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Innovative technology for production and use of feed additives of fish and animal origin

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The purpose. To develop small-sized device (of rotary type) for manufacture of combined energy-protein fodder additives from non-food waste got in processing fish and bird, to mount a technological line from these devices, to study zoochemical structure, nutritiousness and quality indicators of fodder additives, as well as efficiency of their use in feeding pigs. **Methods.** Zootechnical, calculation-statistical, analytical. **Results.** Ecological technology for production of combined energy-protein feed additives of fish and animal origin is developed in SPE «Biokor-Agro» (v. Hryhorivka, Obukhiv region, Kyiv oblast). Annual manufacture of fodder additives in SPE «Biokor-Agro» makes up to 2 thousand tons. In scientifically-economic experiments it is established that use of fodder additives produced in SPE «Biokor-Agro» increases daily average buildup at cultivation of repair young pigs on 21,1 – 25,5 %. **Conclusions.** Small-sized device (of rotary type) is developed in SPE «Biokor-Agro» for manufacture of combined energy-protein fodder additives from non-food waste got in processing fish and bird. Two technological lines consisting of 6 and 3 devices are mounted and work permanently. It is established that at feeding young pigs with fish fodder additive daily average buildup of alive weight have increased from 502 g in control group up to 608 g the test one, that is on 106 g, or 21,1% (P<0,001). At feeding young pigs with high-protein fish additive the daily average buildup of alive weight increased from 517 g in control group up to 649 g in test one, that is on 132 g, or 25,5% (P<0,001).

Key words: *technology, technological line, non-food waste, fodder additives.*

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We will recycle wastes in revenues
and improve the ecology of environment

The production of feeds of fish and animal origin in our country in recent years sharply has dropped, and the cost of imported is very high. At the same time for the production of feed additives for today in world practice are widely used wastes from processing of fish [1 – 5]. In our country a significant amount of inedible wastes during the processing of fish in many fish processing enterprises is not used for feed purposes. In recent years in Ukraine has been intensively developed the farming of poultry, in particular, the growing of meat of broiler chicken in poultry farms of industrial type, a large number of inedible wastes processing production from poultry is not fully used for the production of high-protein feed additives.

All this is causes not only substantial losses of valuable raw materials for the production feeds of animal origin, but also pollution of the environmental. In connection with this the problem of utilization of wastes from fish and poultry processing enterprises is very actual, and the development of effective methods for their use for the production of feed additives for animals requires urgent decision [6].

For today in Ukraine a set of machines and a set of equipment for the processing of waste fish, meat and poultry processing enterprises for feed purposes, for example, boilers of Lapsa in various modifications, are characterized in most cases by large-sized, expensive, low productivity, large losses of nutritive substances

during process of processing, the unsatisfactory environmental conditions of production [7]. At the same time in the conditions of small-product market production there is a great need for small-sized technology for the production of feeds and feed additives in small private and farm enterprises [8].

The purpose of the research is the development of a small-sized device (rotary apparatus) for the production of combined energy-protein feed additives from inedible wastes processing of fish and slaughter of poultry, mounted of a technological line from these devices, studying of zoichitic composition, nutritional value and quality indexes of feed additives and efficiency of their use in feeding pigs.

Materials and methods of the research. Small-sized device for the production of dry combined energy-protein feed additives from inedible wastes processing of fish and animal raw materials was developed on the basis of agglomerator used in the plastic industry [9]. The design of a small-sized device, its test for the production of dry combined feed additives from inedible wastes processing of fish and animal raw materials was carried out at SPE “Biokor-Agro” (v. Grigorivka, Obukhiv district, Kyiv region). During the carried out of scientific and economic experiments used zootechnical, calculative and statistical, analytical methods of research.

Results of the research. Small-sized device (rotary apparatus) of our design consists of a rotor, a frame, a grinding chamber, a mechanism of grinding and agglomeration with an electric drive. Rotor (lat. – rotare – twist) – moving part of the setting inside the still – stator (lat. – stator – stationary). The grinding chamber is a cylindrical, thermally insulated housing (thermos) with an located inside mechanism of grinding. The mechanism of grinding (rotor) is a shaft with fixed on it guiding knives. The shaft is mounted using a bearing knot located below the grinding chamber. The grinding of raw material was carried out by knives of rotor. The heating and drying of raw material was carried out due to the mechanical energy of friction which is due to created the interaction particles of the raw material with the surface of the rotating knives and the inner surface of the chamber. The special location of knives and the original design of the inner surface of the grinding chamber provides during the working cycle of the dust-air mixture with particles of raw material a complex rotational-circular movement, during which is carried out the heating of the raw material to a temperature of 105 – 135 ° C. At the same time was carried out intense evaporation of moisture with simultaneous grinding of raw materials to the sizes 0,1 – 1,0 mm. With a volume of a grinding chamber 0,18 m^3 and 12 – 14 kg loadable of raw material with a humidity of 60 – 70 % for 5 – 7 minutes the technological cycle is formed meal-like fodder product with a humidity of 8 – 10 % [10].

The productivity of a small-sized device in the production of a feed additive in this way – up to 0,4 tons per shift. Small-sized device for the production of dry combined energy-protein feed additives is presented in the figure 1.

Figure 1. Small-sized device for the production of dry combined energy-protein feed additives from inedible wastes processing of fish and animal raw materials

We have also developed a technological line for the production of feed additives from inedible wastes of fish, meat and poultry processing enterprises, which is a set of equipment from several small-sized devices, which are concatenating together into a single technological process with common energy-technical provision: electricity, sewerage, ventilation, raw materials, work force. Small-sized devices have periodic type of action, consisting of working cycles duration of 8 – 12 minutes and periods for their loading of raw materials and unloading of the finished product for a duration of 4 – 6 minutes. At the same time the duration of the working cycles of small-sized devices depends on content of the moisture in the raw materials and with the increase content of moisture in the raw material the duration of the working cycles increases from 8 to 12 minutes. In connection with this small-sized devices are secured with autonomous blocks control, thanks to this periodicity of their work does not depend one from the other [11].

The image of the technological line of 6 small devices is shown in figure 2.

Figure 2. Technological line for the production of dry combined energy-protein feed additives from inedible wastes processing of fish and animal raw materials

SPE “Biokor-Agro” has developed recipes for various feed additives from inedible wastes processing of fish and slaughter of poultry and methods of their production, on which received several patents for inventions. In the composition of the fish feed additive are introduced 66,7 % of fish raw materials and 33,3 % of wheat brans in quality filler and fat absorber. Fish additive high-protein has the following composition, in % by weight on dry matter: fish wastes – 38 %; hydrolysed feather raw materials – 28 %; soybean meals – 25 %; wheat brans – 9 % [12]. Content of the moisture in feed additives should not exceed 10 % (table 1).

Composition of feed additives of fish origin produced by SPE "Biokor-Agro"

Composition, %	Feed additives	
	Fish feed additive	Fish additive high-protein
Fish raw materials	66,7	38,0
Hydrolyzed feathers	–	28,0
Brans	33,3	9,0
Sunflower or soybean meal	–	25,0
Total, %	100,0	100,0

In the table 2 shows the zoochemical composition and nutrition of feed additives produced by SPE “Biokor-Agro” by analyzes of the Kyiv regional state laboratory veterinary medicine and the Testing center of the central state laboratory veterinary medicine [13].

2. Zoochemical composition and nutrition of feed additives produced by SPE "Biokor-Agro"

Index	Fish feed additive	Fish additive high-protein
Mass fraction of moisture, %	12,2	9,6
Mass fraction of crude protein, %	31,4	50,4 – 51,2
Mass fraction of crude fat, %	13,0 – 15,0	12,0 –28,5
Mass fraction of crude fiber, %	2,0 – 4,0	1,1 – 3,7
Mass fraction of calcium, %	1,3	2,9 – 4,5
Mass fraction of phosphorus, %	1,5	1,5 – 2,5

It is established that according to the analysis the content of crude protein in the fish additive high-protein is not less 50,0 %. A characteristic feature of the production of a fish additive high-protein for this technology is high content in it of fish and animal fat – 12,0 – 28,5 %, which in other technologies in most cases is lost.

Feed additives from non-food wastes of fish and poultry processing enterprises produced by developed small-sized technology, are secure for use in feeding different agricultural animals and poultry, and the content in them of toxic metals, pesticides, acid and peroxide numbers, nitrates and nitrites and the specific activity of radionuclides are not exceeds the acceptable levels (table 3).

The scientific and economic experiment by study of the efficiency of feeding fish feed additive was conducted in the PE "Druzhba" of the Obukhiv district of the Kyiv region, and fish additive high-protein in the AU "Rokitne" of the ALLC “Avangard” of Novoselytsky district of the Chernivtsi region. In the main period of the experiment animals of experimental groups in addition to the basic ration received respectively accordingly on 0,18 kg of fish feed additive and 0,15 kg of fish additive high-protein on the head per day.

3. Indexes of security of feed additives

Index	Fish feed additive	Fish additive high-protein
Content of toxic elements, mg/kg:		
Lead	< 0,001	1,92
Cadmium	0,02	0,043
Arsen	–	0,14
Mercury	< 0,001	< 0,001
Zinc	6,0	25,04
Copper	0,26	9,35
Content of pesticide, mg/kg:		
HCCH gamma isomer	< 0,001	< 0,05

DDT and its metabolites	< 0,001	< 0,05
Toxicity	not selected	not selected
Acid number, mg KOH	-	14
Peroxide number (iodine), %	-	0,09
Nitrates, mg/kg	-	< 0,5
Nitrites, mg/kg	-	< 0,05
Specific activity of radionuclides:		
Cs-137; Cs-134, bk/kg	< 7,7	2,41
Sr-90, bk/kg	< 25,9	0,0

Productivity of young pigs in the main period of the experiment is shows in table 4.

4. Productivity of young pigs in the main period of the experiment when feeding feed additives of fish origin

Studied additives / Groups of animals	Fish feed additive		Fish additive highly protein	
	control	experimental	control	experimental
Number of animals in groups, heads	10	10	11	11
Duration of the main period, days	90	90	123	123
Basic ration (BR)	BR	BR	BR	BR
Feed additive, g	–	180	–	150
Average live weight of 1 head:				
at the beginning of the experiment, kg	62,5 ± 0,3	63,2 ± 0,4	26,2	26,0
at the end of the experiment, kg	107,7 ± 0,6	117,9 ± 0,7	89,9	105,8
Growth of live weight on 1 head, kg	45,2	54,7	63,7	79,8
Average daily gain, g (M ± m)	502 ± 9	608 ± 10	517 ± 22	649 ± 8
± g to control	–	+ 106	–	+ 132
±% to control	–	+ 21,1	–	+ 25,5
Probability of difference, p	–	< 0,001	–	< 0,001
Expenses of feeds per 1 kg of growth:				
feed units	–	–	5,6	4,7
±% to control	–	–	–	– 16,1

As a result of the research, it was established that the average daily gains of young pigs, who were fed the fish feed additive increased from 502 g in the control group to 608 g in the experimental group, that is on 106 g (+ 21,1 %), and in the young pigs, who were fed the fish additive high-protein, average daily gains increased from 517 g in the control group to 649 g in the experimental group, that is on 132 g (+ 25,5 %) at high probability ($p < 0,001$).

For the production of high-protein feed additives in the SPE “Biokor-Agro” for 2010 – 2017 years was used 16695 tons of fish wastes in raw form, and on average in the 1 year – 2087 tons, which significantly improves the ecology of the environment (table 5).

5. Total volume of production of feed additives and financial activity of SPE “Biokor-Agro” from 2010 to 2017 year

Year	Produced feed additives, t	Gross income, UAH	Taxes to the state, UAH	Profit, UAH	Use of fish wastes, t
Together for 2010 – 2017	11135	67373300	15340600	7685040	16695
An average of one year	1392	8421662	1917580	960630	2087

In recent years the annual production of feed additives high-protein at the enterprise is makes up about 1,5 thousand tons of realizable value of about 10 million UAH per year. The average monthly salary of 1 worker at the SPE "Biokor-Agro" for 2017 year is 6020 UAH.

The profitability of production of feed additives at the enterprise makes up 25 – 35 %. At present the enterprise is successfully developing and expanding. If in 2001 year at the enterprise was only 5 work places, then in 2018 year – 40, created thanks to the introduction of innovative technology. The enterprise timely pays taxes to the state, on the average for 2010 – 2017 years about 1,9 million UAH annually. The annual profit of an enterprise on average for 2010 – 2017 years makes up is 960 thousand UAH.

Conclusions

1. In SPE "Biokor-Agro" was developed a small-sized device (rotary apparatus) for the production of combined energy-protein feed additives from inedible wastes processing of fish and slaughter of poultry and were mounted constantly working 2 technological lines of 6 and 3 such devices.

2. It was established that when feeding of young pigs of fish feed additive, the average daily gains of live weight increased from 502 g in the control group to 608 g in the experimental group, that is, on 106 g, or 21,1 %, $p < 0,001$), and when feeding of young pigs of fish additive high-protein the average daily gains of live weight increased from 517 g in the control group to 649g in the experimental group, that is, on 132 g, or 25,5 %, $p < 0,001$).

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