Study of quality indicators of mixed fodder when using byproducts of the fat-and-oil industry

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Abstract. At the same time, rapeseed meal has an increased nutritional value and is almost completely devoid of the shortcomings that are characteristic of rapeseed cake. However, a small amount of fat limits their use in feed for valuable fish breeds. During the manufacture of fat-and-oil products, fat waste and other products that have a certain feed value are formed. In particular, we are talking about fat processing - soapstock. The feed value of this product has been confirmed by numerous studies and large-scale feeding experiments conducted by the parent institutes of the Ministry of Agriculture and specialized organizations. The article presents studies of the possibility of introducing rapeseed meal enriched with soapstocks into feed for valuable breeds of fish, and also presents the dynamics of quality indicators of the starting production feed for sturgeon fish during storage in warehouse conditions. During the production of mixed fodder, the preparation and supply to the experimental department of the studied products were carried out through the line of cakes. Grinding of granules was carried out on a crusher with a sieve with holes with a diameter of 6 millimeters, a sheet thickness of 4 millimeters. The shredded meal was sent to the silage of the raw material warehouse and then to the naddozer bunker. The supply of loose enriched meal to the production building was similar. Analysis of the data obtained indicates that the introduction of rapeseed meal enriched with soapstock lipids into the feed does not change the quality and does not reduce its shelf life.

1 Introduction

In modern conditions of growth of the Russian economy and the choice of a rational path for its economic development, the problem of providing enterprises with material resources is of particular relevance [19]. Generalization of the experience of creating recycling and low-waste processes in various industries using natural ecological systems as a standard allowed us to propose an ecological-like model of structural and functional relationships of technological processes of fat-and-oil production (Fig. 1) [20]. Thus, there is an acute shortage of feed components with not only protein balance but also the necessary energy potential. The use of waste oil and fat can reduce this deficit. In addition to common types of waste (waste cake, schrota, phosphate concentrates), the industry has another equally valuable secondary raw material. However, despite sufficient quantities and balanced biochemical composition, some wastes are not used as feed. First of all, this refers to fat processing waste (coapstock, deodorization shoulder straps, and other). At the same time, the basis of the system of centralized processing of fat and oil raw materials is waste-free technology, its essence is the maximum use of all valuable components of the raw material. According to the assigned task one of the directions of work to attract material resources is the effective use of by-products, which will additionally obtain a new finished product with lower production costs and a sufficiently high quality [2, 3, 4, 6, 8, 17].

To increase the energy level of feed, feed fat is used, the need for which the meat and dairy industry is able to satisfy only by about 30-35 %. At the same time, the fat-and-oil industry with alkaline refining of vegetable oils as a by-product receives a fatty product - soapstock. Soapstocks contain at least 20 % fat, glycerides, salts of fatty acids, phosphatides, choline, tocopherols, carotenoids, mineral salts [9, 13, 18]. One kilogram of soapstock contains 8500-8700 kcal of metabolic energy, which is equivalent in energy to 3.4 kilograms of concentrated feed. Soapstock fats contribute to the absorption and deposition of fat-soluble vitamins, participate in water metabolism (when 100 grams of fat are broken down in the body of animals, 107 grams of water are formed), increase the efficiency of nitrogen use, for example, for the synthesis of bacterial protein in the rumen. The introduction of soapstock into animal diets is standardized by the amount of fat in it [14, 15]. Zootechnical studies have established the possibility of using meals in feeding animals and poultry [16].

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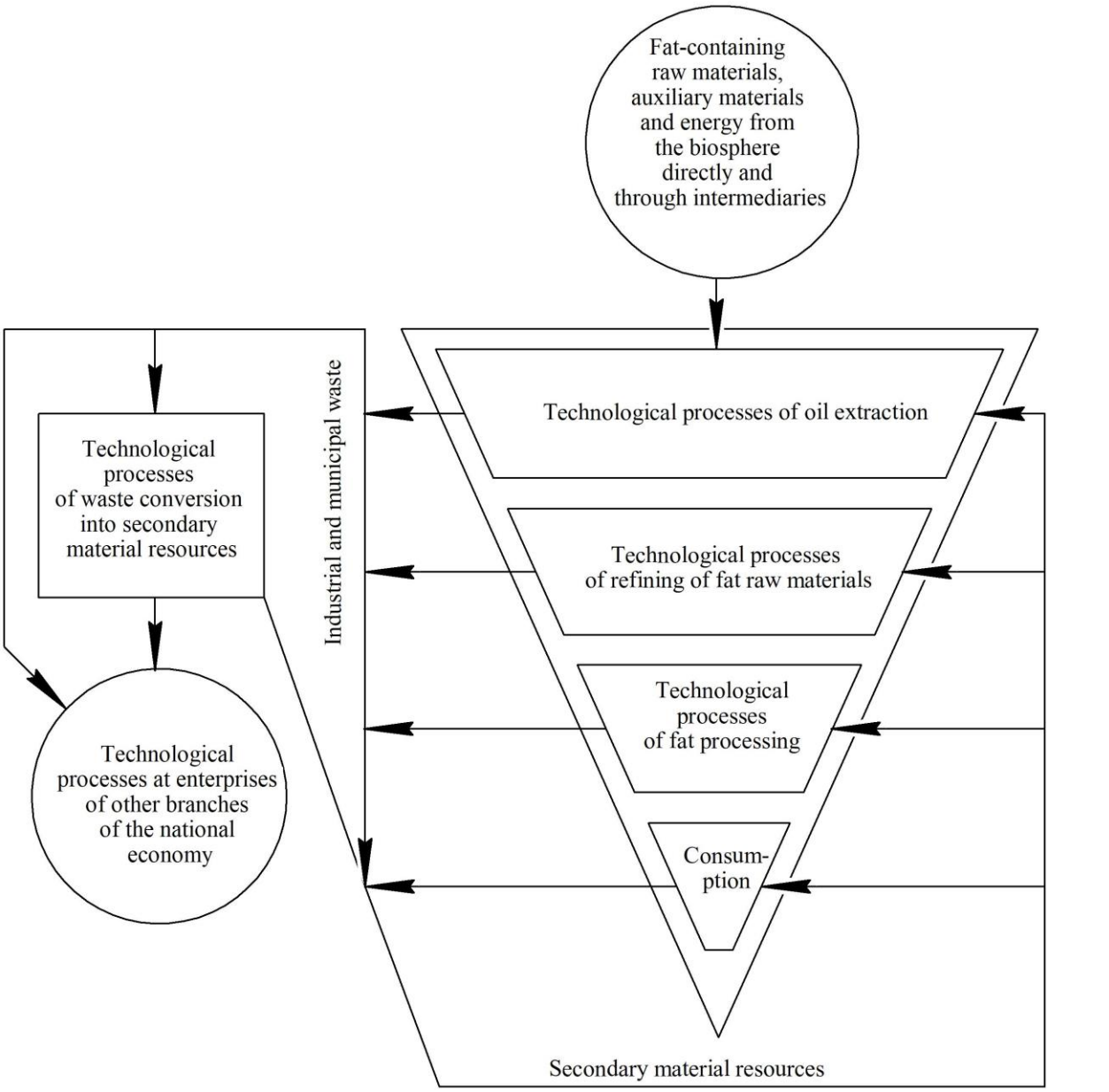

Fig. 1. Model of structural and functional relationships of the recycling technological processes of fat

Soapstocks have an unstable chemical composition, which depends on the quality of the oil and the method of its neutralization, on the number of components that form it, the heterogeneity of their properties and interactions. The consistency of soapstock at a temperature of 20 °C is from liquid to paste-like, depending on the content of the constituent substances. The total fat and moisture content of different batches varies widely, and there are differences in the ratio of neutral fat to fatty acids (Table 1).

Table 1. Chemical composition of various batches of soapstoc,%.

Lot number	Raw fat content	Including		Moisture and volatile substances content
		Fatty acids	Neutral fat	
1	61.63	33.52	29.21	34.40
2	6.20	6.20	-	92.15
3	8.16	5.97	3.24	90.28
4	39.76	23.18	17.72	52.41
5	41.59	22.22	20.26	54.32
6	51.44	34.58	17.92	44.32
7	59.52	48.64	11.81	35.97
8	31.46	19.86	11.82	66.58

The content of other nutrients in the soapstock is small. For example, in the analyzed batches, the amount of crude protein fluctuated between 0.5 - 0.75 %, calcium - 0.2 - 0.4 %, phosphorus 0.04 - 0.06 %.

The most rational way to use soapstock is to introduce it into the meal at the enterprises of the oil-and-fat industry and use this meal in the production of mixed fodder [1, 5, 7, 10-12].

The purpose of our research is the scientific substantiation and confirmation of the feasibility of introducing in the feed for valuable fish breeds rapeseed

schrot enriched with coapstock, on the basis of the obtained quality indicators of experimental batches of schrot and unlicensed product, as well as studying the dynamics of changes in the indicators of feed during storage.

2 Research methods

Subjects of research - rapeseed schrot, coapstock, starting production feed for sturgeon fish. The Center for Collective Use "Control and Management of Energy Efficient Projects" of VSUIT evaluated the quality of experimental batches of loose and granular meal, as well as unenriched product shown.

To assess the chemical composition of fatty acids used Gaschromatographic "Chromos GH-1000" in accordance with GOST ISO /TS 17764-2-2015. To assess the physical and mechanical properties the following indicators were determined: humidity and granulometric composition of mixtures determined by State Standard 13496.3-92 (ISO 6496-83), volume mass and angle of natural slope - by State Standard 28254, granulometric composition of particles - by State Standard 13496.8. They also studied the qualitative characteristics of shroth and feed and determined by standard methods: raw protein content was determined in accordance with State Standard of Russia 51417-99 (ISO 5983-97) by Kjeldal method; raw fat - State Standard 13496.15-97; raw fiber by Ganneberg-Stoman - State Standard 13496-96.91; State Standard 13496.18-85; Peroxide number determination method (hydroperoxides and peroxides) - State Standard of Russia 53024-2008; Phosphorus determination method - State Standard 26657-97; Calcium determination method - State Standard 26570 - 95. Processing and recording of the results were carried out in accordance with State Standard 26670-85 and deviation of calculated and experimental data did not exceed an absolute value of 10 %.

3 Results and analysis

The production of experimental batches of enriched meal was carried out on the experimental line of JSC "Research and Production Center " RRI of feed industry" in Voronezh (Fig. 2).

The experimental line provides for the production of enriched meal in loose and granular form. The technological process includes the following operations: heating the soapstock, supplying the heated soapstock to the auger with a pump, mixing the soapstock with the meal in the auger, heat treatment of the mixture in the brazier, which ensures heating of the product and a more even distribution of the co-starter in it. After the brazier, the enriched product is sent either for release in loose form, or for granulation. When leaving the brazier, the meal has a temperature of 60 - 70 °C. In the process of granulation, additional processing of the meal with steam occurs, as a result of which its temperature rises to 80 °C. Granules are fed by noria into a container for release.

The quality of pilot batches of rapeseed meal is given in Table 2.

Table 2. Quality of experimental batches of rapeseed meal.

Indicators	Unenriched loose meal	Enriched meal	
		Loose	Granular
Crude protein, %	33.21	32.82	34.12
Crude fat, %	1.87	4.9	4.7
Raw fiber, %	11.7	10.5	11.2
Calcium, %	2.4	2.4	2.4
Phosphorus, %	1.8	1.9	1.9
Acid number of fat, milligram of KOH	12.9	27.2	20.7
Angle of natural slope, degrees	31	32	32.5
Volumetric mass, kilogram/metre^3	437	430	531.4
Average particle size, millimeter	1.85	1.85	Ø of the granules is 10

The data presented in Table 2 characterize enriched meal as a product with satisfactory technological properties. However, the negative property of granular meal is the increased strength of the granules (crumbling 0.5 %, passage through sieves with holes Ø 2 millimeters 0.1 %). Therefore, the performance of the crusher when grinding them is lower than when grinding other granular components.

The safety of enriched rapeseed meal was studied in the conditions of the floor-type warehouse of JSC "Research and Production Center "RRI of Feed Industry" (Table 3).

Table 3. Changes in the quality of rapeseed meal enriched with coapstock when stored in warehouse conditions.

Indicators	Shelf life, number of months	Unenriched meal	Enriched meal	
			Loose	Granular
Moisture, %	0	9.17	10.83	10.11
	3	9.62	9.97	10.31
	6	11.55	12.24	11.15
Raw fat content, %	0	1.87	3.37	2.92
	3	1.20	3.56	4.28
	6	1.15	5.25	4.89
Acid number, milligram of KOH	0	12.89	27.22	20.74
	3	16.20	35.24	32.50
	6	30.02	43.52	41.23
Peroxide number, % J_2	0	0.33	0.11	0.20
	3	0.64	0.16	0.22
	6	0.96	0.23	0.29

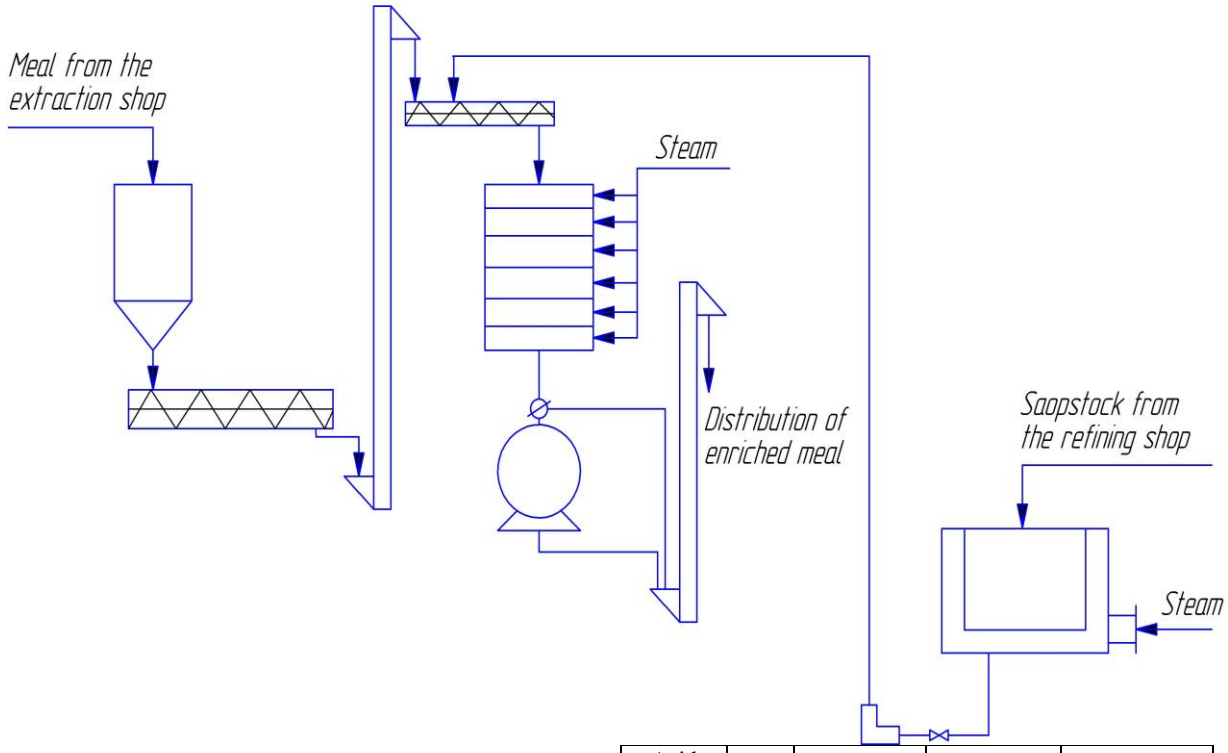

Fig. 2. Experimental line for meal enrichment

The study of the effect of meal enriched with soapstock on the quality of the start-up production feed for sturgeon fish during storage was carried out in the spring-summer period. To balance energy nutrition, 1 % of feed fat was introduced into the control batch.

The data given in Table 4 indicate that the fat content of the feed at the beginning of the experiment in all batches was at the same level and did not change during the entire storage period, the existing fluctuations fit into the error of the method.

The accumulation of fatty acids during storage leads to an increase in the acid number of fat. However there was no variation in this indicator during the retention period.

Table 4. Dynamics of quality indicators of the start-up production feed for sturgeon fish during storage in warehouse conditions.

Indicators	**Shelf life, number of mont**	**Mixed fodder with unenriched meal**	**Mixed fodder with loose enriched meal**	**Mixed fodder with granulated meal**
Moisture, %	0	11.10	11.24	11.44
	1	11.05	11.38	11.64
	2	10.06	10.21	10.26
Raw fat, %	0	14.85 ±0.03	15.36±0.10	14.97 + 0.06
	1	14.90 ±0.01	15.46±0.07	14.86 + 0.03
	2	15.20 ±0.04	15.78+0.05	15.31± 0.01
Peroxide number of fat, % J_2	0	0.09 + 0.00	0.16+0.00	0.17+0.00
	1	0.11±0.003	0.11± 0.002	0.07±0.001
	2	0.12 + 0.001	0.11+0.002	0.11+0.002
Acid number of fat, milligram of KOH	0	43.024-0.07	45.91 + 0.49	39.93 ±0,09
	1	56.52+0.21	-	-
	2	54.37±0.17	54.91 ±0.30	51.91±0.15

4 Conclusions and recommendations

Analysis of the data indicates that the intensity of hydrolytic processes occurring in the fat fraction of the feed with soapstock and feed fat is the same. The introduction of meal enriched with lipids of soapstock into the feed does not change the quality of the latter and does not reduce its shelf life. Thus, enriched meal can be used in the production of mixed fodder, due to the increased strength of granular meal at this stage, preference is given to enriched meal in loose form, enriched meal can be used in the production of mixed fodder.

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