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EFFECT OF SUPPLEMENTATION OF ORGANIC ACIDS ON LAYING PERFORMANCE, BODY FATNESS AND EGG QUALITY OF HENS

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Abstract

The study was conducted to determine the effect of organic acids supplementation on body weight changes, feed intake, feed efficiency, egg production, egg weight and egg quality in laying hens at age between 67 and 74 weeks. A total of 48 Shaver 579 laying hens of 67 weeks age were allotted into 4 groups, each containing 12 hens. The hens were fed basal diet (17% CP and 2800 kcal ME/kg diet) supplemented with 0 (T_1), 260 (T_2), 520 (T_3) and 780 ppm (T_4) of organic acid mixture (fumaric acid and salt of butyric, propionic and lactic acids). The results revealed no effect of organic acids supplementation on body weight change and feed intake but improvement of egg production and feed conversion were observed. Organic acids supplementation significantly increased egg production by about 2.26, 8.0 and 9.84% on 260, 520 and 780 ppm respectively when compared with the untreated group ($P<0.05$). Feed conversion showed a significant ($P<0.05$) improvement in laying hen groups which fed on the basal diet supplemented with organic acids at 260, 520 and 780 ppm by about 1.85, 8.48 and 7.74% respectively when compared with the control. On the other hand, dietary organic acid had no effect on the average egg weight, while showed a lower percentage of large ($P<0.05$) and extra large egg ($P<0.01$) size compared with control group. Body composition parameters were not affected ($P>0.05$) by dietary treatments. Inclusion of organic acids improved egg shell thickness ($P<0.05$) while significantly reduced albumen index ($P<0.05$). Incorporation of organic acids attributed to significant increase per cent albumen ($P<0.01$) and significant decrease in yolk per cent ($P<0.05$). It can be concluded that organic acid supplementation of laying hens diet may improve persistency of lay and feed conversion. From economical point of view, it is concluded that organic acid addition (520 ppm) may result an economic benefit of layer production at older age.

Key words : Organic acids, Egg production, Feed conversion.

Introduction

The disease fatty liver hemorrhagic syndrome normally occurs over 40 weeks of age and results in reduced egg production and increased mortality. In older layers (over 40 weeks) there is a common observation of decreased digestive capacity due to impaired quality of the mucosal cells in the intestine and decreased length of the intestinal villi. This caused lower laying percentage, feed conversion and egg shell calcification (Schwarzer, 2006). Organic

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acids play an important role by restoring the function of damaged cells that are resulted from fat deposition. Research has shown that organic acids, in particular butyrate, facilitate DNA repair enzymes (Langhout and Sus, 2005). Organic acids also stimulate epithelial growth of the intestinal wall. Due to this, calcium metabolism and absorption might also be improved (Langhout and Sus, 2005).

The poultry sector is continuously searching for new feed additives in order to improve the feed efficiency and chicken health. Organic acids are promising alternative materials to antibiotics (Hyden, 2000). Dietary organic acids and their salts are able to inhibit the growth microorganism in the feed and consequently preserve the microbial balance in the gastrointestinal tract. In addition, by modifying intestinal pH, organic acids also improve the solubility of the feed ingredients, digestion and absorption of the nutrients (Vogt *et al*., 1981; Patten and Waldroup, 1988 and Skinner *et al*., 1991). Previous studies reported that organic acids such as fumaric, propionic and butyric acids and their salts have shown variable effects on egg production and egg quality. These discrepancies would be related to the source, the amount of organic acids used, location, environmental condition and the composition of the diets (Gama *et al*., 2000). Therefore, the present research work with some organic acids was undertaken to know the effect of organic acids supplementation on laying performance, body fatness and egg quality and to recommend an optimum dose of organic acids for egg production in older hens.

Materials and Methods

The egg production trial was conducted at Bangladesh Agricultural University Poultry Farm, Mymensingh, Bangladesh for a period of two month. Forty eight egg laying chickens of almost uniform body weight from a high yielding strain (Shaver 579) of 67 weeks of age were selected and the birds were divided into four groups having 3 replications containing 4 birds in each replication. Four diets were randomly distributed to 4 groups in a Completely Randomized Design (CRD). Dietary treatments consist of commercial mash feed without supplementing organic acids (T_1), a similar ration with 260 ppm organic aicds (T_2), 520 ppm organic aicds (T_3) and 780 ppm organic aicds (T_4). ProviMax (commercial feed additive) was used at the rate of 0, 0.5,1.0 and 1.5 kg/tonne feed in T_1, T_2, T_3 and T_4 respectively as a source of organic acids. The concentration of organic acids in ProviMax was referred by Soltan (2008). ProviMax is a combination of fumaric acid (2%), salt of organic acids "calcium butyrate-calcium propionate and calcium lactate (50%), and carrier "sepioliite and corn" until 100% produced by Centraly's Co. France. The birds were reared in laying cages and fed *ad libitum* on a commercial feed (Aftab poultry feed: Layer layer -2). The feed contained 11, 17, 5.0, 3.6 and 0.35% moisture, crude protein, crude fat, calcium and available phosphorus respectively and 2800 ME (kcal/kg diet).

Body weight (initial and final), egg production, feed intake, feed conversion, egg mass/bird/day, average egg weight, and egg sizes were recorded. After completion of the experiment, one bird from each replicate was dissected to record body fat and the weight of

heart, liver, gizzard, spleen, and oviduct. Body fatness was calculated as skin weight plus abdominal fat (Howlider, 1988). For external and internal egg quality determination, two eggs from each replication were collected at 515 days of layer age. Egg quality parameters such as egg weight, shape index (Reddy *et al*., 1979), yolk index (Wesley and Stadelman, 1959), albumen index (Heiman and carver, 1936) and Haugh unit (Haugh, 1937), shell thickness, shell (%), albumen (%), and yolk (%) were determined. Production cost was calculated from the value of feeds and others cost (lighting, veterinary care, management and housing). Egg price was calculated on the basis of market price. Economical Efficiency (EE) was estimated as: EE = (Net revenue/Total production cost) × 100 according to Soltan (2008).

Data were analyzed in a Completely Randomized Design. Analysis of variance was performed with the help of a computer program MSTAT-C.

Results and Discussion

Laying performance

Egg production performance of laying hens during the period between 67 and 74 weeks of age is presented in Table 1. Organic acids had no effect ($P>0.05$) on body weight and feed intake of laying hens. Supplementation of organic acids significantly ($P<0.05$) increased hen day egg production (HDEP) by about 2.26, 8.0 and 9.84% on diets containing 260, 520 and 780 ppm organic acids respectively when compared with the unsupplement group. These results are in agreement with Soltan (2008) and Gama *et al*. (2000). They concluded that organic acid supplementation has positive effects on egg production in laying hens at older age of hens. Feed conversion showed a significant ($P<0.05$) improvement in laying hen fed on the basal diet supplemented with organic acids by about 1.85, 8.48 and 7.74% on 260, 520 and 780 ppm respectively when compared with the untreated group. Improved feed conversion may be the result of the recovery of damaged cells of the digestive wall and preservation of microbial balance and improved nutrient utilization of hens belongs to supplemented groups. These results were highly correlated with the findings of the several authors (Soltan, 2008; Langhout and Sus, 2005; Denli *et al.*, 2003; Vugt, *et al*., 2001; Yalcin *et al*., 2000 and Patten and Waldroup, 1988). All of them observed higher feed efficiency on organic acids supplementation in the diet of chicken.

Egg weight and egg size

Effect of dietary organic acids on egg weight and various egg sizes of laying hens during the period between 67 and 74 weeks of age are presented in Table 2. It is revealed (Table 2) that the supplementation of organic acids had no effect ($P>0.05$) on egg weight in compare is on with the untreated one. These results are in agreement with Gama *et al*. (2000), Yalcin *et al*. (2000) and Yesilbag and Colpan (2006). They indicated that the addition of different organic acids in laying hens diet had no effect on the egg weight of laying hens. Non-significant effect of organic acids on average egg weight contradicted with Langhout and Sus (2005) who observed heavier eggs on organic acids supplementation. On the other hand, egg

classification size showed a significant effect with organic acid supplementation and the statistical analysis showed a decrease of extra large egg and large egg percentage for organic acids supplementation when compared with the control, while jumbo egg size exhibited a surprising tendency to increase (P>0.05) of its production with the higher organic acid supplementation when compared with control.

Table 1. Effect of organic acids on production performance of laying hens

Parameters	Treatments[#]				SED	Level of Sig.[+]
	T_1	T_2	T_3	T_4		
Initial body weight (g)	2316.67	2366.67	2208.33	2329.17	58.258	NS
Final body weight (g)	2329.17	2290.83	2166.67	2287.50	73.115	NS
Feed intake (g)	133.31	134.81	132.05	133.21	1.528	NS
HDEP (%)	72.61^{c}	74.25^{bc}	78.42^{ab}	79.76^{a}	2.156	*
Egg mass production (g/h/d)	49.14	50.67	53.09	52.23	1.740	NS
FCR	2.71^{a}	2.66^{ab}	2.48^{b}	2.50^{b}	0.077	*

[#] T_1 = Control; T_2 = Control + 260 ppm organic acids; T_3 = Control + 520 ppm organic acids; T_4 = Control + 780 ppm organic acids. HDEP = Hen-day egg production, +NS, p>0.05;*, P<0.05

Table 2. Effect of organic acids on egg weight and egg sizes of laying hens

Parameters	Treatments[#]				SED	Level of Sig.[+]
	T_1	T_2	T_3	T_4		
Avg. egg weight (g)	67.71	68.26	67.68	66.72	1.280	NS
Jumbo egg (%)	32.48	36.20	39.79	34.04	4.645	NS
Extra large egg (%)	46.55^{a}	47.24^{a}	41.15^{ab}	33.79^{b}	2.901	**
Large egg (%)	19.13^{b}	15.98^{b}	15.09^{b}	31.49^{a}	4.271	*
Medium egg (%)	1.85	0.58	3.96	0.68	1.602	NS

[#] T_1 = Control; T_2 = Control + 260 ppm organic acids; T_3 = Control + 520 ppm organic acids; T_4 = Control + 780 ppm organic acids. +NS, P>0.05;*, P<0.05; **, P<0.01

Body composition

Effect of dietary organic acids supplementation on body fatness and some carcass characteristics of laying hens during the period between 67 and 74 weeks of age is presented in Table 3. Organic acids had no significant effect on any of the body composition parameters but lower liver weight (P>0.05) was found by about 15.23, 13.08 and 6.84 % on 260, 520 and 780 ppm organic acids supplementation respectively when compared with the control group. Reduction of lipoprotein may attribute to lower liver weight on organic acids supplementation.

Table 3. Effect of organic acids on body fatness and carcass characteristics of laying hens

Parameters	Treatments[#]				SED	Level of Sig.[+]
	T_1	T_2	T_3	T_4		
Total fat (g/hen)	296.17	265.73	279.57	313.40	43.278	NS
Fat (%)	13.84	12.87	13.21	13.39	1.213	NS
Heart weight (g/hen)	9.13	9.47	9.60	10.13	1.019	NS
Liver weight (g/hen)	40.5	34.33	35.20	37.73	2.405	NS
Gizzard weight (g/hen)	27.53	28.73	25.87	31.07	3.173	NS
Spleen weight (g/hen)	1.97	1.67	1.73	2.33	0.361	NS
Oviduct weight (g/hen)	50.40	67.07	77.60	57.87	17.152	NS

[#] T_1 = Control; T_2 = Control + 260 ppm organic acids; T_3 = Control + 520 ppm organic acids; T_4 = Control + 780 ppm organic acids. +NS, P>0.05

Per cent fat also showed a diminishing trend on organic acids supplementation. This result had relation to the findings of Ibrahim *et al*. (1997) who reported that organic acids supplementation reduced visible fat (14.2%) and skin fat (36.9 and 40.2% of high-and low-energy controls) percentages in ducks. There was also an increasing trend of heart weight found on organic acids supplementation. Non-significant effect of organic acids on abdominal fat, liver, gizzard and spleen weight were similar to the findings of Denli *et al*. (2003) who demonstrated that the organic acid dietary regimens in broiler had no effect (P>0.05) on the carcass yield, abdominal fat pad, abdominal fat percentage and liver weight compared with control group.

Egg quality

Effect of dietary organic acids supplementation on egg quality of laying hens is presented in Table 4. Dietary organic acids had no effect (P>0.05) on shape index, yolk index, Haugh unit and yolk color score. Decreasing albumen index (P<0.05) can be explained by dietary organic acids supplementation. Such result was consistent with the findings of Soltan (2008) who showed a slight deterioration of albumen index in layer hens with different inclusion level of organic acids. Increased albumen per cent on organic acids supplementation and older age of hen may be responsible for decreasing albumen index.

Incorporation of organic acids in diet attributed significant increase (P<0.05) in shell thickness which may be the consequence of the increased mineral and protein absorption. Increased shell thickness was supported by Soltan (2008) who found improved egg shell thickness on organic acids supplementation. Contradictory result was found by Yesilbag and Colpan (2006) who reported organic acid mixture did not improved shell thickness. The

difference may be attributed to that organic acid mixture of their trial not including butyrate which plays a role in development of intestinal epithelium more than other organic acids. Supplementation of organic acids had no significant effect on per cent shell. Incorporation of organic acids attributable to significant increase in albumen percentage by about 1.95%, 2.37% and 3.7% on 260, 520 and 780 ppm organic acids respectively than the control group. Decrease in the per cent yolk resulted from organic acids supplementation ($P<0.05$).

Table 4. Effect of organic acids on egg quality parameters of laying hens

Parameters	Treatments[#]				SED	Level of Sig.[+]
	T_1	T_2	T_3	T_4		
Shape index	74.36	73.99	74.19	74.22	1.031	NS
Yolk index	0.397	0.413	0.413	0.420	0.036	NS
Albumen index	0.080^{a}	0.082^{a}	0.700^{b}	0.760^{b}	0.025	*
Haugh unit	79.5	85.83	75.67	78.17	4.415	NS
Yolk color score	5.33	5.50	5.83	5.67	0.288	NS
Shell thickness	0.380^{b}	0.390^{ab}	0.403^{a}	0.403^{a}	0.025	*
Per cent shell	11.64	11.51	11.39	11.29	0.532	NS
Per cent albumen	61.81^{b}	63.02^{ab}	63.28^{ab}	64.10^{a}	0.648	*
Per cent yolk	26.54^{a}	25.46^{b}	25.34^{b}	24.75^{b}	0.306	**

[#] T_1 = Control; T_2 = Control + 260 ppm organic acids; T_3 = Control + 520 ppm organic acids; T_4 = Control + 780 ppm organic acids. +NS, $P>0.05$; *, $P<0.05$; **, $P<0.01$

Economical efficiency of production

Feeding costs, total production costs, net income (taka/treatment) and economic efficiency of production in different laying hen groups is shown in Table 5. It is clear from the obtained data that the total costs of production were Taka 2559.43, 2627.11, 2611.50 and 2672.51 for treatments T_1, T_2, T_3 and T_4, respectively. These results revealed the possibility of increasing economic efficiency by organic acid supplementation of laying hens diet. The highest economical efficiency was obtained by T_3 (520 ppm of organic acid) by about 46.52% compared with the control. Economic efficiency was also higher in T_4 by about 41.37% when compared with the control group, while lower level of organic acids (T_2) exhibited a decrease of economical efficiency of production by about 2.99% when compared with control. The results of increased economical efficiency on organic acids supplementation were consistent with the findings of Soltan (2008).

Table 5. Economic efficiency of production as affected by dietary organic acid supplementation of laying hens

Parameters	Treatments[#]			
	T_1	T_2	T_3	T_4
No of laying hens (No.)	12	12	12	12
Feed cost* (Tk.)	1791.60	1838.98	1828.04	1870.76
Other costs (Tk.)	767.83	788.13	783.46	801.75
Total cost (Tk.)	2559.43	2627.11	2611.50	2672.51
Returns (Tk.)	2927.63	2993.76	3161.89	3215.92
Net income (Tk.)	368.2	366.65	550.39	543.41
Net income/total cost (%)	14.38	23.95	21.07	20.33

[#] T_1 = Control; T_2 = Control + 260 ppm organic acids; T_3 = Control + 520 ppm organic acids

T_4 = Control + 780 ppm organic acids. [*]Feed cost assuming 70% of total cost

Conclusion

Organic acid supplementation at level 520 ppm in laying hen's diet improved persistence of lay, feed conversion and egg shell quality during the period of 67-74 week of age. The variable effect of organic acids inclusion of laying hen diets may be confounded by variations in gut flora and environmental condition. From economical point of view, it may be concluded that addition of organic acid (520 ppm) with basal diet could result an increase in the economical efficiency of layer productivity at older age between 67 and 74 weeks.

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