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Effects of Saponin and L-Carnitine on the Performance and Reproductive Fitness of Male Broiler

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Abstract: A factorial bioassay was made to evaluate 4 different levels of exogenous saponin (S); 0 mg (S_0), 25 mg (S_1), 50 mg (S_2) and 75 mg (S_3) per kg and also a combination (SC) of 50 mg saponin plus 50 mg L-carnitine (S_4) per kg maize-soybean meal based basal diet during the late autumn. In all, 5 experimental diets being iso-nutritive (as per NRC, 1994 recommendation) but for variable in presence and contents of saponin and L-carnitine were prepared. 8-day old male broiler chicks (n=150, Starboro) were distributed randomly into 15 groups of 10 chicks in each housed in separate pen of littered floor. Three such groups received each of 5 test diets *ad libitum* as mash up to 8 weeks of age. The plenty of water was made available to all chicks during the experimental period. It was found that S_2 diet significantly improved body weight gain (BWG) during growing (8 days to 3 weeks) period when compared with S_0, S_1, S_3 and S_4. Dietary S and SC had no significant ($p>0.05$) effect separately and jointly on feed efficiency, protein efficiency and performance index. But S_3 and S_4 diets reduced abdominal fat significantly ($p<0.05$), while only S_3 significantly ($p<0.05$) increased tastes weight. S and SC added all diets significantly ($p<0.05$) reduced liver, gizzard and thyroid size with little enlargement of spleen size compared to S_0 fed group. Finally, it was concluded that 75 mg (S_3) per kg exogenous saponin could be used as feed additive in broiler diet to improve growth and carcass quality.

Key words: Saponin, L-carnitine, broiler, efficiency and dressing yield

Introduction

Saponins are steroidal glycosides occur widely in plants that are consumed by animals and human (Johnson *et al*., 1986; Hostettmann and Marston, 1995). Regarding biological value, saponin has been categorized as antinutritional agent in most cases. Sometimes, it has been claimed to reduce feed intake, inhibit growth rate of swine and poultry and show toxicological effects with higher levels in diets. Surprisingly, it has the potential as dietary additive with optimum level in diet favoring higher growth rate, better feed efficiency (Yejuman *et al*., 1998), lower serum cholesterol level (Udea and Shigemizu, 1998) and reducing the emission of ammonia from animals' excreta (Jonhston *et al*., 1981; Al-Bar *et al*., 1993). Saponins from variety of sources have also been shown to assist the absorption of nutrients by increasing the permeability of the small intestinal mucosa (Seeman *et al*., 1973). Recently, some medicine companies are marketing saponins as feed additive in poultry production. Scientists are putting their efforts to make saponin as an important additive rather than challenge for better and economic poultry diet formulation.

On the other hand, L-carnitine (γ-trimethylamino β-hydroxy butyrate) is an essential precursor for lysine and methionine synthesized in *de movo of* brain, liver and kidneys. L-carnitine has the profound effect on fat metabolism (Olson *et al*., 1989) and most of the broiler rations are deficient of it containing higher percentage of cereals resulting a barrier for optimum metabolic requirement (Baumgartner and Blum, 1997). Insufficient dietary L-carnitine may cause excess abdominal fat in briolers. Low serum carnitine level also alters lipid metabolism. L-carnitine has also found to be an agent for improved growth, better feed efficiency, more breast meat yield and lower abdominal fat content of broiler (Rabie and Szilagyi, 1998). However, the present study was carried out to investigate the effect of different levels of exogenous saponin singly or combined with L-carnitine on the performance of male broiler.

Materials and Methods

The experiment was conducted with 150 day old Starboro male commercial broiler chicks for a period of 49 days during late autumn. The chicks were equally distributed into 5 dietary treatments having 3 replications in each. The experimental lay out is given in Table 1.

The replicate groups of chicks were distributed into 15 littered floor pens (120 cm X 190 cm) randomly. Three types of diet i.e., starter (day old to 21 days), grower (22 to 42 days) and finisher (43 to 56 days) were given to the birds as dry mash at *ad libitum* basis. The diets were formulated with locally available ingredients like maize,

Table 1: The lay out of birds distribution to different treatment and replicates group

Replication	Dietary treatment					Total
	S_0	S_1	S_2	S_3	S_4	
R_1	10	10	10	10	10	50
R_2	10	10	10	10	10	50
R_3	10	10	10	10	10	50

Where; S_0, control diet (without saponin and L-carnitine), S_1, 25 mg saponin per kg feed; S_2, 50 mg saponin per kg feed, S_3, 75 mg saponin per kg feed and S_4, a combination of 50 mg saponin + 50 mg L-carnitine per kg feed.

Table 2: The chemical composition of the basal diet

Nutrients	Starter	Grower	Finisher
Metabolizable energy (Kcal/kg)	3045	3047	3168
Crude protein (g/kg)	21.5	19.45	18.0
Calcium (g/kg)	1.20	1.17	1.20
Available phosphorous (g/kg)	0.80	0.82	0.83
Lysine (g/kg)	1.02	0.90	0.85
Methionine (g/kg)	0.36	0.34	0.34
Tryptophan (g/kg)	0.14	0.27	0.10

rice polish, soybean meal, meat and bone meal, soybean oil, fishmeal etc. The chemical composition of the basal diet was as follows:

Ad libitum dry mash ration was supplied to the birds throughout the experimental period. Starter ration was supplied upto 21 days of age and grower ration from 22 to 42 days of age, where finisher ration was fed from 43 to 56 days of age. Cool and clean water was made available to the experimental birds at all times.

The birds were immunized against Gumboro and Newcastle diseases administering BCRDV (against Newcastle) at 4th and 29th day old and D-78 (against Gumboro) at 14th and 21th day old of the birds. During the experimental period, initial and weekly body weight, feed consumption, temperature and relative humidity, mortality etc were recorded. To evaluate different treatments, weight gain, feed conversion ratio, protein efficiency, energy efficiency, performance index etc parameters were considered. At the end of experiment, one broiler from each replication were randomly selected for processing to have dressing yield and weight of different organs and cut up parts. The collected and calculated data were analyzed for analysis of variance (ANOVA) using principles of completely randomized design (CRD) in MSTAT computer package. Least significant difference (LSD) was calculated to compare between treatments, where ANOVA showed significant difference. The dressing yield parameters were converted in percentage of their respective body weights for statistical analysis.

Results and Discussion

Incorporation of saponin attributed insignificant increase ($p>0.05$) in feed consumption with significantly ($p<0.05$) higher consumption on S_4 at starter period (Table 3). S_3 diet improved body weight gain at all stages of growth compared to other diets where the highest gain attained during 22-42 days of age (Table 3). Increased feed consumption was supported by Eckel's (1997) observation who fed only saponin supplemented feed to chicken at lower level. Sayed *et al.* (2001) claimed higher feed intake using saponin 50mg/kg diet. Higher growth rate found in present study on saponin treated diet that got support from the finding of Nakaue *et al.* (1980) Yejuman (1998). Seeman *et al.* (1973) and Seeman (1974) stated that lower level of saponin would help to increase nutrients absorption from the intestine by increasing villi diameter i.e., 40-50 A° which are permeable for large molecules like ferritin and this fact may be responsible for better growth rate.

Feeding of saponin along with L-carnitine (S_4) caused depressed growth than other treated diets. This result was not consistent with the findings of Rabie and Szilagyi (1998) who found improvement in weight gain on feed containing L-carnitine.

Feed efficiency was not significantly affected by dietary treatments (Table 4) but better utilization was found on S_2 diet during finishing (43-56 days) period. However, feed conversion efficiency increased by 2.73% on D_4 diets than control during whole experimental period.

Protein and energy efficiency of the experimental broilers were statistically similar on all diets. But for both parameters, better efficiency was found in birds fed on S_3 diet. The feed cost/kg live broiler was insignificantly lower on S_2 and S_3 diets. However, the performance index values seemed to be better on S_3 diet than on all other diets specially at 42 days of age (Table 4).

Higher ($p>0.05$) dressing yield was found on S_4 diet compared to all other birds fed on diets containing saponin (Table 5). Similar results were found by Rabie *et al.* (1997) and Rabie and Szilagyi (1998). They observed greater breast and thigh meat yield in broilers

Table 3: Feed consumption (g), body weight and weight gain (g) of broilers on different dietary treatments at different ages

Parameter	Age in days	Diet					LSD (SED) and Significance
		S_0	S_1	S_2	S_3	S_4	
Feed consumtion (g)	8-21	560.33^{b}	587.67^{ab}	648.33^{a}	610.00^{ab}	651.00^{a}	61.54*
	22-42	2463.00	2574.33	2619.33	2831.00	2518.33	(121.57)^{NS}
	43-56	2697.33	2833.33	2701.67	3098.33	2563.67	(185.17)^{NS}
	8-56	5720.67	5995.33	5969.33	6539.33	5733.33	(276.86)^{NS}
Body weight (g)	14	196.66	191.67	196.67	205.00	206.67	(1.75)^{NS}
	21	383.33	401.67	416.67	450.00	438.33	(20.85)^{NS}
	28	680.00	606.00	711.67	777.33	741.67	(35.90)^{NS}
	35	1070.00	1116.67	1133.33	1178.33	1100.00	(59.58)^{NS}
	42	1621.00^{b}	1646.67^{b}	1742.00^{b}	2008.00^{a}	1713.33^{b}	231.10*
	49	2056.67^{b}	2151.67^{b}	2240.00^{b}	2578.33^{a}	2123.33^{b}	287.70**
	56	2701.33^{ab}	2720.00^{ab}	2894.00^{ab}	3156.66^{a}	2677.67^{b}	425.8*
Weight gain (g)	8-21	288.33	306.67	311.67	355.00	343.33	(24.46)^{NS}
	22-42	1237.67^{b}	1245.00^{b}	1325.33^{b}	1558.33^{a}	1287.00^{b}	311.8*
	43-56	1080.00	1073.0	1152.13	1148.33	946.67	(90.55)^{NS}
	8-56	2606.11^{b}	2625.00^{b}	2799.67^{ab}	3061.33^{a}	2582.00^{b}	299.80*

Where: S_0, control diet (without saponin and L-carnitine), S_1, 25 mg saponin per kg feed; S_2, 50 mg saponin per kg feed, S_3, 75 mg saponin per kg feed and S_4, a combination of (50 mg saponin + 50 mg L-carnitine) per kg feed; NS, non-significant; **P<0.01; *P<0.05, Figures having similar superscript in the same row do not differ significantly

Table 4: Feed conversion ratio, protein efficiency, energy efficiency, performance index, feed cost@ Tk./kg live broiler on different dietary treatments

Parameter	Age in days	Diet					LSD (SED) and Significance
		S_0	S_1	S_2	S_3	S_4	
Feed conversion ratio(FCR)	8-21	1.86	1.92	2.08	1.72	1.85	(0.09)^{NS}
	22-42	1.95	1.83	1.97	2.07	1.98	(0.09)^{NS}
	43-56	2.50	2.63	2.34	2.70	2.69	(0.15)^{NS}
	8-56	2.19	2.28	2.13	2.13	2.22	(0.05)^{NS}
Protein efficiency	8-21	2.37	2.26	2.09	2.53	2.29	(0.13)^{NS}
	22-42	2.51	2.42	2.53	2.75	2.55	(0.14)^{NS}
	43-56	2.23	2.11	2.37	2.06	2.08	(0.13)^{NS}
	8-56	2.35	2.27	2.41	2.43	2.32	(0.05)^{NS}
Energy efficiency	8-21	17.54	16.78	15.53	18.77	17.11	(0.94)^{NS}
	22-42	17.18	15.59	16.33	17.75	16.49	(0.93)^{NS}
	43-56	12.90	12.26	13.77	11.94	12.23	(0.66)^{NS}
	8-56	14.69	14.13	15.12	15.10	14.53	(0.38)^{NS}
Performance index	35	51.06	51.70	55.33	56.97	49.55	(3.46)^{NS}
	42	84.48^{b}	79.71^{b}	91.04^{b}	125.50^{a}	95.45^{b}	29.11**
	49	74.29	87.88	93.30	102.74	73.50	(14.89)^{NS}
	56	117.83	97.33	127.24	143.75	105.40	(17.79)^{NS}
Feed cost (Tk/kg broiler)		37.59	38.67	36.80	36.82	37.87	(0.91)^{NS}

Where; S_0, control diet (without saponin and L-carnitine), S_1, 25 mg saponin per kg feed; S_2, 50 mg saponin per kg feed, S_3, 75 mg saponin per kg feed and S_4, a combination of (50 mg saponin + 50 mg L-carnitine) per kg feed; NS, non-significant; **p<0.01; *P<0.05, Figures having similar superscript not differ significantly, @, 60 Tk. = 1US $

fed diets containing L-carnitine. Abdominal fat content and liver size significantly ($p<0.05$) reduced on diets with saponin alone or along with carnitine.

The larger testis was found in birds those received saponin and L-carnitine in the present experiment (Table 5). This finding was supported by Hong *et al.* (1976). He found increased seminiferous tubules diameter in cockerels receiving diet containing 100mg/kg saponin. Baumgartner (2001) and Leibettseder (1995) also found improved reproductive performance i.e., more viable sperm, higher hatch ability in breeder chicken with diet containing carnitine. So,

Table 5: Meat yield (g), abdominal fat and organs weight (g/kg live weight) of broiler on different dietary treatments

Parameter	Diet					LSD (SED) and Significance
	S_0	S_1	S_2	S_3	S_4	
Body weight	2750	2767	2900	3217	2650	$(174.79)^{NS}$
Dressing%	68.45	64.47	66.72	66.29	69.26	$(2.0)^{NS}$
Abdominal fat	15.53^{a}	11.91^{b}	12.09^{b}	11.30^{bc}	10.79^{c}	0.94*
Liver	25.11^{a}	20.58^{c}	21.47^{c}	20.58^{c}	23.04^{b}	1.03*
Heart	3.38^{bc}	2.65^{c}	3.52^{b}	3.42^{bc}	5.19^{a}	0.78*
Spleen	1.77	1.79	1.91	1.56	2.16	$(0.32)^{NS}$
Gizzard	22.19^{a}	16.51^{c}	14.99^{d}	16.30^{cd}	19.25^{b}	1.35*
Thyroid	58.44^{a}	59.73^{a}	50.31^{c}	47.97^{d}	56.03^{b}	2.19*
Testis	161.75^{c}	187.11^{ab}	190.51^{ab}	195.79^{a}	174.38^{bc}	16.40*

Where: S_0, control diet (without saponin and L-carnitine); S_1, 25 mg saponin per kg feed; S_2, 50 mg saponin per kg feed, S_3, 75 mg saponin per kg feed and S_4, a combination of (50 mg saponin + 50 mg L-carnitine) per kg feed; NS, non-significant; **p<0.01; *P<0.05, Figures having similar superscript in the same row do not differ significantly

saponin and carnitine might have great impact on reproductive fitness of breeder chicken and more trail is needed to make sure this phenomena.

However, from the present findings it can be concluded that 75 mg saponin/kg feed (S_3) can safely be used in broiler diet with improved growth, better feed efficiency and performance index and good carcass quality.

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