Original Article

Effect of Phytobiotic fodder additives based on Water-Ethanol extract of Echinacea Purpurea on the qualitative characteristics of rabbit meat

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ABSTRACT

The effect of phytobiotic fodder additive based on a water-ethanol extract of Echinacea purpurea on the productivity of young rabbits, the meat qualitative characteristics were studied, and the optimal dosage of the extract in the phytobiotic fodder additive was determined. The experimental study was conducted at the animal farm of the Kemerovo State Agricultural Institute in 2018. According to the pair-analog principle, groups of young Californian rabbits, each with six animals, were formed: one reference group and five experimental groups. The animals in the experimental groups I, II, III, IV, V received orally a phytobiotic fodder additive based on a water-ethanol extract of Echinacea purpurea at the doses of 0.5, 1, 1.5, 2, and 2.5 g per animal daily in addition to the basic ration for 30 days. The best result was achieved in the experimental group II. Analysis of the slaughter qualities of the rabbits from all experimental groups indicated high meat productivity. At the same time, the obtained data revealed significant intergroup differences. For example, the slaughter yield of meat was higher by 1.2 % in the experimental group I, by 17.3 % ($P > 0.05$) in the experimental group II, by 12.4 % in experimental group III, by 14.6 % in the experimental group IV, and by 0.45 % in the experimental group V compared to the reference group. The maximum fat volume of 2.94 ± 0.80 % and 2.07 ± 0.40 % was observed in the rabbit meat in the experimental groups II and III, respectively, where the dose of purple Echinacea extract was 1.0 and 1.5 g per animal daily. The rabbit meat obtained from the experimental groups was described by both moisture-binding and moisture-retaining abilities higher than those of the reference group.

Keywords: rabbits, phytobiotic fodder additive, water-ethanol extract, Echinacea purpurea, ration, productive qualities, animal feeding, phytobiotics, meat quality characteristics.

Introduction

Provision of the population with high-quality animal and vegetable food products is one of the major social problems that the modern agribusiness faces. Due to the close relationship between nutrition and human health, consumers increasingly use food products that correspond to their preferences, such as taste, nutritional and biological value, etc. It should be noted that the poultry industry is actively developing in Russia in recent decades, as it is able to provide the population's diet with domestic poultry meat; the broiler meat consumption per capita was 33.7 kg in 2017, and its share in the total production of all kinds reached 48 % [1, 2].

However, rabbit breeding is not as developed in our country as it could be, although the nutritional properties of rabbit meat are highly valued, because it is dietary valuable. Rabbit meat contains a low amount of fat with lower content of saturated fatty acids and higher content of unsaturated fatty acids, as well

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as minimal content of cholesterol as compared to other types of meat. It should be admitted that cooking rabbit requires long processing and special skills. For this reason, new tasks may be set for the meat processing industry, aimed at processing and improving the availability of the valuable rabbit meat that would meet the consumer demands. In its turn, it will contribute to the development of new standards in order to improve the sensory characteristics and functional properties of rabbit meat [3, 4].

It is known that the increase in meat productivity, as well as the qualitative characteristics and functional technological properties of animal meat largely depend on the thoroughly designed feeding rations. It should be noted that manipulating the rabbit ration is very efficient in the production of "enriched meat"; some bioactive compounds can easily be incorporated into meat, such as omega-3 polyunsaturated fatty acids (PUFA), conjugated linoleic acid (CLA), and vitamin E [5, 6]. Moreover, the use of fodder additives can improve the quality of livestock products that are not harmful to human health is of great practical interest for both agricultural producers and their consumers. Scientists develop preparations of a new generation, phytobiotics, in the search of alternatives to traditional chemicals, including fodder antibiotics [7]. Their influence on the quality characteristics of rabbit bodies has not been sufficiently studied. Therefore, the authors carried out some studies under the agreement with the Russian Ministry of Education and Science No. 14.610.21.0016 dated October 3, 2017 "Development and implementation of a new series of highly effective phytobiotic fodder additives based on herbs for the transition to highly productive and environmentally friendly agriculture". The unique project identifier is RFMEF161017X0016.

The purpose of the study was to explore the effect of the phytobiotic fodder additive based on a water-ethanol extract of Echinacea purpurea on meat productivity, chemical composition and functional technological properties of rabbit meat. In the course of the experiment, the effect of various concentrations of the phytobiotic fodder additive based on water-ethanol extract added to the main ration and administered instead of fodder antibiotics was studied.

Materials and Methods

The experimental study was conducted at the animal farm of the Kemerovo State Agricultural Institute in 2018. As part of the study, groups of young Californian rabbits, each contained six animals, were formed, according to the pair-analog principle: one reference group and five experimental groups. At the beginning of the experiment (when rabbits were 40 days old), the conditions of housing and feeding were the same in all groups, but the oral phytobiotic fodder additive based on the Echinacea purpurea extract was administered to the animals of the experimental groups in addition to the basic ration, according to the experimental scheme presented in Table 1. Animals from the reference group received the basic ration consisting of complete fodder and hay. The meat of the rabbits that did not receive the water-ethanol extract was used as a reference sample.

Table 1. Scheme of the scientific agricultural experiment

Group	Number, animals	Administration doses of the phytobiotic fodder additive based on the water-ethanol extract
Reference	10	Basic ration (BR)
Experimental I	10	BR + phytobiotic fodder additive containing Echinacea purpurea extract at a dose of 0.5 g per animal daily
Experimental II	10	BR + phytobiotic fodder additive containing Echinacea purpurea extract at a dose of 1.0 g per animal daily
Experimental III	10	BR + phytobiotic fodder additive containing Echinacea purpurea extract at a dose of 1.5 g per animal daily
Experimental IV	10	BR + phytobiotic fodder additive containing Echinacea purpurea extract at a dose of 2.0 g per animal daily
Experimental V	10	BR + phytobiotic fodder additive containing Echinacea purpurea extract at a dose of 2.5 g per animal daily

The live weight of young animals from each group was determined using the method of individual weighing on electronic scales once a month in order to study the growth indicators, and daily average and absolute gains were calculated.

Rabbits were slaughtered at 10 weeks of age. Three rabbits were randomly selected from each group. The weight of the hot carcass, slaughter yield, chemical composition, and functional technological properties of rabbit meat were determined after the slaughter.

The internal organs of the rabbits were visually examined and weighed after the slaughter and cutting the carcasses.

Each body was placed in an individual bag and cooled with ice in a portable cooler. The temperature of the samples was maintained at 4 ± 1°C during transportation. The bodies were delivered to the Agroecology Research Laboratory at the Kemerovo State Agricultural Institute on the same day.

Chemical analysis of meat was made in accordance with the generally accepted methods: moisture determination by drying it in a drying oven at a temperature of 105 ± 2 °C, raw fat determination using a Soxhlet extraction unit, and ash determination by the gravimetric method.

The technochemical studies (determination of the moisture-binding and moisture-retaining abilities, determination of the yield of the finished product, determination of the moisture content in the product) were carried out in accordance with standard methods [8]. The experiment lasted for 30 days.

The obtained digital material was processed statistically [9] in Microsoft Excel software with the determination of the significance of the differences by the Student t-test at three levels of probability. The results are presented as M ± m,

where M is the arithmetic average, and m is the standard deviation.

Results and Discussion

Analysis of the slaughter qualities of the rabbits from all experimental groups indicated high meat productivity. At the same time, the obtained data revealed significant intergroup differences. For example, the slaughter yield of meat was higher by 1.2 % in experimental group I, by 17.3 % ($P > 0.05$) in experimental group II, by 12.4 % in experimental group III, by 14.6 % in experimental group IV, and by 0.45 % in experimental group V compared to the reference group.

No pathologies of the development of the internal organs were found following the results of the procedure for internal organs inspection and weighing. The meat productivity of rabbits is presented in Figure 1.

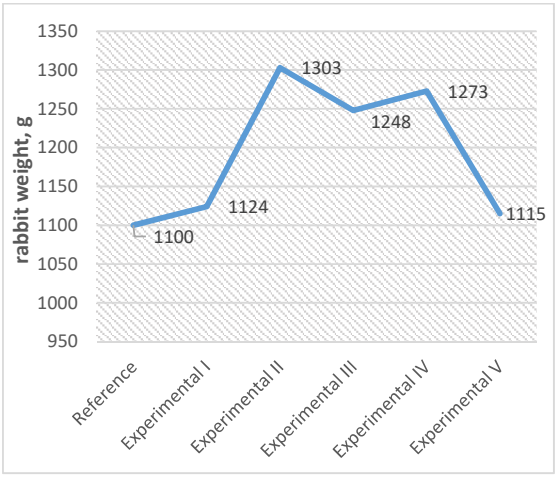

Figure 1. Study of the rabbit meat productivity, g

The results of the chemical analysis of the rabbit meat after feeding the basic ration containing the water-ethanol extract of Echinacea purpurea are presented in Table 2.

Table 2. Chemical composition of the rabbit meat after feeding phytobiotic fodder additive based on the water-ethanol extract of Echinacea purpurea

Rabbit No.	Group					
	Reference	Experimental I	Experimental II	Experimental III	Experimental IV	Experimental V
			Water, %			
1	79.04	78.00	79.40	79.00	78.04	79.00
2	79.81	78.01	77.92	78.14	78.81	78.47
3	79.11	77.98	78.00	77.14	77.89	78.64
Average value	79.32 ± 0.6	78.00 ± 0.02	78.44 ± 1.18	78.09 ± 1.32	78.25 ± 0.70	78.70 ± 0.38
			Protein, %			
1	19.94	19.20	19.34	19.00	18.94	19.20
2	19.66	19.22	19.30	19.07	19.87	19.45
3	19.60	19.00	19.99	19.88	19.77	19.11
Average value	19.73 ± 0.26	19.14 ± 0.17	19.54 ± 0.55	19.32 ± 0.69	19.53 ± 0.72	19.25 ± 0.25
			Fat, %			
1	0.98	0.88	2.58	2.80	1.60	2.70
2	0.30	0.45	3.10	2.25	0.70	0.78
3	0.77	0.67	2.14	2.17	0.99	1.04
Average value	0.68 ± 0.49	0.67 ± 0.30	2.94 ± 0.80	2.07 ± 0.40	1.10 ± 0.65	1.51 ± 1.02
			Ash, %			
1	1.12	1.17	1.19	1.17	1.09	1.07
2	1.18	1.19	1.12	1.14	1.18	1.17
3	1.16	1.15	1.20	1.19	1.15	1.18
Average value	1.15 ± 0.04	1.17 ± 0.03	1.17 ± 0.06	1.17 ± 0.04	1.14 ± 0.06	1.14 ± 0.09

The data presented in Table 2 indicate that the content of moisture, protein, and ash in the rabbit meat did not differ in all experimental groups compared to the reference group. Fat content in meat was of particular interest. The maximum contents of fat of 2.94 ± 0.80 % and 2.07 ± 0.40 % were observed in the rabbit meat from experimental groups II and III, respectively, where the contents of Echinacea purpurea in the phytobiotic fodder additive were 1.0 and 1.5 g/animal. day, respectively. Further, the increase in phytobiotic dosage to 2.0 – 2.5 g per animal decreased the mass fraction of fat in the rabbit meat on average to 1.10 ± 0.65 % and 1.51 ± 1.02 %, respectively.

The moisture and fat yield and content in the product, especially after heat treatment of the meat, are the most important technological characteristics. The moisture and fat binding and retaining abilities depend on them. Therefore, the authors were interested in the effects of phytobiotic fodder additives based on Echinacea purpurea on the functional technological properties of rabbit meat, which are important for production processors.

The moisture retaining ability (MRA) describes the moisture content in muscle tissue and the amount of moisture that has separated during the heat treatment process. The MRA approximately describes changes in colloid chemical and structural mechanical properties of tissues. This indicator is

closely related to the output of finished products. Part of the moisture associated with muscle tissue is lost as the weight loss of the finished product resulting from physicochemical and colloid chemical changes occurring during the heat treatment process. The retained moisture remains in the muscle tissue, the amount of which is described by the MRA [10]. The research results are presented in Figure 2.

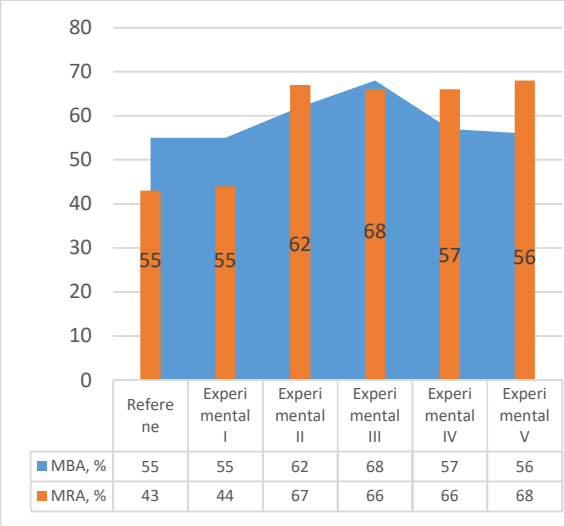

Figure 2. Moisture-binding and moisture-retaining abilities of the rabbit meat from the reference and experimental groups.

The moisture-binding ability (MBA) is one of the most important indicators of raw materials, reflecting the interaction nature in the protein-water system, which, in turn, is influenced by such factors as solubility of protein systems, concentration, type, the composition of protein, etc.

Analysis of the results presented in Figure 2 indicates that the rabbit meat from the experimental groups was described by higher values of both moisture-binding and moisture-retaining abilities than those of the reference group. At the same time, the functional and technological characteristics were noted to be the highest in the rabbit meat from experimental group III, where rabbits with the basic ration were administered the phytobiotic fodder additive with the content of Echinacea purple extract of 1.5 g per animal daily, and the MRA remained within 66 – 68 % if the phytobiotic dose increased. It should be noted that similar results were obtained in assessing the moisture yield and content.

Conclusion

Summarizing the analysis of the study findings, it should be stated that the meat of rabbits that received the phytobiotic fodder additive in the diet has high functional technological properties and can become the basis for creating a wide range of dietary meat products.

The slaughter meat yield was higher by 1.2 % in experimental group I, by 17.3 % ($P > 0.05$) in experimental group II, by 12.4 % in experimental group III, by 14.6 % in experimental group IV, and by 0.45 % in the experimental group, V, compared to analogs of the reference group. The highest fat contents of 2.94 ± 0.80 % and 2.07 ± 0.40 % were observed in the rabbit meat from experimental groups II and III, respectively, where the amounts of Echinacea purpurea in the additive were 1.0 and 1.5 g per animal daily. The rabbit meat obtained from the experimental groups was described by the values of both moisture-binding and moisture-retaining abilities higher than those of the reference group.

The results of the study suggest that the phytobiotic fodder additive containing purple Echinacea extract at a dose of 1.5 – 2.0 g per animal daily is recommended to be included in the basic ration of feeding rabbits as a reasonable way to increase the meat productivity of rabbits and improve the meat quality properties for the production of chopped meat semi-finished products.

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