Cranberry Leaves as Feed Additive in Poultry Nutrition: Effects on Performance and Oxidative Stability

Arabela Elena Untea[1], Iulia Varzaru[1], Mihaela Saracila[1], Petru Alexandru Vlaicu[1], Alexandra-Gabriela Oancea[1], Tatiana Dumitra Panaite[2]

[1]National Research and Development Institute for Animal Biology and Nutrition, Feed and Food Quality Department, 077015-Balotesti, Calea Bucuresti, 1, Romania
[2]National Research and Development Institute for Animal Biology and Nutrition, Animal Physiology Department, 077015-Balotesti, Calea Bucuresti, 1, Romania

Abstract
Cranberries, like other plants from the berry family, are very popular due to their composition rich in bioactive compounds with strong antioxidant activity. The leaves belonging to that species can be considered a cost-effective alternative in the context of reducing antibiotics strategy in animal nutrition. Studies on their potential effects as feed additive are limited in poultry nutrition. The aim of the current study is to assess the effects of inclusion of cranberry leaves in an omega 3 enriched diet of broilers on productive parameters and evaluate the markers of antioxidant defence system. An experiment was conducted on 120 Cobb 500 broiler chickens, housed in an experimental hall with permanent wood shave litter, in boxes of 3 m^2. The dietary treatments were based on corn and soybean meal, and the experimental group fed diets supplemented with 1% cranberry leaves (E1) and other with combination of cranberry leaves (1%) and walnut meal (6%) (E2). The results showed that the presence of cranberry leaves in an omega 3 enriched diet affected the final body weight of broilers (C–3140 g; E1–2649 g and E2–2538 g); the average daily gain (C–92.91 g; E1–88.32 g and E2–84.63 g) compared to other two groups. No significant differences were recorded for average daily feed intake and feed conversion ratio. The antioxidant compounds from cranberry leaves structure positively affected the MDA concentrations determined in serum and liver samples (C–0.153 ppm; E1–0.133 ppm for serum samples and C–0.359 ppm; E1–0.319 ppm for liver samples). By inclusion in an omega enriched diet, no significant differences were detected compared to C for serum (E2–0.155 ppm) and almost 10% decreasing values were recorded for MDA values determined in liver samples (0.324 ppm).

Keywords: broilers, cranberry leaves, MDA values, performance

1. Introduction

Currently, more and more attention is paid to the effects that diet has on human health. Animal products, especially broiler meat, are an important part of the daily diet, being a valuable source of nutrients. Although meat is an important ingredient in the human diet, there are consumer concerns about the effects on health. For example, red meat is associated with the development of chronic diseases, but a direct relationship has not been fully justified [1]. Consequently, researchers have developed nutritional strategies that include bioactive compounds for obtaining animal products with functional food attributes [2]. Among the quality attributes pursued by nutritionists is the enrichment of meat in antioxidant compounds with the role in delaying the occurrence of oxidative processes.

Among vegetal antioxidant sources, cranberries, like other plants from the berry family, are very popular due to their composition rich in bioactive compounds with strong antioxidant activity. The leaves belonging to that species can be considered a cost-effective alternative in the context of

* Corresponding author: Arabela Elena Untea
Email: arabela.untea@ibna.ro

reducing antibiotics strategy in animal nutrition. Studies on their potential effects as feed additive are limited in poultry nutrition. Cranberry by products was used in animal nutrition studies for evaluating their effects on immunomodulatory system [3], or biochemical parameters [4] or meat quality [5] or lipid metabolism [6].

Another low economic vegetal source of antioxidants can be considered walnut (Juglans Regia) meal which is the resulting product from pressing and oil extraction. The fruit is known to be rich in vitamins and minerals and the meal is a valuable source of bioactive compounds in animal nutrition.

The aim of the current study is to assess the effects of inclusion of cranberry leaves and walnut meal in broiler's diets, on productive parameters and the markers of antioxidant defense system.

2. Materials and methods

An experiment on broilers chicken (120 animals), Cobb 500 hybrid took place during finisher stage of growing, in an experimental hall with permanent wood shave litter (10–12 cm thick), simulating the semi-intensive system conditions, in boxes of 3 m^2 (40 broilers/group/box). All the experimental conditions were set according to the sanitary veterinary regulations and recommendations of the breeding guide of the hybrid.

The rules described in Romanian documents 206/2004, 43/11.04.2014 and Directive 2010/63/EU were followed, and Ethical Committee of the National Research Development Institute for Biology and Animal Nutrition approved the experimental protocol.

The control diet was based on corn and soybean meal and experimental diets included 1% cranberry leaves (E1) and 1% cranberry leaves with 6% walnut meal (E2). The diets formulation is presented in Table 1 and followed the nutritional guidelines of the management breeding guide of Cobb 500 hybrids.

Table 1. Diets formulation (finisher phase)

Ingredients (%)	Control	E1	E2
Maize	42.00	42.00	42.00
Wheat	20.56	18.60	15.79
Soybean meal	28.10	28.45	25.40
Oil	5.11	5.67	5.55
Walnut meal	-	0.00	6.00
Cranberry leaves	-	1.00	1.00
Lysine	0.09	0.09	0.02
Methionine	0.20	0.20	0.26
Threonine	0.10	0.10	0.07
Calcium carbonate	1.17	1.17	1.17
Monocalcium phosphate	1.30	1.35	1.36
Salt	0.33	0.33	0.34
Choline	0.04	0.04	0.04
Premix	1.00	1.00	1.00
Total	100	100	100
Chemical composition			
ME, Kcal/kg	3086	3086	3167
Crude protein, %	20.00	20.00	19.00
Crude fat, %	5.93	6.51	8.24
Crude fiber, %	3.78	3.94	4.71
Ca, %	0.84	0.84	0.76
Available P, %	0.42	0.42	0.38

1 kg of premix contains 1,100,000 IU/kg vitamin A; 200,000 IU/kg vitamin D3; 2700 IU/kg vitamin E; 300 mg/kg vitamin K; 200 mg/kg Vit. B1; 400 mg/kg vitamin B2; 1485 mg/kg pantothenic acid; 2700 mg/kg nicotinic acid; 300 mg/kg vitamin B6; 4 mg/kg Vit. B7; 100 mg/kg vitamin B9; 1.8 mg/kg vitamin B12; 2000 mg/kg vitamin C; 8000 mg/kg Mn; 8000 mg/kg Fe; 500 mg/kg Cu; 6000 mg/kg Zn; 37 mg/kg Co; 152 mg/kg I; 18 mg/kg Se. ME-metabolizable energy; Ca–calcium; P–phosphorus

The productive performances were recorded as follows: body weight (BW, g) was registered by weighing every broiler at the beginning (initial BW, g) and at the end (final BW, g) of experiment. Average daily feed intake (ADFI, g feed/broiler/day) was calculated by the difference between the offered and rejected feed, average daily weight gain (ADWG, g) was considered the ratio between broilers weight and the number of experimental days and feed conversion ratio (FCR, kg feed/kg weight) was calculated as the ratio between feed consumed and total weight.

For the study of bioproductive parameters (BWi, BWf, ADWG) every broiler was considered an experimental unit while ADFI and FCR were calculated considering the box as experimental unit for statistical analyses.

At the end of experimental period (42 days), 6 broilers randomly selected from each treatment were slaughtered by cervical dislocation, following two minutes of exsanguination and breast meat samples were collected to determine the oxidative stability parameters.

Peroxide value, conjugated dienes and trienes as primary oxidation products, p anisidine value and TBARS as secondary oxidation products were evaluated for oxidative stability. The analytical determinations were performed using the methods described by Untea et al. [7] and V-530 Jasco (Japan Servo Co. Ltd., Japan) spectrophotometer was used for recording the corresponding absorbance.

The experimental data were statistical analysed using one way ANOVA and a probability level below 5% was considered significant. XLSTAT (Addinsoft, New York, USA) software was used for statistical interpretation.

3. Results and discussion

Regarding the production performances registered during experimental time (Table 2) the dietary supplements simultaneously administrated (E2 group) significantly decreased ($P<0.05$) the performance parameters compared with control group. No statistical differences ($P>0.05$) were noticed between cranberry leaves supplemented group and the control group. None of the productive parameters recorded during experiment was positively influenced by the dietary phytogenic additives. Cranberry extract or pomace used in poultry nutrition was reported in several previous studies but no significant effect ($P<0.05$) on production parameters was noticed [8, 4].

Some researchers considered that the high phenolic content of cranberry, including tannic or gallic acids, can produce an enhanced effect on growth performance of animals [9]. As in our study, the same decreasing effect on growth performances was also noticed in walnut meal supplemented groups, observation reported also by other authors [10]. But tannins are secondary metabolites found in plants, seeds, bark, leaves, and fruit peel affecting the growth performance of farm animals [11]. Negative effects of tannic acid on body weight gain and feed conversion ratio were observed in broilers studies, but the biological effect is considered to be strongly dose dependent. Martău et al. [12] declared that the plants of Vaccinium genus can be considered sources of tannins in hydrolysable and condensed types. Croitoru et al. [13] considered that the anticancer properties of walnut can be attributed to some phenolic compounds including tannic acid. Giura et al. [14] reported over 200 mg/100 g tannic acid in walnut vegetal material harvested from Romanian regions. Taking account the studies mentioned previously, we consider that the negative effects of dietary supplements on productive parameters can be attributed to the presence of tannins in the polyphenolic profile of plants, but further investigation are needed. Myoglobin is a skeletal muscle haemoprotein with essential role in oxygen storage and cellular diffusion. Being the principal heme protein, myoglobin plays a crucial role in pigmentation of meat [15]. Quality of raw meat is closely related to the color. Fresh bright red appearance is the color of oxygenated myoglobin. The lipid peroxidation is catalysed by bivalent iron which is oxidized to trivalent iron. During this process, oxymyoglobin is converted to metmyoglobin which is the indicator of the meat deterioration [16]. The maintaining the freshness of meat can be controlled by preventing the production of metmyoglobin using natural antioxidants, for example. In our study, the presence of cranberry leaves did not influence the myoglobin fractions determined. The combination between cranberry leaves and walnut meal produces a combined antioxidant effect which led to significant decrease of metmyoglobin fraction while oxymyoglobin increased accordingly.

Table 2. Effect of tested feed additives on production performances

Parameter	Control	E1	E2	SEM	P value
BWi ,g	1078	1064	1039	19.29	0.8217
BWf, g	3033[a]	2998[a]	2885[b]	48.32	<0.001
Gain, g	1955[a]	1934[a]	1846[b]	37.56	0.0065
ADG, g/day	96.48[a]	96.81[a]	92.12[b]	2.57	0.0374
ADFI, g/broiler/day	175.0	169.8	170.7	4.32	0.0869
FCR, kg feed/kg weight	1.81	1.75	1.85	-	-

BWi–initial body weight (g); BWf–final body weight (g); ADG–average daily gain (g); ADFI–average daily feed intake (g/broiler/day); FCR–feed conversion ratio (kg feed/kg weight).

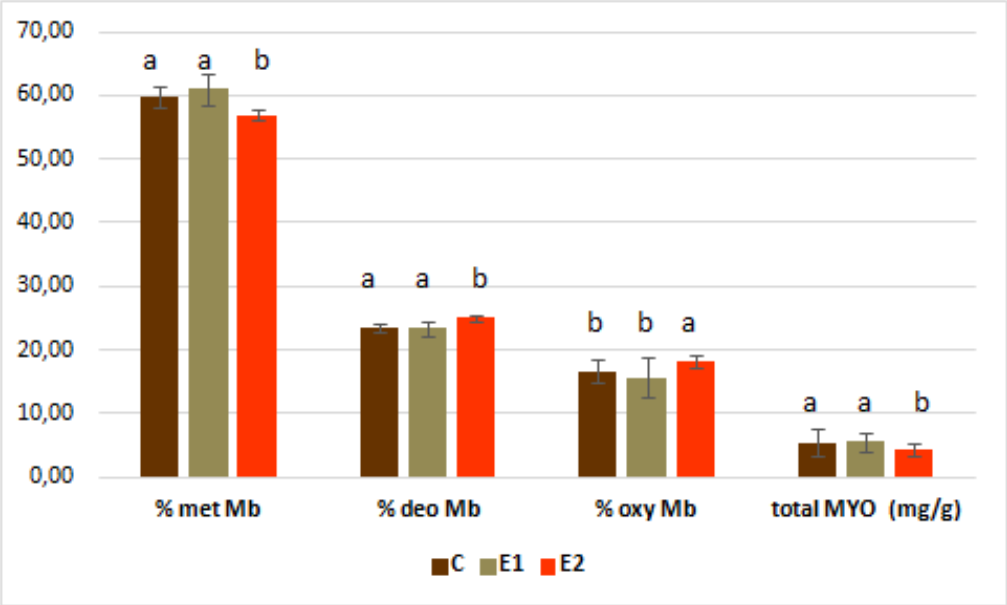

Figure 1. The myoglobin fractions determined in broiler breast meat. met Mb–metmyoglobin; deo Mb–deoxy myoglobin; oxy Mb–oxy myoglobin; MYO–myoglobin. a and b letter, mean significant differences among the groups

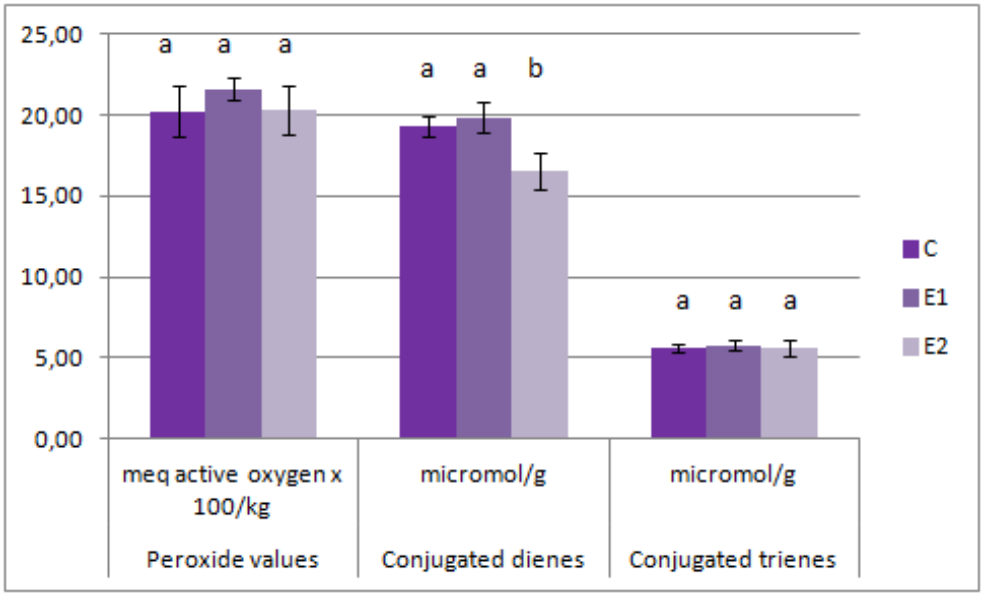

Figure 2. Primary lipid peroxidation products determined in broiler breast meat. a and b letter, mean significant differences among the groups

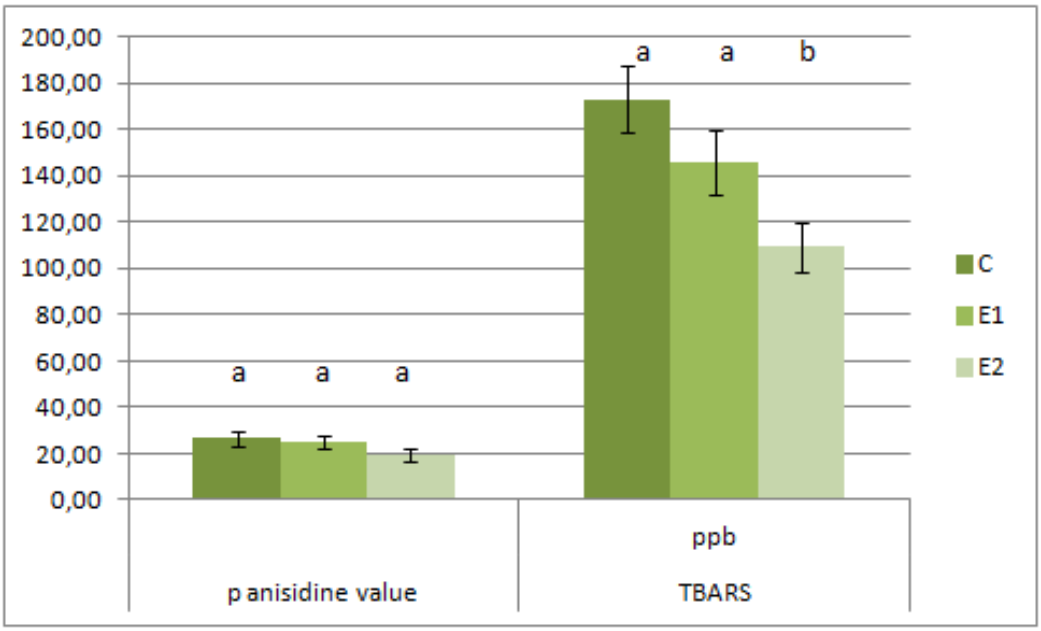

Figure 3. Secondary lipid peroxidation products determined in broiler breast meat. a and b letter, mean significant differences among the groups.

The chicken breast samples collected at the end of the experiment were analysed for evaluation of the effects of vegetable supplements on oxidative stability. The parameters considered in the evaluation of the lipid degradation of the meat samples were primary peroxidation products expressed by the peroxide index, conjugated dienes and trienes and secondary peroxidation products expressed by the para anisidine value and thiobarbituric acid reactive substances (TBARS). The results are presented in figures 2 and 3.

Regarding primary peroxidation products, the combination of cranberry leaves and walnut meal used as supplements in broilers diets decreased the conjugated dienes formation in the first phase of peroxidation. The same effect was noticed for the secondary products, with significant effects in delaying the malonaldehyde formation. The cranberry leaves seem to present effect on the last phase of peroxidation by slowing down the propagation phase, but the results did not differ significant from the control group.

A possible explanation of the effect of slowing down the occurrence of peroxidation phenomena could be the antioxidant composition of the two administered supplements. The antioxidant profile determined in the two vegetal materials [17] revealed important concentrations of flavanols and vitamin E from cranberry leaves and walnut meal is a rich source of hydroxybenzoic acids and xanthophyll's.

4. Conclusions

The results presented in the current study showed that the presence of cranberry leaves in broilers diets does not affect the performance parameters or the oxidation process occurrence. On the other hand, the combination of cranberry leaves and walnut meal affect the final body weight and the gain of broilers but at the same time the meat quality is significantly improved by delaying the oxidation process (both primary and secondary products).

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