1626.8	12.7
Commercial and other expenses	695469	191.4	1,4	996090	277.0	2.2
Total cost of product	50773628	13970.3	100,0	45955805	12779.7	100.0
Cost of 1 ton of flour, rub		15875.6			12894.0	
Commodity products, thousand rub		65818.4			80532.0	
Profit, thousand rub		15044.7			34576.2	
Profitability, %		29.6			75.2	
Net profit, thousand rub		9026.8			20745.7	

In the structure of the production cost by the new technology, there is an increase in material costs and amortization deduction in connection with the acquisition and introduction of new equipment for the extrusion processing of grain, as well as the cost of electricity and water supply. At the same time, there is a significant reduction in the share of return waste used in feed production, which contributes to an increase in the output of finished products per unit of raw materials [7, 8].

The calculation of the standard cost estimate showed that there is a decrease in the cost of 1 ton of flour for all types due to an increase in its output, the volume of commodity products in the processing of wheat will increase by 10.0 %, barley – by 14.8 %, oat – by 22.3 %, which was the main reason for increasing the production profitability of new high-yield types of flour: wheat to 23.2 %, barley – to 48.1 %, oat – to 75.2 %. These calculations show the effectiveness of the proposed technology of grain processing of the main cereal crops.

4. Conclusion

As a result of the research it was found that the proposed technology of obtaining flour from the grain of the main cereal crops by extrusion allows to reduce the cost of production, to fully use the production capacity, to expand the range of products manufactured by flour plants, to reduce technological losses in the production of finished products, increases the output of finished products. This generally determines the economic feasibility of the using new technology in production.

The high economic effect in the production of new flour types according to the developed technologies is due to the low cost of raw materials in barley and oat, as well as the reduction of

technological waste in crops. With the introduction of new technologies for the flour production from extruded grains of the main cereal crops, the net profit of the flour plant will increase by wheat – by 5.3; barley – by 8.7; oat – by 11.7 million rubles.

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