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Research Article

Improving the Protein Nutritional Value of the Diets for Farm Animals and Poultry by Introducing Oil Industry Waste

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Abstract | Today, one of the most urgent problems is finding new alternative sources of protein, deficiency of which affects the productivity of agricultural animals and poultry. On this basis, comprehensive studies on the efficiency of using the products of processing mustard seeds the Sarepta feed concentrate obtained from vegetable raw materials– were made. Before the scientific-economic experiments, the chemical composition of the studied feed concentrate and the sunflower cake traditionally used in the diets for cattle and poultry were comparatively assessed in the conditions of the Volgograd region. Superiority of the Sarepta concentrate over sunflower cake has been proven: by the content of crude protein by 5.7 %, calcium by 0.31 %, phosphorus by 0.25 %, lysine by 2.53 %, methionine by 0.39 %, threonine 0.69 %, and metabolizable energy by 0.35 MJ/100 g. The results of the research have shown that using the Sarepta feed concentrate obtained from vegetable raw materials in the diets of young cattle and poultry contributed to improving their productive qualities. For instance, the introduction of 5 % and 10 % of concentrate into the feed for broiler chickens resulted in increasing their live weight by the end of the experiment by 3.6 % and 5.5 %, respectively; introduction of 7 % and 10 % of concentrate into the diet of laying hens increased egg production during the period of experiment by 20.6 % and 12.8 %, respectively; replacement of sunflower cake with the target concentrate for feeding unweaned calves increased their live weight over six months by 2.2 %, and for fattening bull calves – by 4.4 %. Based on the results of the research, it is possible to recommend introducing the Sarepta feed concentrate obtained from vegetable raw materials into the diets of cattle and poultry with the aim of improving their productive qualities.

Keywords | Sarepta feed concentrate obtained from vegetable raw materials, Productivity, Live weight, Meat, Egg, Growth

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INTRODUCTION

Achievement of sustainable growth in livestock production, ensuring the population's need in food products are the main aims of animal breeding. One of the main factors of increasing the scale of livestock, improving the productivity of animals and poultry is the production of complete feeds (Nikolaev et al., 2018). At present, the low efficiency of agricultural animals and poultry is due to insufficient fodder base and unbalanced diets in terms of the main nutrients (Tahir and Pesti, 2011; Sankina et al., 2017).

The main sources of concentrated feeds in the diets are cereals. Significant potential for saving grain may be related to maximizing the content of byproducts of the processing industry in combined feed (Dyuzheva et al., 2018; Nikolaev et al., 2018; Fleming et al., 2018).

One of the ways of increasing the share of the feeds of plant origin, which are rich in energy and protein, is the use of cake, which is a byproduct from processing cruciferous oilseed crops: Camelina Sativa, rapeseed, and brown mustard (Zoteev et al., 2016, Nikolaev et al., 2018; Tan et al., 2017).

The cakes obtained after processing these crops are almost not used for producing fodder and combined feed. At the same time, these products are good sources of energy, they have a balanced amino acid composition in terms of proteins, and their fatty-acid composition contains significant amounts of linoleic acid (Domoroschenkova, 2012; Penkova and Mishina, 2012).

Currently, however, the shortage of available feed resources and their increasing costs due to economic reforms in the agricultural sector are the main obstacles for increasing the amount of product of livestock and cattle breeding. In this regard, more available and cheap feed resources are commonly used (Poverinova, 2013).

In the area of the Lower Volga region, a valuable essential-oil-bearing plant called brown mustard grows, which is used for making edible vegetable oil, essential mustard oil, fodder mustard oil cake, and the Sarepta fodder concentrate.

Studying the composition and properties of the protein in the mustard cake has shown that protein is well balanced in terms of amino acids and contains essential amino acids (methionine, lysine, tryptophan, leucine-isoleucine). According to the data of the authors, the mustard oil cake obtained after processing mustard oilseeds contains 12–14 % of soluble sugars (Nikishenko et al., 2017; Mézes, 2018; Huang et al., 2018).

In this regard, improving the protein nutritional value of the diets using the product of processing mustard seeds, in particular, the Sarepta feed concentrate obtained from vegetable raw materials is a relevant study.

MATERIALS AND METHODS

Before starting the scientific-economic experiments, the chemical compositions of the traditionally used sunflower cake and the Sarepta feed concentrate obtained from vegetable raw materials were compared.

After that, a series of experiments was made for studying the efficiency of using the Sarepta feed concentrate obtained from vegetable raw materials in the diets of cattle and poultry. The research was performed at the enterprises of the Volgograd region.

During the scientific and economic experiments, growth and development of broiler chickens, laying hens, and the growth rate in unweaned calves and fattening bull-calves were taken into account (Figure 1).

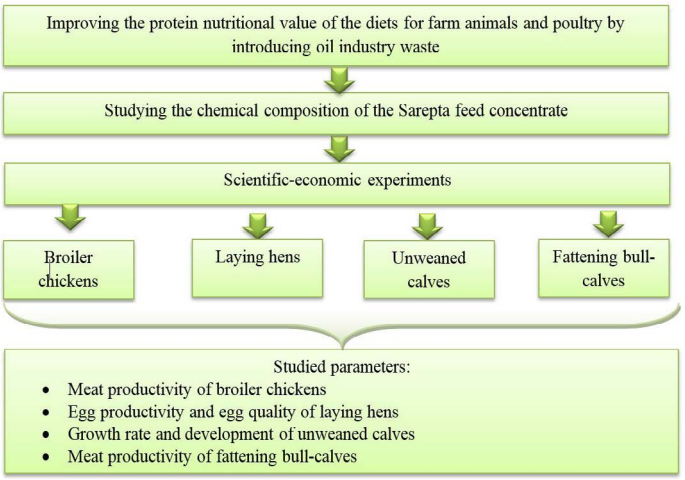

Figure 1: General scheme of the research.

For the experiment with broiler chicken, four groups of one-day-old chickens were formed (one reference and three experimental groups), 50 chickens in each. The chickens were selected by the method of analogs taking into account the cross, the age, the health status, and the live weight. The live weight of the poultry was determined by weekly individual weighing at the age of 1, 7, 14, 21, 28, 35, and 42 days. Meat productivity was determined by anatomical dissection of the carcasses, taking into account the following indicators: the live weight, the weight of an eviscerated carcass, the slaughter yield, and the ratio of edible parts of the carcass to the inedible ones.

During the studies of laying hens, four groups of 70 weeks old Hisex hens were formed with the average egg productivity of 80 %, 150 hens in each group. The duration of the experiment was 83 days. During the experiment, the number of eggs from a single laying hen, the share in egg productivity, and the amount of obtained egg mass were taken into account.

For performing the experiment on studying the effect of the Sarepta feed concentrate on the dynamics of the live weight gain of black-motley unweaned calves, two groups were formed with regard to the breed, the sex, the age, and the live weight, 15 animals in each.

With the purpose of studying the effect of the Sarepta concentrate on meat efficiency, a scientific-economic experiment was performed with black-motley fattening bulls-calves selected by the principle of analogs with regard to the age and the live weight, 10 animals in each group. During the research, the absolute and the average daily gains, as well as the results of check slaughtering were accounted for.

RESULTS AND DISCUSSION

In terms of the organoleptic indicators (color, odor), the feed concentrate from the Sarepta vegetable raw material meets the technical requirements. The product has the appearance of granules in the form of bars and scattering, its color varies between yellow and light-brown with a grayish tinge. Coarse fraction the residue on a sieve with the mesh size of 5 mm amounted to 6.9 % and required granulometric preparation before its introduction into the feed. The product size ranged from 10×15 mm to 30×40 mm. These cakes break up easily into small pieces. Consequently, this product may be easily milled for its further introduction into the feed. The chemical composition of the Sarepta feed concentrate and sunflower cake is shown in Table 1.

The obtained data show that in terms of nutrient value, the feed concentrate is superior to sunflower cake, especially in terms of the content of essential amino acids. For instance, the level of lysine in the concentrate is three times higher than in sunflower cake. The content of methionine, methionine+cystine, and threonine significantly exceeds the level of these amino acids in sunflower cake; the content of tryptophan is slightly lower. The amount of exchange energy in the concentrate is higher by 0.35 MJ/100 g than in sunflower cake. The content of allyl isothiocyanates is 0.05 %, and meets the requirements of TR 9146-045589390-05. The Sarepta feed concentrate contains 9.96 % of soluble carbohydrates, 0.96 mg/kg of carotene, vitamins A, D, E.

Poultry breeding is the source of human food products such as eggs and meat. In this regard, new ways of increasing poultry productivity are searched for (Elliot, 2008). On this basis, experiments were performed for studying the efficiency of using a high-protein additive, the Sarepta feed concentrate obtained from vegetable raw materials, in combined feeds for broiler chickens and laying hens. The chickens in the reference group received the feed with sunflower cake, those in experimental group 1 received 5 % of the Sarepta concentrate instead of sunflower oil cake, and those in experimental group 2 – 10 % of the concentrate. During the experiment, the dynamics of live weight gain by the experimental poultry were accounted for, the results are shown in Table 2.

By the results of weighing experimental broiler chickens, by the age of 42 days, the total weight gain in the reference group reached 2,330.14 g, and the average daily weight gain 55.5 g. In the experimental groups, the total weight gain reached 2,471.54–2,571.74 g, and the average daily weight gain was 58.8–61.2 g, which was higher than in the reference group by 5.9–10.2 % and 6.1–10.4 %, respectively, the difference being veracious.

The live weight gain is only an indirect indicator of meat productivity. The final assessment of the meat productivity of broiler chickens involved slaughtering and anatomic dissection of poultry carcasses.

Table 3 shows the results of anatomical dissection of the carcasses of broiler chickens.

The results of the anatomical dissection of carcasses showed that the lowest slaughter yield was in the broiler chickens in the reference group, which reached 71.32 %, in experimental group 1–71.92 %, which was higher than in the reference group by 0.8 %, in experimental group 2–72.36 %, which was higher than in the reference group by 1.6 %.

One of the important indicators that characterize meat productivity is the edible to inedible parts of the carcass ratio. This indicator was the lowest in the reference group–2.08. In experimental group 1, it was 2.26, which was higher than in the reference group by 8.7 %; in experimental group 2, it was 2.35, which was higher than in the reference group by 13.0 %.

The indicator that characterizes the productivity of laying hens is the egg-laying ability. For the experiment, groups of laying Hisex White hens in the age of 70 weeks with the average egg-laying capacity equal to 80 % were formed. The duration of the experiment was 83 days. In accordance with the task, one group of laying hens was the reference, and received mixed feed without the Sarepta feed concentrate, experimental group 1 received 7 % of the concentrate instead of sunflower cake and grain, experimental group 2 received 10 % of the concentrate instead of sunflower cake and grain, and experimental group 3 received 15 % of the concentrate instead of sunflower cake and grain.

The results of using the concentrate in the feed for laying hens are shown in Table 4.

From the data obtained it follows that despite the fact that at this age laying hens almost reach the end of their productive period, egg production was relatively high: in experimental groups 1 and 2–81.8 % and 76.5 %, which was well above the norm by 20 % and 5 %, respectively. With that, the number of the obtained egg mass was also higher in experimental groups 1 and 2 than in the reference group by 14.46 % and 11.53 %, respectively. Thus, the introduction of 7 % and 10 % of the studied concentrate into the feed of laying hens resulted in an increased egg productivity.

For analyzing the growth and development rate of bull-calves according to the methodology of the studies, check weighing was performed, the information of which is shown in Table 5. The calves in the experimental group received the Sarepta feed concentrate instead of sunflower cake.

Table 1: Comparative chemical composition of sunflower cake and the Sarepta feed concentrate.

Indicators	Units of measurement	Product	
		Sarepta feed concentrate	Sunflower cake
Mass fraction of moisture	%	6.30	8.00
Mass fraction of crude protein	%	37.70	32.00
Mass fraction of crude fat	%	18.30	18.50
Mass fraction of crude fiber	%	9.20	19.00
Mass fraction of crude ash	%	6.38	7.30
Mass fraction of calcium	%	0.64	0.33
Mass fraction of phosphorus	%	0.90	0.65
Amino acids:			
Lysine	%	3.69	1.16
Methionine	%	1.15	0.74
Methionine+cystine	%	2.01	1.32
Threonine	%	1.90	1.21
Tryptophan	%	0.38	0.48
Exchange energy	MJ/100g	1.29	0.94

Table 2: Changes in the live weight of experimental broiler chickens, g (M±m).

Group	Age, days							Total gain	Average daily gain, g	% to the reference
	One-day-old	7	14	21	28	35	42			
1	2	3	4	5	6	7	8	9	10	11
Reference	40.66±0.15	158.80 ±1.16	426.52 ±6.12	801.08 ±12.81	1,379.67 ±24.88	1,979.63 ±24.34	2,370.80 ±29.32	2,330.14	55.50	100.00
experimental 1	40.96±0.14	161.02 ±1.02	431.42 ±8.68	820.48 ±12.65	1,407.13 ±20.02	2,010.00 ±26.36	2,512.54 ±32.00**	2,471.54	58.80	106.10
experimental 2	41.02±0.15	161.73 ±0.80*	437.23 ±3.66	875.90 ±10.06***	1,466.70 ±18.60**	2,072.14 ±27.36*	2,612.76 ±28.36***	2,571.74	61.20	110.40

* P > 0.95, ** P > 0.99, *** P > 0.999

Table 3: Results of anatomic dissection of the carcasses of experimental broiler chickens (M±m).

Indicator	Group		
	Reference	Experimental 1	Experimental 2
1	2	3	4
Pre-slaughter live weight, g	2,355.87 ± 4.05	2,502.05 ± 2.25***	2,598.12 ± 3.12***
Eviscerated carcass weight, g	1,680.30 ± 1.12	1,799.52 ± 1.22***	1,880.05 ± 2.78***
Slaughter yield, %	71.32 ± 0.11	71.92 ± 0.05	72.36 ± 0.03
Total muscles weight, g	1,018.58 ± 1.06	1,092.54 ± 1.05***	1,120.04 ± 1.73***
including breast muscles, g	535.55 ± 1.44	568.31 ± 0.95***	592.26 ± 1.63***
Edible parts of the carcass, g	1,134.35 ± 1.27	1,246.73 ± 1.59***	1,318.74 ± 1.63***
Inedible parts of the carcass, g	545.95 ± 0.03	552.79 ± 0.27***	561.31 ± 0.56***
including bones	476.76 ± 0.03	531.20 ± 0.23***	562.08 ± 0.67***
% of edible parts weight to the live weight.	48.15 ± 0.06	49.83 ± 0.05***	50.76 ± 0.02***
% of inedible parts weight to the live weight	23.17 ± 0.05	22.09 ± 0.05***	21.60 ± 0.04***
The edible to inedible parts of the carcass ratio	2.08 ± 0.002	2.26 ± 0.007***	2.35 ± 0.006***

** P > 0.99, ***P > 0.999.

The calves for the experiment were selected at birth. For instance, the average weight of the calves in the reference group at birth was 33.22 kg, in the experimental group–32.99 kg. At the age of one month, there was almost no difference

Table 4: Productive characteristics of laying hens.

Indicators	Group			
	Reference	Experimental 1	Experimental 2	Experimental 3
Number of hens	150	150	150	150
Obtained eggs during the experiment, pcs	8,439	10,183	9,525	8,325
The number of feeding days	12,450	12,450	12,450	12,450
Egg-laying capacity, %	67.7	81.8	76.5	66.9
Obtained eggs per one laying hen, pcs	56.3	67.9	63.5	55.5
% to the reference	100	120.6	112.8	98.6
Obtained egg mass, kg	550.26	629.84	613.73	548.48
Per one laying hen, kg	3.67	4.43	4.09	3.65

Table 5: The dynamics of the live weight gain in the calves over the main period of the experiment.

Age in months	Reference group		Experimental group	
	Animal live weight, kg	Average daily gain, g	Animal live weight, kg	Average daily gain, g
At birth	33.22 ± 1.17		32.99 ± 1.25	
1 month	54.27 ± 2.30	701.67 ± 30.20	54.32 ± 2.70	711.00 ± 32.42
2 months	72.94 ± 3.85	622.33 ± 31.40	73.44 ± 4.05	637.33 ± 41.70
3 months	91.27 ± 4.27	611.00 ± 38.40	93.28 ± 4.48	661.33 ± 42.50
4 months	113.71 ± 6.05	748.00 ± 41.70	117.08 ± 6.75	793.33 ± 52.40
5 months	137.47 ± 8.06	792.00 ± 46.50	141.83 ± 8.15	825.00 ± 57.80
6 months	161.78 ± 9.10	810.33 ± 52.40	167.11 ± 9.12	842.67 ± 50.30
Total for the experiment		714.22 ± 37.20		745.11 ± 41.40

Table 6: Changes in the live weight and weight gain in the experimental calves over the duration of the experiment, kg.

Age of the calves, months	Live weight of one animal, kg	Absolute weight gain, kg	Average daily gain, g	Relative weight gain, %
Reference				
14	358.0 ± 8.20			
15	382.6 ± 9.72	24.6 ± 1.34	820.0 ± 8.42	6.87
16	408.4 ± 10.30	25.8 ± 2.12	860.0 ± 9.73	6.74
17	433.9 ± 11.04	25.5 ± 3.05	850.0 ± 5.91	6.24
Average for the experiment		75.9	843.3	21.2
Experimental				
14	357.8 ± 9.03			
15	382.9 ± 10.42	25.092 ± 2.10	836.4 ± 5.29	7.02
16	409.5 ± 11.02	26.574 ± 2.70	885.8 ± 9.24	6.95
17	435.8 ± 12.30*	26.265 ± 3.50	875.5 ± 6.57	6.42
Average for the experiment		78.0	866.7	21.8

in the live weight, however, a slight increase was observed in the average daily gains in the experimental group. At the age of two months, calves in the reference group had a live weight of 72.94 kg, and in the experimental group–73.44 kg, which was by 1.5 kg higher. In a period of two to three months of age, the average daily weight gain in the reference group was 611.00 g, and in experimental–661.33 g. At the age of four months, the difference in the average daily gain was 45.33 g in favor of the calves in the experimental group. The five-months-old calves weighed 137.47 kg in the reference group and 141.83 kg in the experimental group. At the end of the scientific and economic experiment, the animals in the reference group had the live weight by 3.29 % lower than the calves of the experimental group.

Feeding the Sarepta concentrate obtained from vegetable raw materials to the calves instead of sunflower cake during the scientific and economic experiment allowed obtaining

average live weight in the calves of the experimental group by 5.33 kg more than in those of the reference group.

In order to study the effects of the Sarepta concentrate on the meat productivity of fattening black-motley bull-calves, a scientific-economic experiment was made. The biological process of increasing the live weight of the animals was studied based on the age dynamics. By the live weight, which ranged in groups between 357.8 and 358.0 kg, the experimental calves differed slightly at the beginning of the experiment (Table 6).

Feeding the Sarepta feed concentrate ensured the highest live weight gain in the bull-calves. The average live weight of the calves in the reference group at the end of fattening amounted to 433.9 kg, in the experimental group – to 435.8 kg which was by 1.9 kg, or by 4.4 % higher than that in the reference group ($P < 0.01$). During the main period of the experiment, the average daily gain of bull-calves in the reference group amounted to 843.3 g, and in the experimental group, after replacing sunflower cake with the Sarepta feed concentrate – to 866.7 g, which was higher than that in the reference group by 2.78 %.

The results of check slaughtering (Table 7) showed that the highest carcass yield was in the bulls from experimental group 1, which amounted to 57.9 % vs. the reference group–56.8 %.

Table 7: The results of check slaughtering of experimental bull-calves.

Indicator	Group	
	Reference	Experimental 1
Live weight at the end of fattening, kg	433.9 ± 12.93	435.8 ± 13.80
Pre-slaughter live weight, kg	411.3 ± 11.01	414.9 ± 11.60
Hot carcass weight, kg	220.9 ± 6.6	226.5 ± 7.3
Carcass yield, %	53.7 ± 1.59	54.6 ± 2.1
Internal fat weight, kg	12.75 ± 0.65	13.9 ± 1.6
Fat yield, %	3.10 ± 0.15	3.35 ± 0.17
Slaughter weight, kg	233.7 ± 11.65	240.4 ± 12.35
Slaughter yield, %	56.8 ± 2.8	57.9 ± 3.8

A similar pattern was observed for other parameters: hot carcass weight in the experimental group was superior to the reference by 5.6 kg, or 2.5 %, fat yield – by 0.9 %, and internal fat weight by 1.15 %.

The studies have revealed the superiority of the studied Sarepta feed concentrate obtained from vegetable raw materials over sunflower cake that was traditionally used in the diets of farm animals in the conditions of the Volgograd region. On this basis, a series of studies were made aimed at studying the efficiency of using this feed additive for feeding young cattle and poultry. The introduction of the studied feed additive had a positive effect on the productivity of animals and poultry.

CONCLUSION

Thus, the results of the research have shown that using the Sarepta feed concentrate obtained from vegetable raw materials in the diets of young cattle and poultry contributed to improving their productive qualities. For instance, the introduction of 5 % and 10 % of concentrate into the feed for the broiler chickens resulted in increasing their live weight by the end of the experiment by 3.6 % and 5.5 %, respectively; the introduction of 7 % and 10 % of concentrate into the diet of the laying hens increased egg production during the period of experiment by 20.6 % and 12.8 %, respectively; and replacement of sunflower cake with the target concentrate for feeding the unweaned calves increased their live weight over six months by 2.2 %, and for fattening bull calves – by 4.4 %.

AUTHORS CONTRIBUTION

All authors contributed equally.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

Ethical Clearance

The ethical permission for the studies was obtained from the methodical Commission of the Department of Biotechnology and Veterinary Medicine of the Volgograd State Agrarian University.

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