USE OF BROMASS IN BROILER RATIONS AS A DIFFERENT PROTEIN SOURCE

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Abstract: In this study, we aimed to determine the effects of betaine-enriched β-vinasse (Bromass) on body weight, body weight gain, feed intake, feed conversion rate, carcass yield, litter quality, blood serum Ca, P and cholesterol and broiler performance index. A total of 600 Ross-308 broiler chicks were used in the experiment, and the chickens were divided into the following 4 main groups: Control (0 g/kg Bromass), Group I (5 g/kg Bromass), Group II (30 g/kg Bromass), and Group III (60 g/kg Bromass). Additionally, each of the main groups was divided into 10 subgroups of 15 chickens each. The trial lasted for 42 days. Supplementation with Bromass (5, 30 and 60 g/kg) caused significant ($p<0.05$) increases in the average body weight, body weight gain, feed intake, feed conversion rate, carcass weights and carcass yield. Additionally, bromass supplementation caused more dry litter at a significant level ($p<0.01$) and significant ($p<0.05$) decrease in serum cholesterol concentration. The addition of bromass to broiler diets resulted in a significant decrease in feed prices ($p\leq0.001$) and an important increase ($p<0.05$) in the broiler performance index values. At the end of the study, we concluded that the addition of Bromass as a different protein source, especially at the 30 g/kg level, caused positive effects and bromass makes it possible to produce a more profitable broiler.
Key Words: Betaine, broiler, bromass, cholesterol, performance, protein source,

Introduction

Feed cost in production, including in the poultry sector, is one of the most important factors affecting profitability. It is not possible to produce and consume cheap chicken meat unless the feed problem in poultry production is solved. For this reason, methods for utilizing all types of feed sources should be investigated. Utilizing by-products as alternative feeds for animals an attractive possibility due to enhanced environmental and economic concerns because most food by-products pose problems in areas of environmental protection.

Molasses is used directly as an animal feed or to obtain different fermentation products (yeast, ethyl alcohol, lysine and betaine). Another fermentation product of molasses is vinasse (Bilal et al., 2001). The chemical composition of vinasse is 48% nitrogen compounds, 10% betaine, and 5-18% potassium. Therefore, vinasse can be used as an animal feed ingredient and a source of nutrients and minerals (Lopez et al., 2011). These levels may vary according to processing conditions and extraction methods. With traditionally produced vinasse, high humidity, potassium and NPN compounds are the major factors that limit its use in poultry. However, with Beta-Vinasse (β-Vinasse), which is produced by Integro (Pak Food Production and Marketing Inc., Kocaeli, Turkey), the high potassium level, which inhibits the use of conventionally produced vinasse, has been reduced to 2% using physicochemical techniques, and the betaine content has been purified. Due to the betaine in the β-Vinasse structure, β-Vinasse has gained importance as a valuable additive in poultry feed. In animal nutrition, betaine is widely discussed as a 'carcass modifier' due to its lipotropic and growth-promoting effects (Eklund et al., 2005). Hassan et al. (2005) suggested that supplementation with betaine at approximately 3-5% in diets with adequate methyl group donors improves weight gain and feed efficiency. Additionally, the high moisture content of β-Vinasse is absorbed into sunflower seeds at a rate of 45-55%, and the result is then dried with a special process to obtain the product termed "Bromass". Thus, the dry matter level is increased to 94% in the Bromass product. Here, we added this product to broiler rations to provide original quality research.

In this study, we aimed to investigate the effects of the addition of Bromass (β-vinasse impregnated with sunflower seeds) to broiler rations as a different protein source on performance parameters, carcass parameters, blood serum parameters, litter quality and economical evaluation parameters.

Material and Methods

Animals, diets and experimental design

A total of 600 Ross 308 male broiler chicks were obtained from the Uludag University Animal Health and Production, Research and Application Centre of broiler breeding (Bursa, Turkey). The study protocol was approved by Ethics Committee of Uludag University (HADYEK decision no: 2016 -16/ 03). One-day-old chicks were obtained from a local hatchery and divided into 4 groups of 150 birds each. The chicks were individually weighed and distributed into 40 floor pens with 15 chicks per pen. Each 2.0x1.2 m floor pen was furnished with wood shaving litter. Fluorescent lamps provided 23 hours of continuous light per day. The chickens were vaccinated against infectious bronchitis and Newcastle disease (Nobilis MA5+Clone30) at 9 days of age and against Gumboro disease at 23 days of age. The experiment lasted for 42 days.

The formulations were adjusted according to phase-feeding practices (three basal diets) as the chickens advanced in age and weight and as established by the breeder (Ross 308). The basal diets were mixed under commercial conditions as one batch, divided into respective parts and then supplemented with Bromass by means of a horizontal mixer. The provided diets were prepared isocalorically (3030-3200 kcal/kg of diet) and isonitrogenously (22.38-19.43% crude protein). Diets were formulated to meet or exceed the requirements of the National Research Council (1994) for broilers at this age. The feeds and water were provided for *ad libitum* consumption. The ingredients and chemical compositions of the basal diets are presented in Table I. The chemical composition of β-vinasse is presented in Table 2. No antibiotics or growth promoters were added to any of the treatment diets. The experimental diets were chemically analyzed according to the methods of the Association of Official Analytical Chemists (2000). The metabolizable energy (ME) levels of the diets were estimated using the equation of Carpenter and Clegg (2001): ME (kcal/kg) = 53+ 38 [(CP, %) + (2.25 x ether extract, %) + (1.1 x starch, %) + (1.05 x sugar, %)]. In the study, the feeding program consisted of a starter diet until 21 d of age, a grower diet until 35 d of age and a finisher diet until 42 d of age. The birds were fed either a basal diet (control group) or the basal diet with bromass supplementation at doses of 5 (0.5%, Group I), 30 (3.0%, Group II), or 60 (6.0%, Group III) g/kg feed.

Table 1. Ingredients (g/kg) and chemical composition of the broiler rations

STARTER				
	CONTROL	**GROUP I**	**GROUP II**	**GROUP III**
Ingredients %				
Corn	53.64	53.64	52.76	51.70
Soybean meal	28.62	28.12	25.62	22.63
Full fat soybean	10.30	10.30	11.08	11.95
Corn Gluten	1.33	1.33	1.33	1.53
Vegetable oil	1.80	1.80	1.85	1.96
Bromass[3]	-	0.50	3.0	6.00
Dicalcium phosphate	1.95	1.95	1.96	1.99
Limestone	0.9	0.90	0.90	0.90
Salt	0.25	0.25	0.25	0.16
Vit-Min Premix[1]	0.25	0.25	0.25	0.25
DL-Methionine	0.34	0.34	0.34	0.20
L-Threonin	0.10	0.10	0.10	0.12
L-Lysin HCl	0.21	0.21	0.24	0.28
Sodium bicarbonate	0.10	0.10	0.10	0.10
Cholin chloride 60	0.11	0.11	0.12	0.13
Anticoccidial	0.10	0.10	0.10	0.10
Analysed concentration, %				
Crude Protein	22.38	22.36	22.32	22.37
Ether extract	6.62	6.60	6.65	6.55
Saccharose	4.66	4.65	4.70	4.78
Starch	38.03	38.59	38.59	38.22
Dry matter	90.88	90.54	90.07	90.23
Ash	10.19	10.42	9.86	9.86
Calcium	1.06	1.15	1.15	1.07
Total Phosphorus	0.73	0.78	0.78	0.71
Metabolisable energy (MJ/kg)	12.68	12.67	12.69	12.67

GROWER				
Ingredients %				
Corn	54.42	54.39	54.00	53.02
Soybean meal	18.03	17.53	15.03	12.03
Full fat soybean	14.00	14.00	14.10	14.50
Corn Gluten	2.70	2.70	2.98	3.38
Wheat	4.42	4.42	4.42	4.41
Vegetable oil	2.75	2.75	2.75	2.90
Bromass[3]	-	0.50	3.00	6.00
Dicalcium phosphate	1.61	1.61	1.65	1.69
Limestone	0.82	0.82	0.80	0.78
Salt	0.20	0.20	0.14	0.07
Vit-Min Premix[1]	0.25	0.25	0.25	0.25
DL-Methionine	0.16	0.16	0.15	0.16
L-Threonin	0.12	0.13	0.15	0.16
L-Lysin HCl	0.17	0.18	0.22	0.27
Sodium bicarbonate	0.17	0.17	0.17	0.17
Cholin chloride 60	0.08	0.09	0.09	0.11
Anticoccidial	0.10	0.10	0.10	0.10
Analysed concentration, %				
Crude Protein	20.42	20.25	20.82	20.92
Ether extract	8.94	8.08	7.56	7.28
Saccharose	5.30	5.88	5.88	5.14
Starch	38.73	40.30	40.80	41.85
Dry matter	90.33	90.35	90.27	90.58
Ash	8.58	9.27	8.58	9.77
Calcium	0.78	0.78	0.78	0.79
Total Phosphorus	0.65	0.65	0.66	0.66
Metabolisable energy (MJ/kg)	13.37	13.39	13.38	13.39
FINISHER				
Ingredients g/kg				
Corn	62.23	62.21	61.55	61.11
Soybean meal	14.50	14.00	11.50	8.62
Full fat soybean	14.41	14.43	14.40	14.60
Vegetable oil	2.00	2.00	2.10	2.20
Corn Gluten	3.23	3.23	3.82	3.82
Limestone	0.80	0.80	0.80	0.76
DCP 18	1.56	1.56	1.60	1.65
DL methyonine 99	0.13	0.13	0.13	0.13
L-Lysin	0.18	0.18	0.23	0.29
Salt	0.20	0.20	0.20	0.12
Sodium bicarbonate	0.20	0.20	0.10	0.10
Vit-Min Premix[2]	0.25	0.25	0.25	0.25
Cholin chloride 60	0.09	0.09	0.10	0.11
L-threonine	0.12	0.12	0.12	0.14
Vit-E	0.10	0.10	0.10	0.10
Bromass[3]	0.00	0.50	3.00	6.00
Analysed concentration, g/kg				
Crude Protein	19.49	19.78	20.28	19.43
Ether extract	7.75	7.45	7.68	7.66
Saccharose	5.60	5.80	4.42	5.42
Starch	41.60	42.00	42.00	42.10
Dry matter	91.63	89.85	90.28	89.96
Ash	8.79	9.93	8.85	7.86
Calcium	0.76	0.75	0.75	0.78
Total Phosphorus	0.62	0.62	0.65	0.66
Metabolisable energy (MJ/kg)	13.34	13.37	13.35	13.36

[1] R.124 STR.VM: Per 2.0 kg premix contains; Vit A 12 500 000 IU, Vit D_3 4 000 000 IU, Vit E 125 000 mg, Vit K_3 3 000 mg, Vit B_1 2 700 mg, Vit B_2 7 000 mg, Vit B_6 4 000 mg, Vit B_{12} 20 mg, Vit C 66 000 mg, Niacine 60 000 mg, Calcium d-pantothenate 15 000 mg, Folic acid 1 500 mg, Biotin 150 mg, Mn 75 000 mg, Fe 15 000 mg, Zn 60 000 mg, Cu 10 000 mg, Co 200 mg, I 1 200 mg, Organic Se 150 mg, Se 150 mg, Crina Poultry Plus 300 000 mg, Fitase 1 000 000 FTU, Xylanase 270 000 U, Beta-Glucanase 80 000 U, Fungal-1.3-B-Glucanase 70 000 U

[2] R.124 GRO. VM: Per 2.0 kg premix contains; Vit A 12 500 000 IU, Vit D_3 3 000 000 IU, Vit E 60 000 mg, Vit K_3 3 000 mg, Vit B_1 2 700 mg, Vit B_2 7 000 mg, Vit B_6 4 000 mg, Vit B_{12} 20 mg, Niacine 40 000 mg, Kalsiyum d-pantothenate

15 000 mg, Folic acid 1 500 mg, Biotin 150 mg, Mn 75 000 mg, Fe 45 000 mg, Zn 60 000 mg, Cu 10 000 mg, Co 200 mg, I 1 200 mg, Organic Se 150 mg, Se 150 mg, Crina Poultry Plus 160 000 mg, Fitase 1 000 000 FTU, Xylanase 270 000 U, Beta-Glucanase 80 000 U, Fungal-1.3-B-Glucanase 70 000 U

[3] Bromass: Contains 45% β-Vinas 55% Sunflower meal (%36 HP)

Table 2. Nutrient Composition of Bromass and β-Vinasse

NUTRIENTS		BETA VINASSE	BROMASS
Dry matter	%	63.0	94.0
Crude Protein	%	22.30	36.50
Crude ash	%	11.00	10.50
Metabolisable Energy	MJ/kg	3.91	9.12
Crude cellulose	%	0.80	10.20
Lysine	%	0.137	0.90
Meth&Cys	%	0.032	1.00
Methionine	%	0.032	0.50
Threonine	%	0.169	1.00
Valine	%	0.206	1.30
Isoleucine	%	0.136	1.00
Arginine	%	0.061	2.00
Tryptophan	%	0.0392	0.30
Calcium	%	0.0276	0.30
Total Phosphorus	%	0.0537	0.70
Sodium	%	1.41	0.90
Potassium	%	2.05	1.80
Betaine	%	20.00	11.10
D.Lysine	%	0.086	0.41
D.Meth&Cys	%	0.20	0.48
D.Methionine	%	0.21	0.29
D.Threonine	%	0.105	0.43
D.Valine	%	0.130	0.58
D.Isoleucine	%	0.084	0.62
D.Arginine	%	0.039	1.05
D.Tryptophan	%	0.024	0.25

Performance parameters

The chicks were weighed individually at the beginning of the experimental period, after which the animals were weighed weekly to calculate the body weight gain (BWG). Mortalities were recorded as they occurred. Feed consumption (FC) was recorded weekly and is expressed as kg per chicks per week. The feed conversion ratio (FCR) was calculated as kg feed per kg body weight gain. At the end of the study, to determine the carcass yield (CY), 50 male animals from each group (a total of 200 animals, 5 from each subgroup) were weighed and slaughtered under commercial conditions. The hot carcass weight was taken as the weight of the carcass after processing. The cold carcass weight was taken as the weight of the carcass after it was kept for 18 h at 4 ^{0}C. The hot and cold CY were calculated by dividing the carcass weights (CW) by the body weights.

Determinations of the European Production Efficiency Factor (EPEF) and the European Broiler Index (EBI)

For the analysis of performance indicators, including the BWG, average daily gain (ADG), FCR, viability, EPEF and EBI, the following formulas were used:

BWG (grams on period) = BW (g) at the end period - BW (g) in first d;

ADG (g/chick/d) = BWG/number of days in the growth period;

FCR (kg feed/kg gain) = cumulative feed intake (kg)/total weight gain (kg);

Viability (%) = chicks remaining at the end of the period (%);
EPEF= [BW (kg) x viability (%) / FCR (kg feed/kg gain) x age (42d)] x100;
EBI= (ADG (g/chick/d) x viability (%)) / (10 x FCR (kg feed/kg gain)).

Determination of serum biochemical values
At the end of the sixth week of the experiment, 10 birds from each pen were selected randomly, and serum samples were taken from the neck vein by puncture and drawn into Vacutainer tubes. Blood samples were collected in glass serum-collecting tubes. The blood samples were then centrifuged at 3000 rpm for 10 min. Serum Ca, serum P, cholesterol were measured by means of commercial kits.

Determination of Litter Dry Matter
Litter samples were taken from each replicate group, and dry matter analyses were performed. Litter quality was assessed in a series of samples that were obtained from five different points located at the edges and in the center of each compartment. A designated cylindrical sampler, which was 30 cm long and 8 cm in diameter, was used to obtain vertical core samples of the litter. Each sample was put in a polyethylene bag that was sealed and temporarily kept in a portable refrigerator until it was transferred to the laboratory for analyses. The analyses of the litter samples were performed immediately when the samples arrived at the laboratory of Animal Nutrition and Nutritional Disease Veterinary Faculty of Uludag University of Turkey. Following the AOAC Analytical Methods (2000), the moisture content was determined for each individual sample. The moisture contents (%) of the samples were determined by drying them at 105°C to a constant weight.

Statistical analyses
The statistical analyses were performed with the SPSS (1997) software package (SPSS Inc., Chicago, IL, USA) for Windows. Variance analysis was used to determine the significance of the differences between the statistical calculations for the groups and the mean values of the groups, Tukey tests were used as post hoc tests, and the level of significance used in all of the tests was $p<0.05$. The results are expressed as the means ± the standard errors of the mean.

Results and Discussion

The present study was conducted to investigate the effects of different levels of Bromass on the performance parameters, carcass parameters, blood serum parameters, litter quality and economical evaluation parameters of broiler chickens. The ingredients and chemical compositions of the diets are presented in Table 1. The nutrient compositions of Bromass and β-Vinasse are presented in Table 2. In summary, the β-vinasse used in this research contained 63% dry matter, 22.3% crude protein, 11% crude ash, 20% betaine and 2.05% potassium. These levels may vary according to processing conditions and extraction methods. The dry matter level was raised to 94% with the Bromass product. Bromass, which was added to the broiler rations in this study, contains 36.5% crude protein, 10.5% crude ash, 11.1% betaine and 1.8% potassium.

The results concerning the effects of Bromass on broiler performance are presented in Table 3. At the beginning of the study, there were no differences in the BW of the animals in the experimental groups. This situation demonstrates that the animals in the experimental groups were homogeneously distributed in terms of body weights. In this study, significant differences ($p<0.05$) in BW and BWG were observed. Specifically, bromass at 30 mg/kg caused a significant increase in BW and BWG during the growing and finishing periods. When we performed assessments across the overall duration of the study (1-42 days), the addition of the high level of bromass resulted in a significant ($p<0.05$) decrease in feed consumption value. In this study, significant differences ($p=0.000$) in feed conversion values between the control and experimental groups were identified in the 1-42 d period (Table 3). The best feed conversion rate in the study was observed in the group in which 30 g/kg (group II) of bromass was added to the ration. Bilal et al. (2001) determined that the effect of the addition of 2.5% vinasse to broiler diets on weight gain was significant ($p<0.05$) from 7 to 14 and 14 to 21 days of age. No difference was observed in the 35-d body weights due to vinasse feeding at the 2.5 or 5% levels. Additionally, neither the feed intake nor the feed conversion of the broilers was influenced by the treatments. The use of vinasse as a feed additive in poultry and pigs has been reported on by Stemme et al. (2005), who demonstrated an influence of this additive on animal performance. The positive effects of the addition of β-vinasse are due to its contents of yeast walls (polysaccharides and beta-glucans), minerals and B-complex vitamins. These compounds, which have been found to increase the efficiency of the utilization of nutrients, can exert effects on the immune systems of the chicken and cause the exclusion of pathogens at the digestive measurement, which therefore, produces better performing birds.

Table 3. Effects of Bromass supplementation on average body weight, body weight gain, feed intake and feed conversion rate in broiler chicks

	Control	Group I	Group II	Group III	*P*
			Average Body weight (g)(n=150)		
1 day	47.67 ± 0.32	47.25 ± 0.30	47.31 ± 0.30	46.75 ± 0.28	0.185
7 day	162.39^{b} ± 1.73	167.65^{ab} ± 1.68	171.65^{a} ± 1.47	170.64^{a} ± 1.53	0.000
14 day	432.07^{b} ± 4.06	439.33^{ab} ± 4.56	449.19^{a} ± 3.84	443.74^{ab} ± 4.11	0.028
21 day	837.57 ± 8.60	848.35 ± 9.61	859.00 ± 8.38	863.59 ± 8.20	0.149
28 day	1371.55 ± 16.60	1392.41 ± 16.74	1407.17 ± 16.15	1399.11 ± 14.30	0.432
35 day	1971.27^{b} ± 24.05	2027.44^{ab} ± 25.49	2062.62^{a} ± 17.88	2028.19^{ab} ± 20.40	0.034
42 day	2605.70^{b} ± 21.78	2644.41^{ab} ± 33.37	2738.72^{a} ± 25.92	2650.16^{ab} ± 25.91	0.019
			Body weight Gain (g)(n= 150)		
1-7 day	114.77^{b} ± 1.46	120.51^{a} ± 1.53	124.35^{a} ± 1.23	123.96^{a} ± 1.31	0.000
7-14 day	269.68 ± 2.70	272.06 ± 3.78	277.89 ± 2.65	273.11 ± 2.75	0.264
14-21 day	406.01 ± 5.27	409.02 ± 5.66	410.16 ± 4.99	419.85 ± 4.56	0.252
21-28 day	533.98 ± 8.89	545.32 ± 8.26	548.17 ± 8.62	537.30 ± 6.92	0.577
28-35 day	604.84^{b} ± 10.78	635.02^{ab} ± 9.99	658.81^{a} ± 7.29	629.08^{ab} ± 7.57	0.000
35-42 day	652.14^{b} ± 12.96	616.97^{b} ± 9.76	716.44^{a} ± 14.00	643.77^{b} ± 11.50	0.000
1-42 day	2558.02^{b} ± 27.90	2597.39^{ab} ± 33.14	2692.27^{a} ± 25.71	2603.83^{ab} ± 25.70	0.010
			Feed Intake (g) (n=10)		
1-7 day	218.46^{a} ± 19.12	162.60^{b} ± 5.55	165.70^{b} ± 4.52	159.07^{b} ± 6.72	0.001
7-14 day	482.17^{a} ± 18.05	427.60^{ab} ± 13.47	416.74^{b} ± 12.16	467.55^{ab} ± 12.98	0.007
14-21 day	641.83 ± 30.01	607.66 ± 7.43	604.59 ± 9.10	691.12 ± 38.30	0.533
21-28 day	955.79 ± 12.73	972.20 ± 18.99	967.78 ± 20.48	955.80 ± 18.18	0.881
28-35 day	1225.90 ± 23.90	1218.64 ± 16.79	1206.85 ± 18.94	1186.20 ± 17.00	0.501
35-42 day	1481.13 ± 16.11	1473.25 ± 23.28	1441.62 ± 17.95	1412.29 ± 18.67	0.060
1-42 day	5005.28^{a} ± 31.00	4861.65^{ab} ± 64.73	4803.28^{b} ± 53.65	4772.02^{b} ± 55.08	0.017
			Feed Conversion Rate (kg/kg) (n=10)		
1-7 day	1.90^{a} ± 0.16	1.36^{b} ± 0.06	1.33^{b} ± 0.02	1.28^{b} ± 0.06	0.000
7-14 day	1.79^{a} ± 0.86	1.58^{ab} ± 0.07	1.50^{b} ± 0.04	1.71^{ab} ± 0.05	0.008
14-21 day	1.58 ± 0.52	1.49 ± 0.02	1.48 ± 0.03	1.42 ± 0.10	0.295
21-28 day	1.80 ± 0.03	1.78 ± 0.03	1.77 ± 0.04	1.79 ± 0.05	0.957
28-35 day	2.05^{a} ± 0.09	1.92^{ab} ± 0.01	1.84^{b} ± 0.04	1.89^{ab} ± 0.03	0.050
35-42 day	2.29^{a} ± 0.08	2.39^{a} ± 0.04	2.01^{b} ± 0.06	2.22^{ab} ± 0.09	0.005
1-42 day	1.96^{a} ± 0.03	1.87^{b} ± 0.01	1.78^{c} ± 0.04	1.84^{bc} ± 0.07	0.000

[a, b, c] Different superscripts in each row shows the significant difference between the groups *P<0.05 **P<0.01 ***P≤0.001

The effects of dietary treatment on carcass weight, carcass yield, litter dry matter and mortality are presented in Table 4. Significant differences (p< 0.05) between the control and experimental groups were observed in the parameters of carcass value (carcass weight and carcass yield).

Additionally, bromass addition to the broiler rations at the 30 and 60 g/kg levels caused a significant increase (p=0.002) in the dry matter of the litter. It should be remembered that the bromass additive was used as a betaine source. Rodriguez et al. (2013) determined that the carcass weights and carcass yields of birds on diets that included 30% vinasse torula yeast were lower than those birds that received 10% supplementation, although the 30% group did not differ from the control group or a group that received feed with 20% supplementation. When using vinasse as an additive (5 mL during the starter, 10 mL during the grower, and 15 mL during the finisher phases), vinasse provoked greater carcass weight (1087 and 1242 g/bird) (Hidalgo et al., 2009).

Table 4. Effects of Bromass supplementation on carcass characteristics, litter dry matter, mortality rate in broiler chicks

	Control	Group I	Group II	Group III	P
Final body weight (g)	2715.28^{b} ± 66.41	2944.50^{a} ± 44.19	2990.28^{a} ± 34.03	2933.40^{a} ± 30.64	0.000
Hot carcass weight (g)	2013.14^{b} ± 50.83	2212.64^{a} ± 32.66	2264.18^{a} ± 26.09	2221.80^{a} ± 23.91	0.000
Cold carcass weight (g)	1962.80^{b} ± 52.28	2186.48^{a} ± 32.64	2232.92^{a} ± 25.83	2194.00^{a} ± 22.89	0.000
Carcass yield (%)	72.42^{b} ± 0.90	74.28^{ab} ± 0.22	74.69^{a} ± 0.27	74.83^{a} ± 0.33	0.003
Carcass Shrink (%)	2.67^{a} ± 0.33	1.19^{b} ± 0.08	1.38^{b} ± 0.06	1.23^{b} ± 0.08	0.000
Litter dry matter (%)	22.56^{b} ± 1.95	31.63^{ab} ± 1.90	35.82^{a} ± 0.68	34.17^{a} ± 3.98	0.002
Mortality (%)	2.67 ± 1.09	3.34 ± 1.49	3.34 ± 1.49	2.67 ± 1.09	0.967

[a, b, c] Different superscripts in each row shows the significant difference between the groups *P<0,05 **P<0,01 ***P≤0.001

Similar to the present study, increased carcass yield following betaine supplementation has been reported in broilers (Virtanen and Rosi, 1995; Firman et al., 1999; Mcdevitt et al., 2000; Wang, 2000). It would be ideal to optimize the quantity of supplemental DL-methionine with betaine, which has a positive influence on carcass meat yield (Mcdevitt et al., 2000; Waldroup, 2006). In the poultry sector, controlling litter moisture is essential for the maintenance of animal health, welfare and production performance. Some feed additives are used with the objective of directly drying litter moisture by maintaining the water balance of the birds. Osmolytes, such as betaine, affect the water balance or osmotic pressure of cells and tissues by regulating the movement of water through the cell. When poultry diets are supplemented with betaine, it is quickly absorbed by intestinal cells and balances the osmotic pressure of the gut, which contains high concentrations of inorganic salts after a meal (Trott, 2013). In other words, water loss is reduced, and the integrity of the intestinal cells is maintained. Betaine seems to be effective at maintaining intestinal water balance and drying poultry litter. In the present study, the addition of bromass to the broiler ration improved the quality of the litter by providing a stable intestinal water balance.

The results concerning the effects of Bromass on some blood parameters are presented in Table 5. In this study, the serum calcium and phosphorus levels were not affected by the levels of bromass in the broiler diets. In contrast, bromass supplementation significantly (p<0.01) decreased the serum cholesterol concentrations. The decreased cholesterol concentrations were 197.12, 190.40 and 186.95 in the broilers fed the diets supplemented with 5, 30 and 60 g/kg bromass, respectively, compared to the control (199.27). These results may have been due to betaine, which plays a major role in lipid metabolism, which in turn is associated with enhanced synthesis of methylated compounds in the liver and muscle including carnitine and creatine (Zhan et al., 2006). Carnitine functions in the transport of long-chain fatty acids across the inner membrane of the mitochondria where fatty acid oxidation occurs, and thus carnitine has a role in the regulation of fat metabolism (Wang et al., 2004). Accordingly, increased hormone-sensitive lipase activity (Zhan et al., 2006) following dietary betaine supplementation results in reduced lipid deposition (Eklund et al., 2005). These results are in agreement with those obtained by Jahanian and Rahmani (2008) who found that betaine enhances lipase activity and decreases the concentrations of plasma triglycerides and cholesterol in broilers and ducklings (Awad et al., 2014).

Table 5. Effects of Bromass supplementation on some blood serum parameters.

Parameters	Control			Group I			Group II			Group III			P
Cholesterol, mg/dL	199.27 [a]	±	2.96	197.12 [a]	±	1.79	190.40 [ab]	±	2.58	186.95 [b]	±	2.57	0.002
Calcium, mg/dL	7.93	±	0.18	7.64	±	0.34	6.71	±	0.49	6.77	±	0.28	0.068
Phosphorus, mg/dL	4.89	±	0.21	5.09	±	0.16	5.26	±	0.18	5.51	±	0.18	0.117

[a, b, c] Different superscripts in each row shows the significant difference between the groups *P<0,05 **P<0,01 ***P≤0,001

The effects of bromass on the economically relevant parameters of the broilers in the trial groups are presented in Table 6. In this study, differences in the total feed consumption, feed cost, average body weight, EPEF and EBI economic parameter were determined to be statistically significant. For the overall experimental period (1 to 42 d), the bromass supplemented broilers ate less feed (P<0.05), required lower feed costs (P<0.01) and reached greater body weights (P<0.05). Production efficiency was assessed using the EBI and EPEF. The best EPEF and EBI values in this study were observed in the experimental groups that received feed with added bromass.

Table 6. Economic Evaluation of Trial Groups

Parameters	Control			Group I			Group II			Group III			*P*
TFC, g/chick	5005.28 [a]	±	31.00	4861.65 [ab]	±	64.73	4803.28 [b]	±	53.65	4772.02 [b]	±	55.08	0.017
FC,€/chick	1.51[a]	±	0.009	1.46[ab]	±	0.019	1.44[b]	±	0.016	1.41[b]	±	0.016	0.001
ABW, kg/chick	2605.70[b]	±	21.78	2644.41[ab]	±	33.37	2738.72[a]	±	25.92	2650.16[ab]	±	25.91	0.019
EPEF Value	309.86[b]	±	12.08	326.11 [ab]	±	5.06	353.07 [a]	±	5.48	335.38[ab]	±	9.66	0.010
EBI Value	304.21[b]	±	11.94	320.29[ab]	±	4.97	346.98[a]	±	9.56	329.48[ab]	±	5.43	0.009

Feed prices has been calculated taking into consideration the T.C. Central Bank's exchange rate dated 25.11.2016 (1 Euro=3,64₺).
(TFC) Total Feed Consumption; (ABW) Avarage Body weight; (FC) Feed Cost
(EPEF) European Production Efficiency Factor = Body weight (kg) x Viability (%) / FCR (kg feed/kg gain) x Age (42 d)
(EBI) European Broiler Index = (Avarage Daily Gain (g/chick/d) x Viability (%)) / (10xFCR (kg feed/kg gain))

Betaine supplementation may stimulate protection of the intestinal epithelium against osmotic disturbances and improve digestion, absorption and nutrient utilization in broiler chickens (Mahmoidnia and Madani, 2012). Betaine supplementation of diets with adequate methyl group donors improves weight gain and feed efficiency by approximately 3-5% (Hassan et al., 2005). Ezzat et al. (2011) found that economic efficiency was improved by betaine supplementation in the Matrouh poultry strain from 24-36 weeks of age under hot Egyptian summer conditions. Zayed (2012), reported that the economic efficiency was increased by feeding turkeys a diet supplemented with 0.75 or 1.5 g betaine/kg in summer conditions.

Conclussion

Particularly in recent years, the spread of genetically modified soy varieties has increased the demand for natural and different protein sources. If all of the yield characteristics are taken into consideration, it is possible to safely use Bromass, which is obtained by special methods, at up to 6% in broiler rations as a performance enhancer different protein source. Moreover, we conclude that the use of Bromass at the 3% level in broiler ratios facilitated the development of chickens by optimizing the use of nutrients in the rations and thus provided an economic benefit.

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