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Comparative Study on the Effect of Organic Acids, Prebiotics and Enzymes Supplementation on Broiler Chicks' Economic and Productive Efficiency

A.M.Abd-El Hamed[1], E.R.Kamel[1], M.E.Abo-Salem[2] and S.T.Atallah[3]
[1]Animal Wealth Development Dept., Faculty of Veterinary Medicine, Benha Univ., Egypt
[2] Forensic Medicine and Toxicology Dept., Faculty of Veterinary Medicine, Benha Univ., Egypt
[3]Animal Husbandry and Animal Wealth Development Dept., Faculty of Veterinary Medicine, Alexandria Univ., Egypt
E-Mail: dr.amira2040@gmail.com

Abstract

This study was conducted to evaluate the effects of different feed additives (Organic acids, Prebiotics and Enzymes) on economic and productive efficiency for two different broiler breeds. A total of 264 healthy unsexed one-day-old broiler chicks (Cobb and Indian River (IR) breeds) were allocated randomly in to eight groups (33 chicks/each group). Each group consists of three replicates (11 chicks/each replicate). Our results clarified that the value of final body weight of Cobb breed was the highest for organic acid (OA) treated group (2176.5187gm) and the lowest value was for prebiotics treated group (1985.14gm), while control group of (IR) breed showed the highest body weight (2238.87gm) and the lowest value was for prebiotics treated group (2086.27gm). Cobb group treated with organic acid showed higher body weight than IR group treated with organic acid. the lowest feed cost was found for OA and prebiotic groups of Cobb breed, and the best total return was found for control group of IR breed and OA group of Cobb breed, Concerning net profit value it was higher for control group of (IR) breed than the control group of Cobb breed (L.E 17.71and 15.47 respectively), and the lowest net profit value was for prebiotics treated group for both Cobb and (IR) breed respectively (L.E 13.50 and 15.28).

From our results, it would be concluded that organic acid was better than other used feed additives, and they had an important role in improving economic and productive efficiency of Cobb broiler Chicks'.

Keywords: Organic acids, Prebiotics, Enzymes, Body weight, IR, Cobb, Net profit.

1. Introduction

The major problem in broiler sector is the dependence on external resources in the supply of parent stock, raw materials of feed(especially corn and soybean), medicines, vaccines and feed additives to a certain extent, and this situation affects the competition of the sector in foreign markets adversely as a result of increasing costs of production [1].

The possibilities to attain optimum broilers performance have led the producers to search for and use alternative promoters, in a particular with the ban of using the antibiotic growth promoters. Thus, their use in feed rations of productive live stocks leads to resistance formation against bacteria that are pathogenic to humans [2], So Several substances have been investigated in recent years for finding alternatives to growth-promoting antimicrobials which are able to support productive performance and prevent the incidence of some diseases in poultry [3].

These alternative feed additives include products such as enzymes, organic acids (OA), prebiotics, probiotics or combinations of these products [4].

The usage of exogenous enzymes in broilers diets enhances the food digestibility, minimizing the anti-nutritional effects and promoting the productivity indices [5] Organic acids have been used as a tool to increase the digestibility of protein and regulate the intestinal micro flora [6]. Broiler chicks fed on dietary organic acids had superior improvement in live body weight, body weight gain, and feed conversion rate[7].

The use of prebiotics or fermentable sugars instead of antibiotics is going to be popular in birds to improve the useful microbial population in the gut [8].The productive efficiency can be achieved when obtaining maximum production with minimum cost and using the least amount of resources to produce a given output level [9].

Therefore, the aim of this study was to make comparative study on the effect of organic acids, prebiotics and enzymes supplementation on economic efficiency via their effects on total costs, total returns, net profit and efficiency measurements and productive efficiency through their effects on growth performance parameters in terms of (feed intake, body weight, body weight gain, relative growth rate and feed conversion rate) of broiler chicks' of both Cobb and IR breeds.

2. Materials and methods

2.1 Experimental chicks

Our study was carried out at Poultry Research Farm belonging to Animal Wealth Development department, Faculty of Veterinary Medicine, Benha University, Egypt, at the period from 7th of May 2016 till 15th of Jun 2016. A total of 264, healthy one day old unsexed broiler (Cobb and Indian River (IR) breed), Cobb breed was purchased from El-Kashlan Company and Indian River IR breed was purchased from El-Desoki Company.

2.2 Management and housing

The broiler chicks were weighted, and wing banded for their identification, A total of 264 classified into two breeds (Cobb and IR) 132 chicks per each breed, allocated in to eight groups (33 chicks/each group). Each group consists of three replicates (11 chicks/each replicate). They were housed in a clean, well ventilated litter floor house (5cm wood shaving litter depth). The house was provided with heaters to adjust the environmental temperature according to the age of chicks. Each partition contained suitable feeders and waterers. The house floor was partitioned into 24 partitions [10]. Brooding temperature started at 33°C during the first 3 days, then 31ºC till the end of the 1st week, followed by reduction of 2°C/week until the temperature reached 28°C at the end of experiment [11, 12].

2.3 Experimental diets

The chicks were randomly allocated into eight groups. Birds were fed on well-balanced diet **[13]** as shown in table 2. Starter diet was given till the 14th day of age after that chicks were fed on grower diet that was given till the 28th day of age after that chicks were fed on finisher diet till the end of the experiment (38th day of age) according to [14]. Chicks were allocated as the following:

- Group 1 received basal diet (Control)
- Group 2 received basal diet + Organic acid (Nutracid® B 30) 1gm/kg ration.
- Group 3 received basal diet + prebiotics (Y-MOS®) 1gm/kg ration.
- Group 4 received basal diet + Enzymes (ECONASE® XT25) 0.15gm/kg ration.

2.4 Studied traits

2.4.1 Productive efficiency measurements

2.4.1.1 Feed intake (FI)

Was calculated by dividing the amount of feed consumed in grams (by a certain group) during the week by the number of chicks of this group during the same week.

2.4.1.2 Growth traits

2.4.1.2.a Body weight (BW)

At the beginning of the experiment (at one day old), the broiler chicks were individually weighted, and then they were weighed weekly till the end of the experiment [15].

2.4.1.2.b Body weight gain (BWG)

The weekly body weight gain was calculated by subtracting the body weight between two successive weights according to [16].

2.4.1.2.c Relative growth rate (RGR %)

Relative growth rate (expressed in percentage) was calculated every week according to [17, 18] using the following formula:

$$RGR = \frac{100\,(W_2 - W_1)}{½\,(W_2 + W_1)}$$

Where: W1= Body weight at the beginning of week.

W2= Body weight at the end of week.

2.4.1.2.d Feed conversion ratio (FCR)

according to [19].

$$FCR = \frac{\text{Feed intake (g) bird/week}}{\text{Body weight gain (g) bird/week}}$$

2.4.2 Economic efficiency measurements

2.4.2.1 Costs of production

were classified into total fixed costs, total variable costs, and total costs.

-Total Variable Costs (TVC): Included costs of feed, feed additives, labor, litter, total veterinary management (drugs, vaccine and veterinary supervision), water and electricity. It was calculated for each chick per Egyptian pound during the period of the experiment according to [9].

-Total Fixed Costs (TFC): These costs included building and equipment depreciation, these parameters considered as a fixed costs for all the experimental groups [20].

-The depreciation rates were calculated for the building to serve for 25 years and for the equipment to be used for 5 years. The straight line method implied by [21]) was used for calculation of depreciation rates according the following equation:

Equipment depreciation = (Value of equipment (L.E)/Number of years/Number of project cycles per year) /Total number of chicks.

- Total Costs (TC) = TFC + TVC.

2.4.2.2 Returns parameters

2.4.2.2.a Total returns (TR)

([9, 10, 22, 23].

- Total returns = Litter selling + Broiler selling.
- Litter selling = Litter selling price / No. of broilers at end of project.
- Broiler selling = Body weight/Kg at end of experiment (6th week) x Kg market price.

2.4.2.2.b Net profit (NP)

It was calculated according to [9, 15, 24] using the following equation: NP= TR – TC.

2.4.3 Economic efficiency measurements

- Percentage of total returns to total costs (TR/TC).
- Percentage of net profit to total costs (NP/TC).

Statistical Analysis

Differences between studied groups and breeds were analyzed by using One-Way ANOVA and Duncan's multiple comparison Post Hoc tests [25]. Statistical analysis was performed using the statistical software package SPSS for Windows SPSS/PC+ "version 16"[26]. Statistical significance between mean values was set at ($p \leq 0.05$). Data were reported as means and standard error.

Table (1) Composition of starter, grower and finisher diets. (Basal diet)

Ingredients %	Starter	Grower	Finisher
Corn grain	53.55	52.88	59.46
Soyabean (44%) protein	33.2	31.10	25.5
Corn gluten meal	5.5	5.60	5.5
Vegetable oil	2.85	5.85	5.40
Mono-calcium phosphate	2.03	1.85	1.825
Limestone	1.18	1.17	0.95
L-Lysine	0.50	0.455	0.335
D-L methionine	0.33	0.24	0.20
Sodium chloride	0.30	0.30	0.30
Vit &min premix(1)	0.30	0.30	0.30
Sodium bicarbonate	0.15	0.15	0.15
L- threonine	0.12	0.10	0.08

(1)Purchased by AGRI-VIT 10th of Ramadan city, Egypt. Each 3 kg contains contain**:** Vitamin A = 12,000,000 IU, D_3 = 2,000,000 IU, E = 10,000 mg, K_3= 2000mg, B_1 = 1000 mg, B_2 =5000 mg, B_6 =1500 mg, $B_{12=}$ 10mg, Biotin= 50 mg, pantothenic acid= 10000 mg, Nicotinic acid = 30000 mg, Folic acid =1000 mg, Zinc = 50,000 mg, Manganese = 60,000 mg, Iron = 30,000 mg, Copper = 10,000 mg, Iodine =1,000 mg, Selenium = 100 mg, Cobalt = 100 mg, Cobalt = 1000 mg, and Calcium carbonate up to 3 Kg.

Table (2) Chemical composition of starter, grower and finisher diets

Item	Starter %	Grower %	Finisher %
Crude protein	22	21	19
MEn	3000	3177	3225
Lysine	1.35	1.27	1.05
Lysine dig	1.25	1.17	0.97
Methionine	0.67	0.57	0.51
Methionine Dig	0.64	0.54	0.48
Methionine+ cysteine	1.05	0.94	0.85
Methionine+ cysteine Dig	0.95	0.84	0.76
Threonine	0.90	0.85	0.76
Threonine Dig	0.78	0.73	0.65
Calcium	1.05	1.00	0.90
Available phosphorus	0.50	0.46	0.45
Chloride	0.22	0.22	0.22
Na	0.17	0.17	0.17

Calculated according to [13].

3. Result

3.1 Effect of different experimental diets among different breeds on productive efficiency measurements

Result in table (3) revealed that growth performance and feed efficiency parameters including feed intake, body weight (BW), body weight gain (BWG), relative growth rate (RGR %) and final feed conversion rate (FCR) were differed significantly ($p \leq 0.05$) among different groups for both Cobb and IR breeds.

3.2 Effect of different experimental diets among different breeds on feed additives cost and total feed cost (L.E /chick)

Result in table (4) showed that feed additives cost and total feed cost were differed significantly ($p \leq 0.05$) for both Cobb and IR breeds.

3.3 Effect of different experimental diets among different breeds on the economic efficiency parameters

Result in table (5, 6) clarified that total return parameters and net profit were differed significantly ($p \leq 0.05$) among different experimental groups.

Table (3) Growth performance of growing chicks fed the experimental diets

Breed	Group	Feed intake	Initial BW	Final BW	BWG	RGR%	FCR
Cobb	Control	3693.87a^{ab}±77.06	39.54^{a}±0.69	2104.18^{abc}±43.87	2064.64^{abc}±43.33	192.62^{ab}±0.09	1.79^{ab}±0.02
	Organic	3549.77^{b}±180.23	40.15^{a}±0.40	2176.51^{ab}±72.80	2136.37^{ab}±73.16	192.74^{a}±0.30	1.66^{b}±0.04
	Prebiotic	3549.04^{b}±97.61	40.75^{a}±0.54	1985.14^{c}±14.30	1944.39^{c}±14.23	191.95^{bc}±0.11	1.83^{a}±0.06
	Enzyme	3648.85^{ab}±78.34	40.60^{a}±1.18	2040.03^{bc}±45.56	1999.43^{bc}±45.72	192.19^{abc}±0.30	1.83^{a}±0.05
IR	Control	3814.73^{ab}±21.24	42.27^{a}±0.95	2238.87^{a}±66.81	2196.60^{a}±65.86	192.59^{ab}±0.05	1.74^{ab}±0.04
	Organic	3623.90^{b}±86.95	43.78^{a}±0.76	2120.59^{abc}±27.83	2076.81^{abc}±28.33	191.90^{bc}±0.22	1.74^{ab}±0.02
	Prebiotic	3610.91^{b}±99.63	43.94^{a}±0.84	2086.27^{abc}±69.57	2042.33^{abc}±69.37	191.73^{c}±0.29	1.77^{ab}±0.05
	Enzyme	3988.84^{a}±156.85	42.71^{a}±0.53	2172.15^{ab}±67.07	2129.43^{ab}±66.83	192.27^{abc}±0.21	1.87^{a}±0.02

Means within the same column carrying different superscripts are significant at ($P \leq 0.05$)

Table (4) Feed additives cost and total feed cost (L.E /chick)

Breed	Group	Feed additive cost Mean±Std. Error	Total feed cost Mean±Std. Error
Cobb	Control	-	14.78^{ab}±0.31
	Organic	0.13^{b}±0.01	14.20^{b}±0.72
	Prebiotic	0.18^{a}+0.001	14.20^{b}±0.39
	Enzyme	0.03^{c}+0.001	14.60^{ab}±0.31
IR	Control	-	15.26^{ab}±0.08
	Organic	0.13^{b}+0.001	14.50^{b}±0.35
	Prebiotic	0.18^{a}+0.001	14.44^{b}±0.40
	Enzyme	0.04^{c}+0.001	15.96^{a}±0.63

Means within the same column carrying different superscripts are significant at ($P \leq 0.05$)

Table (5) Total returns parameters (L.E /chick)

Breed	Group	Broiler selling	Litter selling	Total return
		Mean±Std. Error	Mean±Std. Error	Mean±Std. Error
Cobb	Control	42.08^{abc}±0.88	0.18^{a}±0.01	42.26^{abc}±0.88
	Organic	43.53^{ab}±1.46	0.18^{a}±0.001	43.71^{ab}±1.45
	Prebiotic	39.70^{c}±0.29	0.18^{a}±0.01	39.88^{c}±0.28
	Enzyme	40.80^{bc}±0.91	0.18^{a}±0.001	40.98^{bc}±0.91
IR	Control	44.78^{a}±1.34	0.18^{a}±0.001	44.96^{a}±1.33
	Organic	42.41^{abc}±0.56	0.18^{a}±0.01	42.59^{abc}±0.55
	Prebiotic	41.73^{abc}±1.39	0.18^{a}±0.001	41.90^{abc}±1.39
	Enzyme	43.44^{ab}±1.34	0.18^{a}±0.01	43.62^{ab}±1.34

Means within the same column carrying different superscripts are significant at ($P \leq 0.05$).

Table (6) Economic efficiency parameters

Breed	Group	Total Return	Total Cost	Net Profit	Total Return /Total Cost	Profit /Total Cost
		Mean±Std. Error	Mean±Std. Error	Mean±Std. Error	Mean±Std. Error	Mean±Std.Error
Cobb	Control	42.26^{abc}±0.88	26.79^{a}±0.29	15.47^{ab}±0.62	1.58^{a}±0.02	0.58^{a}±0.02
	Organic	43.71^{ab}±1.45	28.43^{a}±1.65	15.27^{ab}±2.14	1.55^{a}±0.10	0.55^{a}±0.10
	Prebiotic	39.88^{c}±0.28	26.38^{a}±0.40	13.50^{b}±0.61	1.51^{a}±0.03	0.51^{a}±0.03
	Enzyme	40.98^{bc}±0.91	26.17^{a}±0.74	14.81^{ab}±0.92	1.57^{a}±0.04	0.57^{a}±0.04
IR	Control	44.96^{a}±1.33	27.25^{a}±0.07	17.71^{a}±1.27	1.65^{a}±0.05	0.65^{a}±0.05
	Organic	42.59^{abc}±0.55	26.61^{a}±0.35	15.99^{ab}±0.20	1.60^{a}±0.001	0.60^{a}±0.001
	Prebiotic	41.90^{abc}±1.39	26.62^{a}±0.42	15.28^{ab}±1.19	1.57^{a}±0.04	0.57^{a}±0.04
	Enzyme	43.62^{ab}±1.34	28.00^{a}±0.63	15.62^{ab}±0.72	1.56^{a}±0.01	0.56^{a}±0.01

Means within the same column carrying different superscripts are significant at ($P \leq 0.05$)

4. Discussion

Feed consumption was varied among different breeds, IR breed consumed more amount of feed than Cobb breed, the highest total feed intake value was found for IR group treated with enzyme (3988.84gm), while the lowest value was found for Cobb group treated with prebiotic (3549.04gm). These results in agreement with [27] who mentioned that there was a significant decrease in feed intake by prebiotic supplementation, while disagree with [28, 29] who found that feed intake was higher for prebiotics supplemented group compared with control one at (0-6th) week of age. Regarding the enzyme result [30, 31] mentioned that feed intake increased by xylanase supplementation , while disagree with those reported by [32, 33] they indicated that addition of enzyme resulted in low feed intake in broilers.

Concerning the body weight at the end of experiment, Cobb group treated with OA showed the highest body weight (2176.51gm), while control group of IR breed showed the highest body weight (2238.87gm), and the lowest value was found for prebiotic treated group of both Cobb and IR breed. These results agree with [34, 35]they found that body weight at the 6th week of age was higher in Cobb breed treated with OA than control group, while disagree with[14]who clarified that body weight decreased by organic acid supplementation. In regard to prebiotic result, it was agree with [36] who concluded that prebiotic supplementation decreased the body weight of broilers at the six week of age, while disagree with [27, 37] they stated that weight of broiler at the 6th week of age was higher in prebiotic group compared to control group.

In regard to final BWG, all experimental groups except OA group of Cobb breed showed lower value than the control group. Beneficial effect of OA may be attributed to protein digestion improvement by stimulating pancreatic enzyme secretion [38]. This result was in accordance with [39, 40] who reported that BWG was higher in OA group than control one. Concerning the prebiotic result, it was in accordance with [36] who found that body weight gain was lower in prebiotics supplemented group compared with control. On the other hand [29, 37] concluded that body weight gain increased by prebiotics supplementation. In regard to enzyme results [33] concluded that body weight gain decreased by enzyme supplementation, while [41] stated that body weight gain increased by addition of enzymes to broilers diet.

Results of final relative growth rate showed significant differences ($p \leq 0.05$) for Cobb and IR breeds. It was the highest for OA group of Cobb breed (192.74 %), while the lowest value was found for prebiotic group of IR breed (191.73%). The previous findings for organic acid supplementation agreed with [35, 42] they reported that of OA supplementation had positive effect on growth performance of broilers, this may be due to reduction of pH values in digestive tract, that act as a barrier against pathogenic microorganisms which are highly sensitive to low pH values and direct antimicrobial effect with improving digestibility [43]). Concerning the result of prebiotic treated group, it was disagree with [28, 44] who clarified that addition of prebiotics improved growth performance of bird.

Our results showed that final feed conversion rate value was the highest for enzyme group of IR breed (1.87), while the lowest value was found for OA group of Cobb breed (1.66). The above results are in accordance with those obtained by [31] they clarified that feed conversion rate value was higher in enzyme treated group than control group (at 21 day, 35 day and at 42 day of age), while disagree with [45] who indicated that FCR improved by xylanase supplementation. Regarding to the result of organic acid addition, it agreed with [35, 46, 47] who reported that addition of OA resulted in improving feed conversion rate, while disagree with [48] who stated that feed conversion (42 day) was lower in acidifier treated group compared to control.

Regarding total feed cost, there were significant differences ($p \leq 0.05$) for both Cobb and IR breeds. Value of feed cost vary among different groups, the highest value was found for enzyme group of IR breed (L.E 15.96), while the lowest value was found for OA and prebiotic groups of Cobb breed (L.E 14.20). These results were in agreement with[49] who clarified that feed cost increased by enzyme supplementation. On the other hand [50] reported that economic benefits from exogenous enzymes utilization on poultry nutrition is related to feeding costs reduction.

Additive cost, had a significant difference ($p \leq 0.05$) for both Cobb and IR breeds. It differed according to the type of feed additive that added, they were about L.E 0.13 for OA group of both breed, while enzyme group ranged from L.E 0.03 to 0.04 (for Cobb and IR breed, respectively), and was about L.E 0.18 for prebiotic group of both breed.

Our results showed that total return, was significantly differed ($p \leq 0.05$) among different groups of both breeds. Value of total return was higher in IR breed than Cobb breed (L.E 44.96 and 42.26, respectively). This result agreed with [51] who concluded that total returns differed significantly ($p \leq 0.05$) among the breeds within different seasons. The highest value was found for control group of IR breed followed by OA treated group of Cobb breed (L.E 44.96 and 43.71, respectively), while the lowest value was recorded in prebiotic treated of Cobb breed (L.E 39.88) followed by enzyme group of same breed (L.E 40.98). In regard to enzyme result [52] reported that no monetary benefits from including the enzymes in poultry diets as there were non-significant effect on final BW. Furthermore, birds fed Control diets weighed heavier than birds fed enzyme-supplemented diet. Concerning prebiotic result these results disagreed with[53, 54] they reported that prebiotics can improve the weight of birds.

Net profit value was the highest for control group of IR breed followed by OA treated group of the same breed (L.E 17.71 and 15.99 respectively), while the lowest value was found for prebiotic treated of Cobb breed followed by enzyme treated group of same breed (L.E13.50 and 14.81 respectively). These results were in agreement with [47] who found that commercial mixture of organic acids (Galliacid®) improved the net profit and economic efficiency.

5. Conclusion

From the previous results we concluded that the lowest feed cost was found for OA and prebiotic groups of Cobb breed, and the best total return was found for control group of IR breed and OA group of Cobb breed, it would be concluded that organic acid was better than other used feed additives, and they had an important role in improving economic and productive efficiency of Cobb broiler Chicks'.

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