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EVALUATION OF MICROBIOLOGICAL SAFETY, QUALITY, AND ORGANOLEPTIC PROPERTIES OF BROILER CHICKEN MEAT WITH INCLUSION OF GRAPE SEED MEAL IN THE DIET

Annotation: *The study aimed to evaluate the microbiological safety, quality, and organoleptic properties of broiler chicken meat when grape seed meal was included in the diet. The research was conducted on two groups of broilers: a control group fed a standard balanced diet, and an experimental group whose diet was supplemented with grape seed meal as a source of natural polyphenolic compounds and antioxidants. Microbiological analysis of whole carcasses and livers, collected on the day of slaughter after cooling, showed lower microbial counts in the experimental group. The total count of mesophilic aerobic and facultative*

anaerobic microorganisms in whole carcasses was less than 4×10¹ CFU/g compared to 1.1×10² CFU/g in the control, while in livers, TAMC was 1.1×10³ CFU/g versus 2.1×10⁴ CFU/g, well below established limits. Listeria monocytogenes and pathogenic microorganisms, including Salmonella spp., were not detected in either group. Analysis of toxic elements (lead, arsenic, cadmium, and mercury) revealed values below detection limits, confirming the toxicological safety of the meat. Shelf-life evaluation demonstrated that meat from the experimental group remained acceptable 2 days longer than control meat, with delayed changes in odor and spoilage. Organoleptic assessment of boiled breast and thigh fillets showed slightly higher scores in the experimental group, particularly for aroma, juiciness, tenderness, and overall quality (breast fillets: 9.1 vs. 8.9, thigh fillets: 9.4 vs. 9.2). The results indicate that the inclusion of grape seed meal in broiler diets improves microbiological safety, extends shelf life, and enhances sensory quality without negatively affecting organoleptic characteristics. These findings support the use of grape seed meal as a functional feed additive in poultry production, including products intended for children.

Key words: *broiler chickens, grape seed meal, microbiological safety, organoleptic properties, shelf life, functional poultry products.*

Introduction

Under the conditions of modern poultry production, obtaining products that meet the requirements of biological safety, high nutritional value, and consistent quality is becoming increasingly important. Broiler meat occupies a leading position in the structure of animal protein consumption due to its high digestibility, balanced amino acid composition, and affordability [1, 2]. However, intensive fattening technologies are associated with risks of deteriorating microbiological parameters, accelerated oxidative processes, and reduced shelf life of products, which necessitates the search for new effective feed solutions [3, 4].

One promising approach is the use of natural antioxidants of plant origin, which can positively influence the physiological status of poultry and the quality of the resulting meat [5, 6]. In this regard, particular attention is given to a processed by-product of the wine industry—grape seed flour derived from *Vitis vinifera* seeds. It is rich in polyphenolic compounds (proanthocyanidins, catechins, flavonoids), dietary fiber, and biologically active substances with pronounced antioxidant and antimicrobial properties [7, 8].

It is well known that lipid peroxidation processes are among the key factors contributing to the deterioration of meat quality during storage. The accumulation of lipid oxidation products negatively affects sensory characteristics, reduces nutritional value, and may promote the growth of opportunistic microflora [9, 10]. The inclusion of natural antioxidants in poultry diets can stabilize cell membranes, enhance the antioxidant status of the organism, and consequently improve the microbiological and sensory characteristics of the final product [11,12].

An important aspect of assessing the safety of meat products is the determination of contamination levels by mesophilic aerobic and facultative anaerobic microorganisms (MAFAM), as well as the absence of pathogenic microorganisms, including *Salmonella spp.* and *Listeria monocytogenes* [13, 14]. Additionally, monitoring the content of toxic elements capable of accumulating in animal tissues and posing potential risks to consumers is of significant importance [15].

Despite the availability of individual studies addressing the use of plant-based feed additives in poultry production, the issue of a comprehensive evaluation of the effects of grape seed flour on microbiological safety, shelf life, and sensory properties of broiler meat remains insufficiently studied and requires systematic analysis [16, 17].

The aim of the present study is to assess the microbiological safety, quality, and sensory properties of broiler meat when grape seed flour is included in the fattening diet, as well as to determine the effect of this feed additive on product stability during storage.

Materials and methods

The object of the study was the meat of broiler chickens reared under two feeding regimens: a control and an experimental diet. The control group received a standard complete compound feed balanced according to current nutritional requirements, whereas the experimental group was additionally supplemented with grape seed meal as a source of natural polyphenolic compounds and antioxidants.

The experiment was conducted on two groups of broiler chickens formed by the principle of analogs. Each group consisted of 30 birds. The control group received a standard balanced diet, while the experimental group received the same diet supplemented with grape seed meal at a

dosage of 3% of the total feed weight. The feeding trial lasted for 42 days, corresponding to the standard broiler growing period. Birds were kept under identical housing and management conditions throughout the experiment, with free access to feed and water.

Microbiological analyses were carried out in accordance with the following regulatory standards: determination of the total count of mesophilic aerobic and facultative anaerobic microorganisms (MAFAM) was performed according to GOST 10444.15-94; detection of Salmonella spp. was conducted according to GOST 31659-2012 (ISO 6579:2002); detection of Listeria monocytogenes was performed according to GOST 32031-2012 (ISO 11290-1:1996). The obtained microbiological indicators were evaluated in compliance with the requirements established for poultry meat safety.

The content of toxic elements (lead, arsenic, cadmium, and mercury) in muscle tissue was determined by atomic absorption spectrometry in accordance with the following standards: GOST 30178 (lead, cadmium), GOST R 51776 (arsenic), and GOST R 53183 (mercury). The obtained values were compared with the maximum permissible levels established for poultry meat.

To evaluate product shelf life, a comparative analysis of the storage stability of chilled meat obtained under different feeding regimens was performed. Samples were stored under refrigerated conditions with daily monitoring of organoleptic parameters for 12 days post-slaughter. Changes in odor, the appearance of spoilage signs, and visual surface alterations were recorded. The assessment of storage stability and shelf life of chilled poultry meat was performed taking into account the requirements of TR CU 021/2011 “On Food Safety”, TR CU 034/2013 “On Safety of Meat and Meat Products”, and GOST 31962-2013 regulating the quality and safety indicators of chilled poultry meat during refrigerated storage.

Organoleptic evaluation was carried out using a 10-point scoring scale.

All experiments were carried out in triplicate. The obtained data were processed using standard methods of variation statistics and are presented as mean values ± standard deviation (M ± SD). Statistical significance of differences between the control and experimental groups was evaluated using Student’s t-test. Differences were considered statistically significant at $p < 0.05$.

Results

To assess the safety of the products, the microbiological indicators of meat and by-products were evaluated. Whole carcasses and livers (considered the most “contaminated” product) were sampled on the day of slaughter after cooling. The results of the study are presented in Table 1.

Table 1 – Microbiological indicators of poultry meat in the control and experimental groups

Naming of indicators	units of measurement	Test result		the standard
		Experimental group	The control group	
Whole carcass broiler chicken grade 1 chilled according to GOST R 52702-2006				
Total viable count of mesophilic aerobic and facultative anaerobic microorganisms	CFU/g	less than 4·101	1,1·102	no more than 1·105
Listeria monocytogenes	g	not detected	not detected	not allowed
Pathogenic microorganisms, including Salmonella spp.	g	not detected	not detected	not allowed
By-product broiler chicken, chilled liver according to GOST R 53157-2008				
Total viable count of mesophilic aerobic and facultative anaerobic microorganisms	CFU/g	1,1·103	2,1·104	no more than 1·106
Listeria monocytogenes	g	not detected	not detected	not allowed
Pathogenic microorganisms, including Salmonella spp.	g	not detected	not detected	not allowed

Data from Table 1 show that the poultry meat from the experimental group had better microbiological indicators, which may be associated with the presence of antioxidants in the grape seed meal. The obtained results are consistent with previous studies reporting that grape-derived polyphenols exhibit antimicrobial and antioxidant activity in poultry production systems. Romero et al. [18] demonstrated that dietary grape by-products improve oxidative stability of broiler meat, while Aditya et al. [19] reported improved meat quality and physiological status in broilers receiving grape pomace supplementation. Similar observations were described by Brenes et al. [20], who noted that

polyphenol-rich grape by-products contribute to stabilization of lipid oxidation processes and reduction of microbial spoilage in animal products.

The improvement of microbiological indicators observed in the present study may be associated with the inhibitory effect of polyphenolic compounds on the growth of spoilage microflora. In addition, antioxidant compounds contained in grape seed meal are capable of reducing oxidative degradation of lipids and proteins, thereby slowing quality deterioration during refrigerated storage.

The assessment of toxic elements revealed their complete absence (Table 2).

Table 2 – Content of toxic elements in poultry meat

Naming of the indicator	units of measurement.	Test result		the standard	Regulatory documentation for the test method
		Experimental group	The control group		
Lead	mg/kg	<0,001	<0,001	no more than 0,5	GOST 30178
Arsenic	mg/kg	<0,003	<0,003	no more than 0,1	GOST R 51776
Cadmium	mg/kg	<0,001	<0,001	no more than 0,05	GOST 30178
Mercury	mg/kg	<0,002	<0,002	no more than 0,03	GOST R 53183

To assess product shelf life, a comparison of the storage periods of poultry meat obtained under different feeding regimes was carried out. The results are presented in Table 3.

Table 3 – Comparison of poultry meat shelf life depending on the feeding regime

Products	Shelf life of products during											
	24 hours after slaughter	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days
Broiler chicken carcass (experimental group)	+	+	+	+	+	+	+	+	+	change of smell	spoilage of meat	
Broiler chicken fillet (experimental group)	+	+	+	+	+	+	+	+	+	+	change of smell	spoilage of meat
Broiler chicken carcass (control group)	+	+	+	+	+	+	+	change of smell	spoilage of meat			
Broiler chicken fillet (control group)	+	+	+	+	+	+	+	+	change of smell	spoilage of meat		

The data in Table 3 clearly illustrate the superior shelf life of poultry meat from the experimental feeding group-lasting 2 days longer than meat from the control group. Thus, broiler meat obtained from the experimental feeding group can be used for the production of functional food products, including those intended for children. The positive effect of grape seed meal on meat quality can be explained by its high content of biologically active polyphenols, including catechins, flavonoids, and proanthocyanidins. These compounds possess strong antioxidant properties and are capable of neutralizing free radicals, stabilizing cell membranes, and inhibiting lipid peroxidation processes. Moreover, certain phenolic compounds demonstrate antimicrobial activity against spoilage microorganisms, which may contribute to the reduced microbial contamination and prolonged shelf life observed in the experimental group. The improvement in juiciness and tenderness may also be associated with better preservation of muscle tissue structure under reduced oxidative stress.

The organoleptic assessment of meat included evaluation of appearance and color, the condition of muscles on the cut surface, texture, odor, as well as the clarity and aroma of the broth.

For organoleptic analysis, breast and drumstick samples with and without skin, obtained on the day of slaughter after chilling, were boiled. For taste and texture evaluation, skinless samples were used. For broth assessment, meat with skin and bones was boiled. Appearance and color were

evaluated by inspecting the surface of the product, noting the condition of the skin (for products with skin) and its dryness. Odor was assessed on the cut surface in the inner layers. The condition of muscles on the cut: breast and thigh muscles were cut across the muscle fibers and their appearance was evaluated. Clarity and aroma: broth was prepared from the breast and drumstick, and its odor and aroma were evaluated; clarity was determined visually.

The evaluation was conducted using a 10-point scale, and the results are presented in Table 4.

Table 4 – Organoleptic assessment of boiled broiler meat

Naming of the indicator	Breast fillet		Thigh fillet	
	Control group of chickens	Experimental group of chickens	Control group of chickens	Experimental group of chickens
Appearance	9,8	9,8	9,8	9,8
View and color on the section	9,8	9,8	9,8	9,8
The flavor of meat	8,7	8,8	9,0	9,3
The flavor of the broth	9,8	9,9	9,8	9,8
Transparency of the broth	8,8	9,0	8,9	9,1
Meat consistency	8,5	8,7	8,8	9,2
Juiciness	8,0	8,5	8,6	9,0
Softness	8,0	8,5	8,6	9,1
Overall assessment	8,9	9,1	9,2	9,4

The results presented in Table 4 show that the inclusion of grape seed meal in the diet of chicks does not negatively affect the organoleptic properties of the meat. The organoleptic evaluation of boiled broiler meat can be visually represented using radar (spider) charts (Figures 1 and 2).

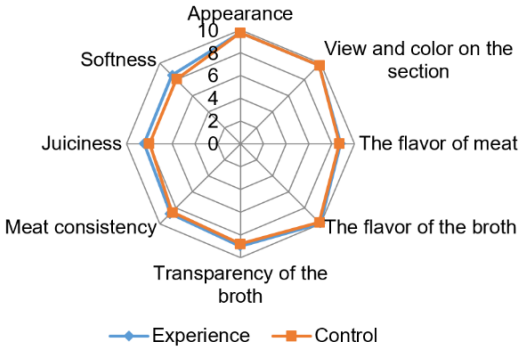

Figure 1 – Radar chart illustrating the organoleptic evaluation of boiled broiler breast fillets from the control and experimental groups.

The experimental group supplemented with grape seed meal demonstrated slightly higher scores for aroma, juiciness, tenderness, broth transparency, and overall sensory quality compared to the control group

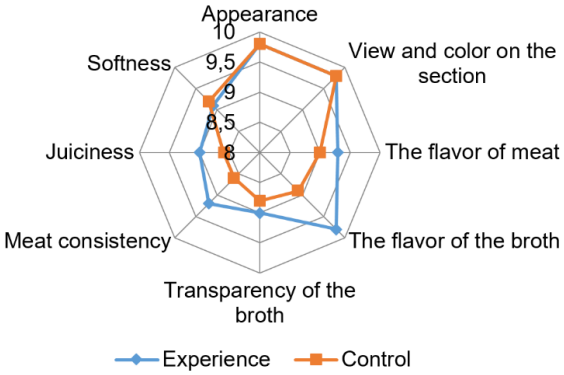

Figure 2 – Radar chart illustrating the organoleptic evaluation of boiled broiler thigh fillets from the control and experimental groups.

Meat obtained from broilers fed grape seed meal showed improved sensory characteristics, particularly in juiciness, softness, meat flavor, and overall acceptabil

As evidenced by the obtained results, the meat from the experimental feeding group exhibited slightly higher quality. At the same time, almost all parameters of thigh fillets were higher than those of breast fillets.

Conclusion

The results of the study demonstrated that the inclusion of grape seed meal in the diet of broiler chickens positively affected the safety, quality, and shelf life of meat. Microbiological analysis showed that meat from the experimental group had lower levels of contamination. In whole carcasses, the total count of mesophilic aerobic and facultative anaerobic microorganisms (TAMC) was less than 4×10^1 CFU/g, compared to 1.1×10^2 CFU/g in the control group, while the standard limit is 1×10^5 CFU/g. In the liver, the TAMC in the experimental group was 1.1×10^3 CFU/g, which is 19 times lower than in the control group (2.1×10^4 CFU/g) and well below the permissible limit (1×10^6 CFU/g). *Listeria monocytogenes* and pathogenic microorganisms, including *Salmonella* spp., were not detected in 25 g of samples from either group. Analysis of toxic elements showed either undetectable levels or values below the limits of detection: lead – <0.001 mg/kg (limit ≤0.5 mg/kg), arsenic – <0.003 mg/kg (limit ≤0.1 mg/kg), cadmium – <0.001 mg/kg (limit ≤0.05 mg/kg), mercury – <0.002 mg/kg (limit ≤0.03 mg/kg). These data confirm the toxicological safety of the meat. Shelf-life evaluation demonstrated an increase in the storage stability of meat from the experimental group by 2 days. Changes in odor in whole carcasses of the control group were observed on day 8, while in the experimental group they appeared on day 10. Spoilage was recorded on day 9 in the control group and on day 11 in the experimental group. A similar trend was observed for fillets: deterioration in the control group occurred on day 9, while in the experimental group it occurred on day 11. Organoleptic evaluation of boiled meat using a 10-point scale showed slightly higher scores for the experimental group. The overall score for breast fillets was 9.1 versus 8.9 in the control; thigh fillets scored 9.4 versus 9.2. For juiciness and tenderness, breast fillets from the experimental group scored 0.5 points higher than the control (8.5 vs. 8.0), and thigh fillets scored 0.4-0.5 points higher (9.0-9.1 vs. 8.6). In conclusion, the inclusion of grape seed meal in broiler diets resulted in a significant reduction of microbial contamination (up to 19-fold in liver), extended shelf life by 2 days, maintained toxicological safety, and improved organoleptic properties of meat. These results support the potential use of grape seed meal as a functional feed additive in poultry production. However, additional toxicological and clinical studies are required before recommending such products for children's nutrition.

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ЖҮЗІМ ДӘНДЕРІНІҢ ҰНТАҒЫН БРОЙЛЕР ТАУЫҚ РАЦИОНЫНА ҚОСҚАНДА ЕТТІҢ МИКРОБИОЛОГИЯЛЫҚ ҚАУІПСІЗДІГІ, САПАСЫ ЖӘНЕ ОРГАНОЛЕПТИКАЛЫҚ ҚАСИЕТТЕРІН БАҒАЛАУ

Зерттеу бройлер тауық етінің микробиологиялық қауіпсіздігі, сапасы және органолептикалық қасиеттерін бағалауға бағытталған, рационға жүзім дәндерінің ұнтағы енгізілген жағдайларды ескере отырып. Зерттеу екі бройлер тобында жүргізілді: стандартты теңдестірілген рацион алған бақылау тобы және рационға табиғи полифенолды қосылыстар мен антиоксиданттар көзі ретінде жүзім дәндерінің ұнтағы қосылған тәжірибелік топ. Салқындатылғаннан кейін, соғылған күні алынған толық тушка мен бауырдың микробиологиялық талдауы тәжірибелік топта микробтық ластанудың төмен екенін көрсетті. Толық тушкалардағы мезофильді аэробты және факультативті анаэробты микроорганизмдердің жалпы саны тәжірибелік топта 4×10¹ КОЕ/г-дан төмен болса, бақылау тобында 1,1×10² КОЕ/г болды; ал бауырда — 1,1×10³ КОЕ/г қарсы 2,1×10⁴ КОЕ/г, бұл нормативтік көрсеткіштерден айтарлықтай төмен. Listeria monocytogenes және Salmonella spp. сияқты патогенді микроорганизмдер екі топта да анықталған жоқ. Зерттеу нәтижелері бойынша токсикалық элементтердің (қорғасын, мышьяк, кадмий және сынап) мөлшері анықтау шегінен төмен болып, еттің токсикологиялық қауіпсіздігін растады. Сақталу мерзімін бағалау көрсеткендей, тәжірибелік топтағы ет бақылау тобындағы етке қарағанда 2 күнге ұзақ жарамды болып шықты, сонымен қатар иіс өзгерісі мен шіріктің

белгілері кеш байқалды. Вареная төс және жамбас филеін органолептикалық бағалау тәжірибелік топта біршама жоғары көрсеткіштерді көрсетті, әсіресе иіс, шырындылық, жұмсақтық және жалпы сапа бағасы бойынша (төс филесі: 9,1 қарсы 8,9; жамбас филесі: 9,4 қарсы 9,2). Зерттеу нәтижелері жүзім дәндерінің ұнтағын бройлерлердің рационына енгізу микробиологиялық қауіпсіздікті арттыратынын, сақтау мерзімін ұзартады және сенсорлық қасиеттерді жақсартады, органолептикалық қасиеттерге теріс әсер етпейтінін көрсетеді. Бұл деректер жүзім дәндерінің ұнтағын функционалды жемдік қосымша ретінде, соның ішінде балаларға арналған өнімдерде қолданудың тиімділігін растайды.

Түйін сөздер: *Бройлерлер, жүзім дәнінің ұны, микробиологиялық қауіпсіздік, органолептикалық қасиеттер, сақтау мерзімі, функционалды құс өнімдері.*

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ОЦЕНКА МИКРОБИОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ, КАЧЕСТВА И ОРГАНОЛЕПТИЧЕСКИХ СВОЙСТВ МЯСА БРОЙЛЕРОВ ПРИ ВКЛЮЧЕНИИ МУКИ ИЗ ВИНОГРАДНЫХ КОСТОЧЕК В РАЦИОН

Исследование было направлено на оценку микробиологической безопасности, качества и органолептических свойств мяса бройлеров при включении в рацион муки из виноградных косточек. Исследование проводилось на двух группах бройлеров: контрольной, получавшей стандартный сбалансированный рацион, и опытной, рацион которой был дополнен мукой из виноградных косточек как источником природных полифенольных соединений и антиоксидантов. Микробиологический анализ целых тушек и печени, отобранных в день убоя после охлаждения, показал более низкое микробное обсеменение в опытной группе. Общая численность мезофильных аэробных и факультативно-анаэробных микроорганизмов в целых тушках составила менее 4×10^1 КОЕ/г по сравнению с $1,1\times10^2$ КОЕ/г в контрольной группе, а в печени – $1,1\times10^3$ КОЕ/г против $2,1\times10^4$ КОЕ/г, что значительно ниже установленных нормативов. Listeria monocytogenes и патогенные микроорганизмы, включая Salmonella spp., не были обнаружены ни в одной из групп. Анализ содержания токсичных элементов (свинец, мышьяк, кадмий и ртуть) показал значения ниже предела обнаружения, что подтверждает токсикологическую безопасность мяса. Оценка сроков годности показала, что мясо из опытной группы оставалось пригодным на 2 дня дольше, чем мясо контрольной группы, при этом изменения запаха и признаки порчи отмечались с задержкой. Органолептическая оценка вареных филе грудки и бедра показала несколько более высокие показатели у опытной группы, особенно по показателям аромата, сочности, нежности и общей оценки качества (филе грудки: 9,1 против 8,9; филе бедра: 9,4 против 9,2). Результаты исследования показывают, что включение муки из виноградных косточек в рацион бройлеров повышает микробиологическую безопасность, продлевает срок годности и улучшает сенсорные показатели без негативного влияния на органолептические свойства. Эти данные подтверждают целесообразность использования муки из виноградных косточек в качестве функциональной добавки к корму для птицы, в том числе для продуктов, предназначенных для детского питания.

Ключевые слова: *Бройлеры, мука из виноградных косточек, микробиологическая безопасность, органолептические показатели, срок годности, функциональные продукты из птицы.*

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DEVELOPMENT OF SOFT CHEESE TECHNOLOGY FROM BLENDED MILK WITH OPTIMIZATION OF COAGULATION PARAMETERS

Abstract: *The rational use of mixed dairy raw materials is a promising direction in soft cheese technology, as it allows to increase the cheese suitability and improve the quality of the finished product. The study investigated the effect of the ratio of cow's, goat's and camel's milk on the coagulation processes and the quality of soft cheese. The temperature regimes of coagulation, duration of coagulation, organoleptic, physic-chemical and textural parameters of the product were studied.*

It has been established that optimal coagulation conditions for combined dairy raw materials are achieved at a temperature of 40 ° C and a duration of 40 minutes. The best results were shown by a sample