Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Animal Science and Biotechnologies
Open Access

Evaluation of the Effect of Sea Buckthorn Meal on Production Performance and Meat Chemical Composition in Broiler Chickens

Mihai Iacob BENȚEA*, Cristian Ovidiu COROIAN*, Andrei Alexandru ONA

Faculty of Animal Science and Biotechnologies, University of Agricultural Science and Veterinary Medicine Cluj-Napoca, Mănăștur Street, No.3-5, Cluj-Napoca, Cluj, 400372, Romania
** Corresponding authors: M.I. Benţea e-mail: mihai.bentea@usamvcluj.ro and C.O. Coroian e-mail: cristian.coroian@usamvcluj.ro*

RESEARCH ARTICLE

Abstract

The aim of the research was to highlight the effects of sea buckthorn meal on production and consumption indices and meat chemistry in broiler chickens. The research was carried out on 50 Ross-308 hybrid broiler chickens in two groups (25 heads/group): a control group and an experimental group (0.5% buckthorn meal) over a period of 28 days. During and at the end of the experiment, the following parameters were recorded and analysed: body mass development, daily growth gain, feed consumption, feed conversion ratio (FCR) and meat quality. The best results were recorded in the experimental group, with a body weight of 2683.24 g, an average daily gain of 79.48 g and a feed conversion index of 1.70. Meat quality was improved by increasing crude protein content in the experimental group. The addition of sea buckthorn meal had a favourable influence on the productive performance and meat quality of broiler chickens.

Keywords: broilers, sea buckthorn, production performance, meat quality.

Received: 14 March 2024
Accepted: 22 April 2024
Published: 15 May 2024

DOI:
10.15835/buasvmcn-asb:2024.0005

INTRODUCTION

Massive global population growth in recent times has led to the need for accelerated and forced development of the food industry worldwide, with massive population growth causing increasing problems in providing food for the earth's population. In addition to quantitative shortcomings, another problem is food quality, which is largely related to the provision of animal protein, a protein with high biological value, in quantities that ensure the consumption needs of the population. For this reason, researchers around the world through their research have been looking for alternative solutions to feed farm animals with natural products, leading to improved meat quantity and quality (Krejcarová et al., 2015; Zhao et al., 2017; Chikwanha et al., 2019; Nobre et al., 2020; Qin et al., 2020) animal health and therefore human consumers. One of the most consumed species worldwide, due to meet quality and economy, is the Galinaceae species, respectively the meat broiler chicken. There are various ways to improve broiler meat production and quality, such as through continuous genetic improvement of hybrids, rearing systems and maintenance conditions (Cai et al., 2018; Aksoy et al., 2021) or through the use of different nutritional supplements to make it possible to improve feed assimilation and weight gain (Benţea et al., 2016; Şara et al., 2016; Colibar et al., 2021; Seregin et al., 2021). Lately, there is a worldwide trend to use natural, wild flora resources that used as adjuvant supplements can

influence broiler production and production quality while maintaining bird health (Colibar et al., 2021; Seregin et al., 2021). The fruits of sea buckthorn together with the by-products obtained from their processing such as sea buckthorn meal or seeds, as well as the vegetative parts of the sea buckthorn shrub are such natural products that can be used in poultry feed have prospects in increasing broiler chick production (Biswas et al., 2010; Seregin et al., 2021). It has long ago been observed that wild birds and rodents of many species living in thickets covered by sea buckthorn bushes and feeding on these fruits show increased body weight and a more attractive overall appearance (Seregin et al., 2021). At the same time, sea buckthorn accelerates the healing process of wounds and frostbite and reduces feather fall (Bal et al., 2011; Suryakumar and Gupta, 2013). This observation has contributed to the development of sea buckthorn juice and oil production for human consumption as well. Sea buckthorn meal is a valuable feed product obtained after oil extraction, which contains proteins with high biological value (contains a large proportion of essential and non-essential amino acids), sugars, polyunsaturated fats, vitamins (A, B2, B6, F, E, K, P), pigments, tannins, copherols, fatty acids, phytoncides, flavonoids, sterols, macroelements (P, Ca, Mg, K, Na) and microelements (Fe, Zn, Mn, Se) (Brad et al., 2002; Zeb, 2004; Gâtlan and Gutt, 2021; Seregin et al., 2021). Following the administration of sea buckthorn meal in broiler chicken feed, Colibar et al., 2021 and Seregin et al., 2021, observe an increase in average daily gain correlated with a reduction in specific intake and an improvement in broiler meat quality. Due to the above mentioned, sea buckthorn meal can be considered a valuable feed supplement that can be used as a supplementary source of biologically active substances in broiler feed (Biswas et al., 2010; Seregin et al., 2021).

The aim of this research was to highlight the effects of sea buckthorn meal on some production and consumption indices and meat chemical composition in broiler chickens, sexed females.

MATERIALS AND METHODS

The experiment was conducted between April 2023 and May 2023, over a period of 28 days in a private household in Sighetul Marmaţiei, Jud. Maramureş, Romania, on a flock of 50 broilers (females only, sexed biological material) divided into 2 groups as follows: control group and experimental group (buckthorn meal 0.5%). Broilers from the 2 groups were kept on the ground under the same microclimate, density, care and feeding conditions, being purchased at 14 days of age and further reared on two growth phases, respectively the growth phase (15-35 days) and the finishing phase (36-42 days). The broiler chickens in the two groups were fed with powdered compound feeds that had an energy and protein level specific to the broiler chicken rearing technology in intensive system (Şara and Benţea, 2013), the energy value (Kcal/kg) being 3100-3200 for growth and 3150-3250 for finishing; and crude protein (%) 21.0-21.5 for growth and 19.8-20.5 for finishing. Chickens and feed were purchased from the Cicârlău chicken farm in Maramureş county and have the composition and nutritional value shown in Table 1.

Table 1. The structure and nutritional value of the diet of the control group on the two growth phases

Raw material	Phase II (14-35 days)	Phase III (36-42 days)
Structure of combined feed (g/kg mixture)		
Corn	395.1	440
Barley	-	50
Wheat	120	50
Sunflower meal (36% CP)	100	80
Soybean meal (46% CP)	280	270
Vegetal fat	60	70
L-lisin HCl	1.5	-
DL-metionin	1.4	1
Calcium carbonate	18	16
Monocalcium phosphate	11	10
Salt	3	3
Vitamin-mineral premix	10	10
Nutritional characteristics of food (g/kg calculated based on composition)		
M.E. (kcal/kg)	3125.2	3218.7
Crude protein	213.2	201.1
Lisin	11.3	9.7
Metionin	4.7	4.2
Met+ Cistein	6.8	6.7
Tryptophan	2.5	2.4
Ca	9.9	8.9
P	7.1	6.8

In the case of the experimental batch, in addition to the combined feed, a supplement of 0.5% of buckthorn meal

was introduced (Table 2). As the crude protein content of the sea buckthorn meal was 11.45% and the proportion of its inclusion in the feed structure was only 0.5%, it can be considered that the addition of sea buckthorn meal did not influence the composition of the feed significantly.

Table 2. The structure and nutritional value of the diet of the experimental group on the two growth phases

Raw material	Phase II (14-35 days)	Phase III (36-42 days)
Structure of combined feed (g/kg mixture)		
Corn	395.1	440
Barley	-	50
Wheat	120	50
Sunflower meal (36% CP)	100	80
Soybean meal (46% CP)	280	270
Vegetal fat	60	70
L-lisin HCl	1.5	-
DL-metionin	1.4	1
Calcium carbonate	18	16
Monocalcium phosphate	11	10
Salt	3	3
Vitamin-mineral premix	10	10
Sea buckthorn meal	5	5
Nutritional characteristics of food (g/kg calculated based on composition)		
M.E. (kcal/kg)	3122.8	3215.9
Crude protein	212.7	200.7
Lisin	11.3	9.7
Metionin	4.7	4.2
Met+ Cistein	6.8	6.7
Tryptophan	2.5	2.4
Ca	9.9	8.9
P	7.1	6.8

In order to highlight the effect of sea buckthorn supplementation on growth performance, the following parameters were monitored and recorded: body mass development, growth gain, feed consumption and feed conversion ratio (FCR).

At 42 days of age, 5 chickens from each group were slaughtered and a total of 10 samples from 10 different chickens were sampled from the carcass muscle (breast and tigh) to determine the meat chemistry respectively dry matter content (Latimer, 2023), crude protein (Kjeldahl method) (Latimer, 2023), crude fat (Soxhlet method) (Shahidi and Wanasundara, 2002, Latimer, 2023) and crude ash (calcination method) (Perez and Andujar, 1981, Latimer, 2023), in the feed and product quality control laboratory of USAMV Cluj-Napoca.

All data are presented as mean $\pm$ mean error, standard deviation, and the coefficient of variation and differences at the statistical level were calculated using the Student test and GraphPad InStat ver.3.10.

RESULTS AND DISCUSSIONS

Mean values and variability of body mass of chicks over the experimental period (14- 42 days) are shown in Table 3.

Table 3. Mean values and variability of body mass in broiler chickens by growing week (g/head)

Age (days)	CG, N = 25			EG, N = 25		
	X±Sx̄	S.D.	V%	X±Sx̄	S.D.	V%
Experiment starting	456.84 ± 1.23	6.16	1.35	457.72± 1.21 ns	6.06	1.32
14 days						
21 days	847.88 ± 7.65	38.26	4.51	861.96 ± 7.31 ns	36.54	4.24
28 days	1364.12 ± 15.15	75.76	5.55	1398.52 ± 7.17*	35.85	2.56
35 days	1917.08 ± 9.35	46.74	2.32	2040.80 ± 7.65***	38.27	1.79
42 days	2542.52 ± 9.92	49.58	1.95	2683.24 ± 9.36***	46.80	1.74

Note: ***p<0,001- very significant differences (Student test); *p<0,05- significant differences (Student test); ns p>0,05- not significant differences (Student test); CG- control group; EG- experimental group.

At 21 days of age, the differences between the experimental and control groups were increasingly large, being significant at 28 days of age with an average of 1398.52 g in the experimental group (EG) with buckthorn meal followed by 1364.12 g in the control group (CG).

Starting at 35 days of age, the differences between the two groups increase, being very significant, with the chicks recording 2040.80 g in the EG compared to 1917.08 in the CG at 35 days of age, respectively 2683.24 g compared to 2542.52 g at 42 days of age. These results indicate the favorable influence of sea buckthorn meal on the growth performance of broiler chickens. The higher body mass accumulation in case of sea buckthorn administration in the experimental group was also confirmed by Ma et al. (2015) and Seregin et al. (2021).

For a true estimation of the growth dynamics of broiler chickens in the two experimental groups, the daily growth rate was determined as an indicator of the growth rate of body mass, and to determine the economics of feeding the chicks, daily feed consumption was noted, based on which the feed conversion ratio (FCR) was calculated, the data being presented in Table 4.

Table 4. Average daily gain, feed consumption and feed conversion ratio over the experimental period

Parameter	U.M.	CG	EG
Average daily gain (g/day)	g/day	74,49	79.48
	%	100.00	106.70
Average daily feed consumption (g/day)	g/day	138.42	142.60
	%	100.00	103.02
Average feed conversion ratio (FCR; kg/kg)	kg feed/ kg body mass	1.75: 1	1.70: 1
	%	100	97.14

Note: UM- unit of measurement; CG- control group; EG- experimental group.

Growth and consumption indicators recorded for the two groups of broilers during the experimental period showed the favorable influence of the addition of sea buckthorn meal on weight gain and feed conversion. The average daily gain was 6.70% higher in EG than in the CG (79.48 g vs 74.49 g), with a slightly higher average daily feed intake (142.60 g vs 138.42 g), and a 2.86% improvement in feed conversion rate in EG (1.70:1) compared to the CG (1.75:1). This increase in productive efficiency was also observed by Ma et al. 2015 and Seregin et al. 2021.

In addition to growth and consumption indicators, the effect of sea buckthorn meal supplementation on the crude chemical composition of meat was also determined. The results of the chemical analysis of breast and thigh meat are shown in Table 5.

Table 5. Chemical composition of meat (breast and thigh) in control and experimental groups

Parameter	CG, N = 5	EG, N = 5
Chemical composition of breast (%)		
Dry matter	24.79±0.22^{ns}	23.44±0.36
Crude protein	79.24±1.12	82.04±1.18**
Crude fat	13.23±0.27	14.41±0.42*
Crude ash	4.24±0.42*	2.37±0.04
Chemical composition of thigh (%)		
Dry matter	29.45±0.60^{ns}	28.04±0.20
Crude protein	58.87±0.93	62.01±0.88***
Crude fat	28.00±0.22	29.43±1.29*
Crude ash	3.47±0.35^{ns}	2.59±0.06

Note: ***p<0,001- very significant differences (Student test); **p<0,01- distinct significant differences (Student test); *p<0,05- significant differences (Student test); ns p>0,05- not significant differences (Student test); CG- control group; EG- experimental group.

The raw chemical composition of the breast and thigh meat of the two groups showed differences at different thresholds of statistical significance. Thus, the chemical composition of the breast meat from the EG shows the highest crude protein content (82.04%), the differences being distinctly significant compared to the CG (79.24%), also the crude fat content is higher than in the CG (14.41% versus 13.23%).

The crude ash is found in the highest proportion in the CG with a value of 4.24% statistically significant difference at the significance threshold ($p<0.05$).

Analyzing the chemical composition of the meat from the thigh, the meat content in crude protein of the chickens in the experimental group was higher, with values of 62.01% in the EG compared to only 58.87% in the chickens from the CG, the differences between the two groups being very significant. The value of crude fat is also higher in the chickens of the EG, being 29.43% compared to 28.00% in the CG. The increase in crude protein and fat percentage was also reported by Ma et al. (2015) and Siregin et al. (2021). Ma et al. (2015) studying also the amount

of intra-abdominal fat of the chickens, observed a reduction in the amount of intra-abdominal fat in the experimental group, the amount of intra-abdominal fat being inversely proportional to that of intramuscular fat. The same author observed that the chick fat in the group with sea buckthorn had a higher ratio of unsaturated fatty acids compared to the control group and a low level of triglycerides and cholesterol being a healthier fat for consumers.

The way in which sea buckthorn meal could influence productive performance by having a biostimulatory and detoxifying role is also based on the following fact: pectic substances present in sea buckthorn meal are able to regulate the water regime in tissues and participate in cell renewal in various organs. It is also known that the carboxyl groups of galacturonic acid provide the ability of pectic substances to bind heavy metal ions and other harmful substances in the gastrointestinal tract with the formation of insoluble complexes excreted from the body together with faeces (Qin et al., 2020 cited by Seregin et al., 2021). It has been established that sea buckthorn meal is among the biologically active, adaptogenic feed supplements that participate in the regulation of many functions of the poultry body, which are externalized by increasing chicken meat production and improving meat quality (Qin et al., 2020, cited by Seregin et al., 2021).

CONCLUSIONS

The use of sea buckthorn meal in broiler feed improved the main production and consumption indices of broilers, which characterise the bio-productive effect of a fodder or rations.

The use of sea buckthorn meal in broiler feed increased the body mass of the chicks in the experimental group, increased the average daily gain and reduced the feed conversion ratio during the growing period compared to the control group. The accumulation of higher body masses in chickens from the experimental group compared to chickens from the control group and the reduction of food consumption per kg gain in this group denoted the increase in the degree of bioconversion of food following the administration of sea buckthorn as a biostimulatory product. Also increasing the protein and fat content of the meat results in more nutritionally valuable meat.

Based on the results obtained, we recommend the use of sea buckthorn meal in the feeding of sexed-female broilers, as it improves the main bioproductive indices (digestibility, average daily gain, conversion index) and meat quality.

Author Contributions: M.I.B. introduce the values in the database, designed and wrote the paper, C.O.C. wrote and analysed the paper, A.A.O. performance of measurements of biological material and collected the biological material for analysis.

Funding Source: This research was funded by the authors' own income.

Acknowledgments

We would like to thank Mr. Liviu Clapa for his help with the chemical analysis of the meat samples.

Conflicts of Interest

The authors declare that they do not have any conflict of interest.

REFERENCES

1. Aksoy T, Çürek Dİ, Narinç D, Önenç A. Effects of season, genotype, and rearing system on broiler chickens raised in different semi-intensive systems: performance, mortality, and slaughter results. Trop. Anim. Health Pro. 2021; 53(1):189.
2. Bal LM, Meda V, Naik SN. Sea buck thorn berries: a potential source of valuable nutrients for neutraceuticals and cosmoceuticals. Food Res. Int. 2011; 44(7):1718-1727.
3. Benţea MI, Marţi R, Şara A, Toader I, Gabor EF. The Effects of Some Prebiotic Products (Actigen, Biotronic Top3) on the Production and Consumption Indices in Broiler Chickens. Bull. UASVM Animal Science and Biotechnologies. 2016: 73(2):197-201.
4. Biswas A, Bharti VK, Acharya S, Pawar DD, Singh SB. Seabuckthorn: new feed op portunity for poultry at cold arid Ladakh region of India. World. Poult. Sci. J. 2010; 66(4):707-714.
5. Brad I, Brad IL, Radu F. Sea buckthorn: a pharmacy in a plant (in Romanian), Ed. Tehnica, Bucureşti, România. 2002.
6. Cai K, Shao W, Chen X, Campbell YL, Nair MN, Suman SP, et al. Meat quality traits and proteome profile of woody broiler breast (pectoralis major) meat. Poult.Sci. 2018; 97(1):337-346. https://pubmed.ncbi.nlm.nih.gov/29053841/ doi: 10.3382/ps/pex284

7. Chikwanha OC, Muchenje V, Nolte JE, Dugan MER, Mapiye C. Grape pomace (Vitis vinifera L. cv. Pinotage) supplementation in lamb diets: Effects on growth performance, carcass and meat quality, Meat Science. 2019; 147:6-12.
8. Colibar O, Hotea I, Sîrbu CB, Herman V. Considerations Regarding the Supplementation of Broiler Chicken Diets with Sea Buckthorn (Hippophae Rhamnoides), Rev. Rom. Med. Vet. 2021; 31(1):45-48.
9. Krejcarová J, Straková E, Suchý P, Herzig I, Karásková K. Sea buckthorn (Hippophae rhamnoides L.) as a potential source of nutraceutics and its therapeutic possibilities- a review. Acta Vet. Brno. 2015, 84:257–268.
10. Latimer GW Jr, editor. Official Methods of Analysis, 39.1.02 AOAC International (22nd Edition) Official Method 950.46 Loss on Drying (Moisture) in Meat. 2023, Ch.39, Meat and meat products, pages C39-2–C39-33, https://doi.org/10.1093/9780197610145.003.515
11. Latimer GW Jr, editor. Official Methods of Analysis, 39.1.15 AOAC International (22nd Edition) Official Method 928.08 Nitrogen in Meat: Kjeldahl Method. 2023, Ch.39. Meat and meat products, pages C39-2–C39-33, https://doi.org/10.1093/9780197610145.003.515
12. Latimer GW Jr, editor. Official Methods of Analysis, 39.1.08 AOAC International (22nd Edition) Official Method 991.36 Fat (Crude) in Meat and Meat Products: Solvent Extraction Method. 2023, Ch.39. Meat and meat products, pages C39-2–C39-33, https://doi.org/10.1093/9780197610145.003.515
13. Latimer GW Jr, editor. Official Methods of Analysis, 39.1.09 AOAC International (22nd Edition) Official Method 920.153 Ash of Meat. 2023, Ch.39. Meat and meat products, pages C39-2–C39-33, https://doi.org/10.1093/9780197610145.003.515.
14. Perez D, Andujar G. Determination of ash content in meal products. Meat Sci. 1981;5(3):165-70.
15. Gâtlan AM, Gutt G. Sea Buckthorn in Plant Based Diets. An Analytical Approach of Sea Buckthorn Fruits Composition: Nutritional Value, Applications, and Health Benefits, Int. J. Environ. Res. Public Health. 2021; 18(8986):1-23.
16. Ma JS, Chang WH, Liu GH, Zhang S, Zheng AJ, Li Y, et al. Efects of favones of seabuckthorn fruits on growth perfor mance, carcass quality, fat deposition and lipome tabolism for broilers. Poult Sci. 2005; 94:2641-2649.
17. Nobre PT, Munekata PES, Costa RG, Carvalho FR, Ribeiro NL, Queiroga RCRE, et al. The impact of dietary supplementation with guava (Psidium guajava L.) agroindustrial waste on growth performance and quality of lambs. Meat Sci. 2020;164:108105, doi: 10.1016/j.meatsci.2020.108105
18. Seregin IG, Kozak SS, Semenov VG, Kozak YuA, Boronin VV. Improving the quality of broiler meat when using sea buckthorn meal in feed, International AgroScience Conference (AgroScience-2021) IOP Conf. Series: Earth and Environmental Science 935. 2021, 012042:1-9, doi:10.1088/1755-1315/935/1/012042
19. Shahidi F, Wanasundara PKJPD. Extraction and analysis of lipids. In: Akoh CC, Min DB, editors. Food Lipids: Chemistry, Nutrition, and Biotechnology. 2nd ed. Revised and expanded. 2002, New York, NY, USA: Marcel Dekker, Part.I.(6): 152-187.
20. Suryakumar G, Gupta A. Medicinal and therapeutic potential of Sea buckthorn (Hippophae rhamnoides L.), J of Ethnopharmacol. 2011; 138:268-278.
21. Şara A, Benţea M. Animal feed. 2nd revised and added edition, Ed. Risoprint, Cluj-Napoca. Subchap. 7.4. Feeding of broilers, p.191. 2013.
22. Şara A, Marţi R, Benţea MI, Toader I, Gabor EF. The Effects of Some Prebiotic Products (Actigen, Biotronic Top3) Administrated in the Food of Broiler Chickens on the Meat Quality. Bull. UASVM Animal Science and Biotechnologies. 2016; 73(2):202-205.
23. Qin X, Zhang T, Cao Y, Deng B, Zhang J, Zhao J. Effects of dietary sea buckthorn pomace supplementation on skeletal muscle mass and meat quality in lambs. Meat Science. 2020; 166 108141 DOI:10.1016/j.meatsci.2020.108141.
24. Zeb A. Chemical and Nutritional Constituents of Sea Buckthorn Juice, Pakistan Journal of Nutrition 3. 2004; 2:99-106.
25. Zhao J, Li K, Su R, Liu W, Ren Y, Zhang C, et al. Effect of dietary Tartary buckwheat extract supplementation on growth performance, meat quality and antioxidant activity in ewe lambs, J. Meat Sci. 2017; 134:79-85. doi: 10.1016/j.meatsci.2017.07.016.