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RESEARCH ARTICLE

The Effect of Lichen (*Xanthoparmelia somloensis*) Added in Broiler Rations on Performance Parameters and Organ Weights

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HIGHLIGHTS

> The effects of lichens on performance parameters in broiler nutrition were determined.
> Lichens can be used as a feed additive in broiler nutrition.

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ABSTRACT

In this study, it was aimed to investigate the effect of feeding broilers with lichen supplemented feed on performance parameters and organ weight. 120 male Ross 308 animals (chicks) were used in the study. Chicks were randomly divided into 3 groups with 4 replications. There were 10 chicks in each subgroup. The control group (Group C) was formed with the group fed with additive-free feed. Lichen 1 group (Group L1) included the chicks fed with lichen added at the rate of 0.1% to their feed, while lichen 2 group (Group L2) included the ones fed with lichen added at the rate of 0.05% to their feed. In the 7-14 day period of the study, the highest body weight gain (BWG) and feed intake (FI) were in group L2 while the lowest feed conversion rate (FCR) was in the control group. When the whole study was evaluated, the highest FI and BW were in group L2 while the lowest FCR was determined in the control group. Group L2 had the lowest mortality rate in the study. The hottest and coldest carcass and neck, thigh, chest and heart weights in the study were observed in Group L2. Consequently, it was found that lichens can be used as antimicrobial feed additive to broiler rations at certain rates.

Contents

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1. Introduction

One of the main goals in animal feeding is to meet the nutritional needs of animals with minimum amount of feed raw materials without damaging the health of animals, and to obtain maximum yield and product [1]. Accordingly, the usage of antimicrobial feed additives gained importance at the end of the 20th century. Especially in the poultry industry, antimicrobials are highly preferred due to their disease preventive, therapeutic and growth promoting properties [2–4]. However, as a result of the excessive usage of antimicrobials, they generated residues in many animal products and this caused the development of cross-resistance against antibiotics and adverse effects on human health [5–7].

For this reason, the usage of antibiotics as feed additives was prohibited [8, 9] Thus, many aromatic plants and mushrooms, which have been used in alternative medicine since ancient times, started to be used as organic feed additives [10]. In this process, the possibility of using lichens, which are naturally found in nature and have many biological activities, as a feed additive emerged. Lichens are organisms that can survive by combining with a symbiotic relationship in environments where fungi and algae or cyanobacteria cannot live alone [11, 12].

Lichens may contain hundreds of bioactive components in their structures. These components may have a ratio between 0.1–30% of the dry weight of lichens [13]. Additionally, lichens contain polysaccharides and macrophages [14]. In a study on broilers, it was reported that lichens have antifungal [15], analgesic [16] and anti-inflammatory [17] effects, as well as anticoccidal effects [18] thanks to these components they have. It was also shown that a polysaccharide derived from lichen has antiviral activity against yellow fever virus and RNA viruses in poultry [19]. In another study, it was reported that usnic acid is effective in treating trichomoniasis in pigeons [20]. Moreover, it was reported that usnic and vulpinic acid, which are lichen compounds, have an antimicrobial effect against some Gram-positive (*Enterococcus faecalis, S. aureus, E. faecium*) bacteria [13, 21]. Considering all these features of lichens, it was thought that they can be used in poultry both for health and as a feed additive.

In this study, the effects of powdered lichens, which were added to broiler rations, on performance parameters and organ weights were determined.

2. Materials and Methods

2.1. Animals and Management

In the study was used of 120 male Ross 308 chicks. Chicks were purchased from a commercial enterprise with vaccinations at the age of 1 day. The trial lasted 42 days. The chicks were bred for adaptation in the first 7 days of the experiment, without grouping. Then the chicks were randomly divided into 3 groups with 4 replications. There are 10 chicks in each subgroup. The chicks were housed in floor cages measuring 1.5 m x 2.5 m, littered with 8cm deep wood shavings on the floor, a hanging drinker and a feeder. The ambient temperature was set to 33°C on the first day, then it was stabilized by gradually lowering it to 23°C. During the study, water and feed were given to chicken *ad libitum*.

In the study was used *Xanthoparmelia somloensis* type lichen. Lichens were collected in Turkey's Erzurum province. Species of lichen were determined using various flora books and papers [22, 23]. The lichen dried at room temperature was powdered.

2.2. Experimental Design

The rates of lichen included in diets in the study are below the toxic effect limits [18, 24]. In the study, broilers were divided into 3 groups after 7 days of adaptation. The control group (Group C) was formed with the group fed without any feed additives in their feed (Table 1 and Table 2). Lichen 1 group (Group L1) was created by adding 0.1% lichen to feeds. Lichen 2 group (Group L2) was created by adding 0.05% lichen to feeds. Lichen was added to the feed at the rates specified in the commercial feed factory where the feed was prepared.

2.3. Performance Measurements

Chicks body weights and feed consumption were taken at the same day and time every week. Performance parameters (body weight gain and feed conversion rate) were calculated at 14, 21, 28, 35, 42 days and all of the work. Mortality was calculated between the 7th and 42nd days of the study.

2.4. Statistical Analysis

Statistical analysis was performed with SPSS package program version 20.00 with a General Linear Model. Ago group effects were tested, then post-hoc Tukey tests were used to compare group differences. Data are expressed as mean (M) ± standard deviation (SD).

Table 1 Composition of the experimental diet

Ingredients (%)	1-42 days
Maize	36.00
Full fat soybean meal	19.70
Dry soybean	17.20
Wheat	12.90
Vegetable fat	5.10
Poultry meal	3.00
Maize gluten	1.50
Meat and bone meal	2.45
DCP (Dicalcium phosphate)	0.73
Methionine	0.23
Vitamin-mineral premix	0.50
Sodium chloride	0.18
Sodium bicarbonate	0.15
Antitoxin	0.10
Choline chloride	0.09
Threonin	0.07
Lysine	0.10
TOTAL	100
C alculated Values	
Dry matter	89.20
Crude protein	22.05
Metabolisable energy (MJ/kg)	13.8
Crude fat	7.40
Crude fibre	3.78
Ca	0.88
P	0.44

Table 2 Supplied per kg of diet

Ingredient	Amount
Vitamin A	10000 IU
Vitamin E	12 mg
Vitamin D	2000 IU
Niacin	36 mg
D-pantothenic acid	10 mg
Riboflavin	3.61 mg
Pyridoxine	3.52 mg
Thiamine	2.41 mg
Folic acid	1.39 mg
Biotin	0.16 mg
Vitamin B	0.03 mg
Manganese	59 mg
Zinc	41 mg
Iron	1281 mg
Copper	7.9 mg
Iodine	0.31 mg
Selenium	0.22 mg

3. Results

In the 7-14 day period of the study, the highest body weight gain (BWG) and feed intake (FI) were in group L2, while the lowest feed conversion rate (FCR) was in the control group ($P<0.05$). In the 15-21 day period, the best body weight (BW) and BWG were observed in group L2, and the highest FI and FCR were observed in group L1 ($P<0.05$). In the 22-28 days period, the highest values of BW and BWG and FI were obtained in group L2, and FCR was obtained in group L1 ($P<0.05$). In the 29-35 day phase of the trial, the lowest BW and FCR, the highest BWG and FI were in group L1 ($P<0.05$). In the 36-42 days period, L2 had the heaviest BW while the least FI was in the control group ($P<0.05$). During this period, there was no significant difference in BWG and FCR ($P<0.05$). When the whole study (1-42 days) was evaluated, it was seen that the highest BW and FI were in group L2, while the lowest FCR was in the control group. Furthermore, the lowest mortality rate in the study was group L2 (Table 3)

Table 3 Performance parameters

	Control group	Group L1	Group L2	P
Starting weight	48.2	46.8	47.6	
7-14 days				
BW (g)	355.75±13.24	344.75±15.04	356.0±15.14	0.068
BWG (g/d)	189.38±4.17^{a}	180.38±3.58^{b}	192.50±4.84^{a}	0.041
FI (g/d)	260.87±5.21^{b}	271.87±5.11^{a}	278.66±6.47^{a}	0.027
FCR	1.38±0.03^{b}	1.51±0.04^{a}	1.45±0.03^{ab}	0.034
15-21 days				
BW (g)	700.25±21.18^{b}	693.0±20.54^{b}	723.02±19.82^{a}	0.037
BWG (g/d)	344.50±15.03^{b}	348.0±15.26^{b}	367.00±15.43^{a}	0.029
FI (g/d)	571.25±18.62^{b}	588.25±19.32^{a}	580.33±19.25^{a}	0.033
FCR	1.66±0.06^{a}	1.69±0.02^{a}	1.58±0.04^{b}	0.042
22-28 days				
BW (g)	1157.75±25.14^{b}	1090.25±26.07^{c}	1204.33±26.59^{a}	0.028
BWG (g/d)	457.50±16.81^{b}	397.25±15.23^{c}	481.33±17.08^{a}	0.035
FI (g/d)	755.75±19.47^{b}	737.0±18.51^{c}	789.67±18.79^{a}	0.021
FCR	1.65±0.04^{b}	1,85±0.03^{a}	1.64±0.03^{b}	0.032
29-35 days				
BW (g)	1616.75±28.05^{b}	1589.0±27.17^{b}	1676.0±28.84^{a}	0.019
BWG (g/d)	459±16.27^{b}	498.75±17.86^{a}	471.67±17.21^{b}	0.023
FI (g/d)	849.5±20.16^{b}	879.75±20.65^{a}	878.0±20.41^{a}	0.037
FCR	1.85±0.06^{a}	1.76±0.04^{b}	1.86±0.04^{a}	0.029
36-42 days				
BW (g)	2068.50±32.83^{b}	2052.75±32.57^{b}	2136.67±33.42^{a}	0.043
BWG (g/d)	451.75±15.73	463.75±15.33	460.67±15.81	0.087
FI (g/d)	899.50±21.49^{c}	939.75±22.58^{a}	918.0±22.88^{b}	0.027
FCR	1.99±0.08	2.03±0.12	1.99±0.11	0.062
Finishing data				
BW (g)	2068.50±32.83^{b}	2052.75±32.57^{b}	2136.67±33.42^{a}	0.043
FI (g/d)	3544.37±59.47^{b}	3691.06±59.15^{a}	3732.39±61.41^{a}	0.032
FCR	1.71±0.05^{b}	1.80±0.06^{a}	1.75±0.05^{b}	0.037
Mortality (%)	6	8	2	

Values are expressed as means±SEM. $^{a-c}$ Mean values within rows with different letters are significantly different

The hottest and coldest carcass and neck, leg, chest and heart weights in the study were in group L2, while gizzard was in the control group and liver was in group L1 ($P<0.05$). There was no significant difference in gizzard and heart weights between the groups (Table 4)

Table 4 Organ weights

	Control group	Group L1	Group L2	P
Hot carcass (g)	1585±18.20[c]	1620±18.57[b]	1722±18.61[a]	0.022
Cold carcass (g)	1556±18.03[c]	1595±17.84[b]	1696±18.27[a]	0.036
Neck weight (g)	112.75±11.44[b]	120.86±10.93[a]	125.58±11.87[a]	0.035
Leg weight (g)	586.50±10.11[b]	618.26±11.67[a]	625.00±11.34[a]	0.031
Chest weight (g)	702.11±13.71[b]	752.00±14.53[a]	759.00±14.19[a]	0.027
Liver weight (g)	42.90±1.73[b]	51.24±1.67[a]	44.82±1.82[a]	0.043
Gizzard weight (g)	48.24±1.27	47.05±1.64	46.37±1.51	0.124
Heart weight (g)	11.04±0.33	12.65±0.41	12.71±0.37	0.092

Values are expressed as means±SEM. [a-c] Mean values within rows with different letters are significantly different.

4. Discussion

Recently, with the prohibition of the usage of antimicrobials as feed additives in terms of food safety and public health, local organic plants that do not require high costs started to be used as feed additives in animal diets. Lichens have been used as medicinal plants since ancient times and have been the subject of scientific studies [25]. Studies showed that lichens are mainly composed of pigments such as chitin (in hyphal walls), pectins, polyalcohols, lichen, isolycenin, hemicellulose, disaccharides, enzymes, amino acids, algal chromophores and chlorophyll, β carotenes, and xanthophylls [26]. As secondary metabolites, many polyphenolic compounds (gallic acid, usnic acid, epigallo-catechin gallate, curcumin, quercetin, eugenol), lichestrerinic acid and polysaccharide was found in its structure [27]. These phenolic compounds give lichens a powerful antioxidant property, thus they provide intracellular antioxidant-oxidant balance. If this balance is disrupted by the increase of reactive oxygen species (ROS) formed during cellular metabolism and the inadequacy of antioxidants that detoxify them, oxidative stress occurs [28], which negatively affects the integrity and functions of cell components, causing health deterioration [29]. Furthermore, phytochemicals such as phenolics and flavonoids, which are naturally found in the structure of lichens, was reported to increase the number of beneficial bacteria (probiotic effect) that prevent the proliferation of harmful bacteria in the intestines [30–32]. Thus, it is thought that it can provide better usage of nutrients by creating a positive effect on both cellular balance and intestinal health, and consequently, it increases body weight, body weight increase and feed consumption. Guven et al. (2016) reported that as a result of the relaxation of the intestinal mucosa in broilers, lichens improved the increase in body weight and feed intake and the feed conversion rate [18].

In addition to lichens, studies have been carried out in which many medicinal and aromatic plants with antimicrobial properties are used as feed additives. These studies have also reported that tarragon, which is included in the ration, does not affect the carcass weight of the broiler [33, 34], and there are studies reporting that it increases the carcass weight [35]. In another study, while sumac berries (*Rhus coriaria L*.) and thyme (rate of 2%) (*Thymus vulgaris*) added to broiler feed reduced feed intake, it had no effect on feed conversion rate and body weight, in the same study, it was reported that the addition of sumac also reduced the carcass weight [36]. Zhu et al. (2014) showed that thyme oil has no effect on feed consumption in chickens, but increases the growth rate [37]. In another study conducted on poultry, it was found that the application of plant extract as a feed additive did not affect the increase in body weight and feed intake, and it improved the feed conversion rate [38]. In another study, it was reported that St. John's Wort (*Hypericum perforatum*) powder added to broiler feed did not have a positive effect on growth performance, but it reduced live weight [39]. In addition, it was found that there was no significant difference in performance parameters of broiler chicks fed with anise extract (*Pimpinella anisum L*.) [40] and yarrow (*Achillea millefolium*) [41] supplemented feed.

Additionally, studies in rats [42] and cattle [43] reported a positive effect on body weight gain. The data obtained in this study are consistent with the literature. Moreover, hot-cold carcass, neck, thigh and breast weights analyzed in the study increased in parallel with the increasing body weight.

It was reported that lichens have an antibacterial effect against various pathogenic bacteria. It was determined that especially usnic acid, vulpinic acid, pulvinic acid, depsidones and lichestinic acids, which are among the lichen components, have antibiotic properties. But more importantly, some lichen compounds were also found to act against bacteria resistant to some multidrug [44, 45]. *E. Faecalis*, one of the Gram-positive bacteria, causes many pathogenic conditions in poultry. In particular, it causes an increase in chick mortality rate [46], as well as pulmonary hypertension syndrome and amyloid atropia [47, 48]. However, usnic acid was reported to have a strong antibacterial effect, especially against *E. Faecalis* [13]. In a study, it was stated that a synergistic effect was tried to be generated by combining lichens with antibiotics. One of the most important features emerging from studies showed that it inhibits bacterial growth at much lower concentrations than other sources of antibiotic therapy [49, 50]. Thus, chickens, whose diets includes lichen, may have resistance to many bacterial infections, which may cause a decrease in the mortality rate in chickens. The low mortality rate in the study is considered as a reflection of this feature.

Different medicinal plant derivatives (powder, oil extract, hydraulic or organic extracts and infusion) were used on the organ weights of poultry. It has been reported that tarragon added to broiler feed has no effect on gizzard, heart and liver weights [33]. In another study using the tarragon additive diet, it was found that it did not affect intestinal length and weight, pancreatic and gizzard weights [34]. On the other hand, sumac berries (*Rhus coriaria L*.) and thyme (*Thymus vulgaris*) added to broiler feeds do not affect heart, neck and testicular weights, while sumac supplementation has been reported to be affected by the weight of the head, lungs and

kidneys [36]. In another study, it was reported that liver weight did not change in broilers fed with phytogenic extract supplemented feed [51]. Lichens were found to increase liver weight both in this study and in the study performed on rats [42]. It is thought that this result may be caused by the hepatotoxic effect of usnic acid, one of the lichen compounds, causing necrosis and causing dysfunction by affecting mitochondrial functions [52], as well as by the mobilization of lipids by the thermogenic effect of usnic acid and its accumulation on the ground tissue of the liver [42].

5. Conclusion

In conclusion, it is thought that lichens can be used in a moderate amount as feed additive to broiler rations. However, since the properties of lichens depend on the compounds they contain, it should be kept in mind that these compounds can change under the influence of many factors, including the geographical origin of the lichen, sampling time, drying and extraction method. Much more scientific studies are needed so that lichens can be used as the feed additives in poultry.

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This study was conducted in accordance with ethical norms approved by Atatürk University Experimental Animal Education and Research Center Ethics Committee (No: 2011/181).

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