

USING FEED ADDITIVES FOR BETTER UTILIZATION OF PHOSPHORUS AND NITROGEN IN BROILERS FEEDS

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ABSTRACT

One hundred fifty Arbor Acers broiler chicks were distributed into five groups to study effects of using sodium formate, formic acid, Lactobacillus acidophilus and beta mannanase enzyme, in broiler feeds, on production performance, carcass traits, blood parameters, tibia properties and economic efficiency. Each group of birds, was divided into three replicates of ten chicks. The control group was fed basal (starter, grower and finisher) with no additives (T1), while other groups were offered basal diets supplemented with 2g sodium formate/kg (T2); 2 ml formic acid / kg (T3); 1g Lactobacillus acidophilus/ kg (T4) and 0.3 g beta mannanase/ kg (T5), respectively. The results indicated that all production performance parameters: initial and final body weight, daily body weight gain, daily feed intake and feed conversion ratio, were not significantly affected by treatments throughout experimental period. Also, data of carcass, indicated that treatments had no significant effects compared with control group. Plasma total protein, uric acid, calcium, phosphorus and activity of alkaline phosphatase, were significantly different within groups. Tibia bone parameters: breaking force, density, robusticity index, Seedor index, were not significantly affected by treatments. Economical evaluation showed that, relative economic efficiency, was improved with chicks fed (T2) or (T3) diets, while those fed (T4) or (T5) diets, recorded lower values. It could be concluded that, supplementation of basal diets with sodium formate or formic acid enhanced economic efficiency of broiler chickens, without affecting performance or carcass traits.

Key words: feed additives, performance, carcass, economic efficiency.

INTRODUCTION

Poultry excreta contain significant quantities of nitrogen, phosphorus, and other expelled elements which were presented in their feeds (FAO, 2006). Besides, conversion of feed nitrogen is fairly inefficient; about 50 - 80 percent of the nitrogen is excreted (Arogo *et al.*, 2001).

Regarding phosphorus, using plant-based feedstuffs, results in excess phosphorus excretion and might cause ecologic pollution (Nahm and Carlson, 1998). Using organic acids in poultry feeds increase mineral utilization due to the complex of acid anion with calcium, phosphorus, magnesium and zinc, resulting in higher utilization of these minerals (Andreopoulou *et al.*, 2014).

Several scientific reports demonstrated that organic acids might stimulate natural immune response of poultry, reducing activity of pathogenic bacteria (Cross, 2002; Dalloul *et al.*, 2003). As well, formic acid and its salts improve productivity, mineral utilization, protein digestibility, acting against pathogens, which improves bird's immune system. (Hebeler *et al.*, 2000; Desai *et al.*, 2007; Abdelhady *et al.*, 2015). Several nutritional studies indicated that using formic acid or formate salts in broiler feeds, improved mineral utilization (Selle *et al.*, 2004) weight gain (Panda *et al.*, 2009), feed efficiency (Helen and Christian, 2010), feed intake (Abdelaziz, 2015). The function of probiotics as natural feed supplements is based upon inhibiting harmful bacteria and lowering intestinal pH via production of volatile fatty acids (Makled, 1991; Seleem *et al.*, 2011).

However, probiotics can only be effective, as their growth requirements are present in bird's intestine. Nematallah *et al.* (2015) reported that, using probiotics at 0.5 g/ kg feed, appeared adequate to achieve satisfactory results.

Feed-added enzymes improve nutrient and energy digestibility of poultry feeds (Yang *et al.*, 2010; Hahn-Didde and Purdum, 2014).

Generally, feed viscosity is reduced by plant cell walls breakdown, which includes proteins and antinutritional factors (Cowieson, 2010; Perazzo Costa *et al.*, 2015). Commonly, using nutritional matrix of enzyme products is suggested for feed formulation, allowing reduction of feed energy, phosphorus, protein, and amino acid contents (Campasino *et al.*, 2015), which present benefits of reducing environmental pollution and reduced feed costs (Dersjant-Li *et al.*, 2015).

The present study was carried out to investigate effects of using sodium formate, formic acid, *Lactobacillus acidophilus* and Beta Mannanase on performance, carcass, blood plasma, tibia bone and economic efficiency of broilers.

MATERIALS AND METHODS

This study was carried out at poultry production department experimental farm, faculty of agriculture, Ain Shams University, Egypt, in order to investigate the effect of using sodium formate, formic acid, *Lactobacillus acidophilus* and beta mannanase enzyme, on growth performance, carcass characteristics, blood parameters, tibia traits and economic efficiency of broilers.

Experimental diets and birds: At the present trial, 150 sex-mixed one-day-old age Arbor Acers broiler chicks, distributed over 5 groups up to 35 days of age. Birds were allocated in wire batteries with feed and water provided ad-libitum, during whole experimental period. Each treatment contained 3

replicates of 10 broiler chicks. Daily lighting program was about 22 hours light + 2 hours dark. The composition and calculated analyses of basal diets (starter, grower and finisher) are presented in Table (1). The diets were formulated based on corn-soybean meal as prescribed by NRC requirements (1994). Treatments were: T1: (control diet) basal diet without additives; T2: basal diet + sodium formate 2 g/ kg feed; T3: basal diet + formic acid 2 ml/ kg feed; T4: basal diet + *Lactobacillus acidophilus* 1 g/ kg feed and T5: basal diet + beta mannanase enzyme 0.3 g/ kg feed.

Birds' performance: Live body weight and feed intake for each replicate of all groups during the experimental period were recorded. Body weight gain and feed conversion ratio were calculated during the same period.

Table (1): Feed ingredients and chemical analyses of basal diets.

Ingredients	Basal Diets		
	Starter (0-14 days)	Grower (15-28 days)	Finisher (29-35 days)
Yellow Corn Grains	51.72	57.34	62.68
Soy Bean Meal 44%	35.00	29.79	24.70
Corn Gluten Meal 60%	5.20	4.90	4.60
Lime Stone (CaCO ₃)	1.35	1.10	1.08
Di-Ca Phosphate	1.90	1.68	1.55
Salt (NaCl)	0.40	0.40	0.40
Premix*	0.30	0.30	0.30
Plant Oil	3.50	4.00	4.25
DL-Methionine	0.31	0.24	0.21
Lysine – HCl	0.32	0.25	0.23
Total	100	100	100
Calculated Chemical Analysis			
Crude Protein %	23.01	21.01	19.04
ME Kcal/ Kg diet	3046	3159	3238
Calcium %	1.07	0.90	0.85
Available Phosphorus %	0.51	0.45	0.42
Lysine %	1.45	1.25	1.10
Methionine & Cysteine %	1.08	0.95	0.87

* Each 3 Kg of premix contains: Vitamins: A: 12000000 IU; D3: 2000000 IU; E: 10000 mg; K3: 2000 mg; B1:1000 mg; B2: 5000 mg; B6:1500 mg; B12: 10 mg; Biotin: 50 mg; Choline chloride: 250000 mg; Pantothenic acid: 10000 mg; Nicotinic acid: 30000 mg; Folic acid: 1000 mg; Minerals: Mn: 60000 mg; Zn: 50000 mg; Fe: 30000 mg; Cu: 10000 mg; I: 1000 mg; Se: 100 mg and Co: 100 mg.

Slaughter and carcass: At 35 days of age, slaughter of birds was performed using three chickens selected according to average live body weight of each treatment. carcass characteristics as dressed carcass, liver, heart, gizzard,

giblets and edible parts were estimated as a percentage in relation to live weight of birds.

Blood plasma: Blood samples of chosen chickens were taken during slaughtering into collecting tubes with heparin. Plasma were separated by centrifugation at speed of 3000 rpm for about 10 minutes, then transferred into clean vials and stored in a deep freezer for later analyses. Plasma constituents including total protein, albumin, creatinine, urea, uric acid, calcium, phosphorus and activity of alkaline phosphatase were determined calorimetrically by commercial diagnostic kits using a spectrophotometer.

Tibia bones: Tibia bone traits were recorded as described; volume (Zhang and Coon, 1992), Seedor index (Seedor *et al.*, 1991), Robusticity index (Reisenfeld, 1975) and Breaking force (Rowland *et al.* 1967).

Economical traits: Economic assessment and production cost analysis were carried out for all groups to investigate effects of different feed additives inclusion on relative economic efficiency.

Statistical Analysis: Data were analyzed using the general linear model (GLM) procedure of SAS (2004). Means were compared using Duncan's Multiple Rang test (Duncan, 1955).

The statistical model was: $Y_{ij} = \mu + T_i + e_{ij}$

Where: Y_{ij} = observation of measured parameter, μ = overall mean

T_i = diet treatment (i: 1 to 5), e_{ij} = experimental error

RESULTS AND DISCUSSION

Productive performance: As shown in Table (2), values of live body weight (LBW), daily body weight gain (DBWG), daily feed intake (DFI) and feed conversion ratio (FCR), were not significant different between basal diet and

all treatments. However, numerically, (T4) had the lowest one in LBW and DBWG. Also, (T2) and (T3) were the best treatments for FCR. That's mean, these additives had no effects on the growth performance, but improved FCR especially Sodium formate, and formic acid little bit than other treatments, but these differences failed to reach significances. These results in agreement with those of Higgins *et al.*, (2008); El-Faham *et al.*, (2014) and Abdelaziz (2015).

Table (2): Effect of treatments on productive performance

Items	Experimental Treatments					Sig.
	T1	T2	T3	T4	T5	
LBW (g) (1 day)	38.83 ±0.01	38.44 ±0.01	38.73 ±0.01	39.60 ±0.01	40.09 ±0.01	NS
LBW (g) (35 days)	1859.58 ±60.45	1888.70 ±29.62	1883.38 ±62.21	1770.01 ±25.01	1806.30 ±44.16	NS
DBWG (g/ day) (0-35 days)	52.02 ±1.72	52.86 ±0.84	52.70 ±1.77	49.44 ±0.71	50.46 ±1.25	NS
DFI (g/day) (0-35 days)	84.25 ±0.30	82.48 ±1.04	83.10 ±2.79	82.72 ±2.53	84.02 ±1.36	NS
FCR (0-35 days)	1.62 ±0.04	1.56 ±0.02	1.57 ±0.01	1.67 ±0.04	1.66 ±0.04	NS

Sig. = Significance, NS: Non-Significant.

Similar observation was reported by Loddi *et al.*, (2000) who found that there were no beneficial effects of probiotic supplementation and negative influenced body weight and weight gain of broilers. On the other hand, these results were in contrast with the results obtained by Tollba *et al.* (2004), Nagla *et al.* (2012), Awad *et al.* (2013) and Nematallah *et al.* (2015) who reported that increased significantly adding the tested biological additives or different types of organic acids increased significantly live body weight and

weight gain than control, these additives or different types of organic acids and their salts improved protein and energy digestibility by reducing microbial competition with birds for nutrients. Also, this limits endogenous nitrogen loss with decreasing occurrence of sub-clinical contamination. Also, reducing the production of ammonia as indirect effect and other growth suppressing microbial metabolites. So, broilers that fed organic acids or their salts can be improved nutrient utilization, enlarged gut surface and counteract potential pathogenic bacteria without any significant differences as reported by Vale *et al.* (2004); Leeson *et al.* (2005) and Gunal *et al.* (2006).

Carcass characteristics: Table (3) showed the carcass traits as affected by treatments. All traits were not significantly affected by treatments. However, numerically dressed carcass percentage had the lowest in T3 and T4. Also, numerically, gizzard percentage was the highest in value T5 than other treatments and control. These results in agreement with those postulated by Abdel-Azeem and Hamid (2000); El-Yamny and Fdel (2004) and Nematallah *et al.*, (2015) who reported that growth promoters had no significant differences among all groups in carcass weight and dressing percentage. These results are in contrast with the results obtained by Leeson *et al.*, (2005) in broiler chickens and Abdel-Mageed (2012) in Japanese quail. They found that feeding butyric acid supplemented diets lead to significantly increased on carcass parameters.

Table (3): Effect of treatments on some carcass characteristics

Items	Experimental Treatments					Sig.
	T1	T2	T3	T4	T5	
Dressed carcass %	71.06 ±1.23	70.14 ±0.14	68.15 ±0.21	68.67 ±1.04	69.71 ±0.95	NS
Liver %	2.41 ±0.12	2.19 ±0.20	2.24 ±0.17	2.24 ±0.15	2.17 ±0.10	NS
Gizzard %	0.90 ±0.08	0.93 ±0.08	0.79 ±0.06	0.89 ±0.05	1.10 ±0.02	NS
Heart %	0.52 ±0.04	0.56 ±0.03	0.59 ±0.02	0.54 ±0.02	0.52 ±0.04	NS
Giblets¥ %	4.20 ±0.16	4.20 ±0.24	4.19 ±0.24	4.12 ±0.18	4.28 ±0.21	NS
Total Edible Parts # %	75.27 ±1.39	74.34 ±0.38	72.34 ±0.32	72.79 ±1.07	74.01 ±0.94	NS

Sig. = Significance, ¥ Giblets = Liver + Gizzard + Heart, # Total Edible Parts = (dressed carcass + giblets), NS: Non-Significant.

Blood plasma parameters: Effect of treatments on some blood parameters illustrated in Table (4). Total protein had significant difference, and that related to growth performance and that means these additives had improved growth and the best one that birds fed (T2) and the lowest one was (T4). Although albumin and globulin had no significant difference, but (T2) and (T3) had the best values compared with control and other treatments. Also, globulin value for birds that fed (T2) had better than other treatments and control numerically. That's mean bird's immunity had improved by this treatment. Concerning to A/G ratio, the best treatment was (T5) then control compared with other treatments. Regarding to kidney function; creatinine and urea values were not significant different between treatments and control. So, these additives had no adverse effects on kidney function. About uric acid concentration, the highest value was recorded for (T5) compared with control

and other treatments. So, enzyme supplemented had a worse effect on kidney function or this enzyme had effect and increased the protein metabolism than other treatments and control that led to increase uric acid concentration in blood. Concerning to calcium values, (T2) and (T4) had increased Ca levels than other treatments and control, and (T5) the lowest value. Phosphorus concentration, control and (T3) had the highest values than other treatments. That's mean these treatments had increased the Ca, and P metabolism. Regarding to activity of alkaline phosphatase (ALP), (T4) had the lowest one then (T3) compared to control and other treatments. It's worthy to note that (T3) and (T4) had decreased the ALP concentration and the differences had highly significant ($P \leq 0.01$). It's logically ALP activity and Ca and P concentrations have related to each other. When Ca and P concentrations decreased, the activity of ALP increased in the serum of broilers (Rama Rao *et al.*, 2006).

These results are disagreement with those reported by many investigators (Kalavathy *et al.*, 2003; Abdel-Azeem and Hamid, 2006; Abdallah *et al.*, 2008; Nematallah *et al.*, 2015). They reported that there were no significant differences in blood parameters (Tp., Alb., and Glo), due to probiotic supplementation. On the other hand, Tollba *et al.*, (2004) postulated that adding probiotic additives to broiler feeds increase plasma Tp, Alp, Glo, compared to control.

Table (4): Effect of treatments on some blood plasma parameters

Items	Experimental Treatments					Sig.
	T1	T2	T3	T4	T5	
Total Protein g / dL	3.75 ^{ab} ±0.37	3.97 ^a ±0.23	3.73 ^{ab} ±0.21	3.09 ^b ±0.10	3.66 ^{ab} ±0.17	*
Albumin g / dL	1.89 ±0.09	2.06 ±0.06	1.98 ±0.05	1.89 ±0.05	1.81 ±0.13	NS
Globulin g / dL	1.85 ±0.28	1.91 ±0.19	1.74 ±0.17	1.20 ±0.11	1.85 ±0.23	NS
Albumin/ Globulin ratio	1.06 ^b ±0.12	1.10 ^{ab} ±0.11	1.15 ^{ab} ±0.10	1.61 ^a ±0.18	1.03 ^b ±0.21	NS
Creatinine mg / dL	0.47 ±0.03	0.47 ±0.03	0.52 ±0.09	0.46 ±0.02	0.39 ±0.01	NS
Urea mg / dL	7.10 ±0.78	6.93 ±0.73	7.50 ±0.60	8.76 ±0.52	8.50 ±1.81	NS
Uric Acid mg / dL	4.38 ^c ±0.16	4.84 ^c ±0.43	6.41 ^b ±0.38	6.31 ^b ±0.80	8.72 ^a ±0.23	**
Calcium mg / dL	10.46 ^{bc} ±0.40	13.10 ^a ±0.66	10.60 ^{bc} ±0.72	11.93 ^{ab} ±0.46	9.50 ^c ±0.73	**
Phosphorus mg / dL	3.98 ^{ab} ±0.16	4.83 ^a ±0.40	3.96 ^{ab} ±0.04	4.92 ^a ±0.52	3.43 ^b ±0.12	*
ALP U/L	2885 ^b ±185	2732 ^b ±287	2065 ^c ±153	1853 ^c ±65	3470 ^a ±159	**

a, b Means within the same row with different superscripts are significantly different. Sig. = Significance, ** (P≤0.01), * (P≤0.05). NS: Non-Significant.

Tibia traits: Table (5) showed the effect of treatments on some tibia indices. Although there were not significant differences between control and other treatments, but numerically tibia breaking force had the best values for (T4) and (T5) and that's mean these additives improved the breaking force than control and other treatments. Also, density of tibia for (T3) and (T4) had the highest values than control and other treatments and these results had harmonious with ALP concentrations levels, and that led to these treatments improved the density of tibia. Finally, (T3) and (T5) had the highest values

for tibia Seedor index than control and other treatments. It's worth to note that most of the additives had improved the growth performance, carcass traits, some blood parameters and tibia indices without any adverse effect on bird's health and that elucidated by blood parameters.

Table (5): Effect of treatments on some tibia indices

Items	Experimental Treatments					Sig.
	T1	T2	T3	T4	T5	
Tibia Breaking Force (Kg)	25.16 ±2.41	25.37 ±4.31	26.35 ±2.79	31.52 ±2.04	31.36 ±2.59	NS
Tibia Density (g/ cm ³)	1.19 ±0.01	1.19 ±0.02	1.22 ±0.01	1.22 ±0.01	1.18 ±0.01	NS
Tibia Robusticity Index	3.96 ±0.05	3.91 ±0.07	3.95 ±0.03	3.94 ±0.04	3.91 ±0.06	NS
Tibia Seedor Index	1.19 ±0.08	1.24 ±0.05	1.33 ±0.01	1.29 ±0.06	1.33 ±0.06	NS

a, b, c, d Means within the same row with different superscripts are significantly different. Sig. = Significance, ** (P≤0.01), * (P≤0.05).

Economic parameters: Calculations economic efficiency of feeds were carried out according to the prices of feed ingredients, additives and live body weight as shown in Table (6). Feeding relative economic efficiency values of broiler chickens were improved by 107.75 and 103.85% for the groups fed diets supplemented with sodium formate (T2) and formic acid (T3), respectively when compared to control (T1) group (100%) during overall period (0-35 days). On the other hand, chickens fed diets supplemented with *Lactobacillus acidophilus* or beta mannanase (T4 and T5) had lower values, being 84.62 and 90.52%, respectively.

Table (6): Effect of treatments on some economic traits

Items	Experimental Treatments				
	T1	T2	T3	T4	T5
Feed Cost / Bird (LE)	18.87 ±0.07	18.61 ±0.22	18.88 ±0.63	18.90 ±0.58	18.90 ±0.31
Total Cost [¥] / Bird (LE)	31.87 ±0.07	31.61 ±0.22	31.88 ±0.63	31.90 ±0.58	31.92 ±0.31
Total Return [#] Bird (LE)	46.49 ±1.51	47.22 ±0.74	47.08 ±1.55	44.25 ±0.62	45.15 ±1.10
Net Return / Bird (LE)	14.61 ±1.44	15.60 ±0.66	15.19 ±0.92	12.35 ±0.56	13.23 ±1.02
Economic Efficiency	45.82 ±4.47	49.37 ±2.06	47.58 ±1.92	38.77 ±2.15	41.48 ±3.16
Relative Economic Efficiency [⌘]	100.00	107.75 ±4.50	103.85 ±4.20	84.62 ±4.70	90.52 ±6.90

¥ Total cost = (feed cost + price of one-day live chicks + incidental costs); L.E.: Egyptian Pound

According to the local price of Kg sold live birds which was 25.00 L.E.

⌘ Assuming that the relative economic efficiency of control group equals 100.

These results agreed with those of El-Faham *et al.* (2014) who found that chicks fed diets contained with *Lactobacillus acidophilus* had lower relative economic efficiency when compared to control group. Additionally, Abdelaziz (2015) indicated that, sodium formate as feed additive could be included at different levels in broiler feeds presenting better economic efficiency of feeds. These results are in contrast with those of Qota *et al.* (2002) who reported insignificant effect of probiotic supplementation on economic efficiency of broiler feeds up to 42 days of age. Alternatively, Soliman *et al.* (2003) found that inclusion of probiotic or herbal feed

additives in broiler feeds, resulted in least feed cost per kg gain and the higher percent of economic efficiency as compared with control group.

CONCLUSION

Thus, it could be concluded that, supplementation of basal diets with formic acid or its sodium salt, enhanced performance and economic efficiency of broiler chickens. These additives present a promising tool for reducing the risk environmental pollution with phosphorus and/ or nitrogen through better utilization of these elements in poultry feeds.

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إستخدام إضافات غذائية لتحسين الإستفادة من عنصرى الفوسفور والنيتروجين فى الأعلاف دجاج التسمين

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المستخلص

أجريت تجربة للتعرف على تأثير إضافة فورمات صوديوم، حامض فورميك، لاکتوباسيلس أسيدوفلس أو بيتامنايز، لعلائق بدارى التسمين المكونة من ذرة + كسب فول صويا على الأداء الإنتاجي وصفات الذبيحة وبعض مكونات بلازما الدم وصفات عظم الساق والكفاءة الاقتصادية. حيث استخدم فى التجربة عدد ١٥٠ كتكوت اربوايكرز عمر يوم ووزعت على (خمس معاملات غذائية/ ثلاث مكررات/ عشرة كتاكيت). وكانت المعاملات: كمنترول (بدون إضافات) عليقة قاعدية بادية، نامي، ناهي (T1)؛ عليقة قاعدية + ٢ جم فورمات صوديوم/ كجم (T2)؛ عليقة قاعدية + ٢ ملل حامض فورميك / كجم (T3)؛ عليقة قاعدية + ١ جم لاکتوباسيلس أسيدوفلس / كجم (T4) و عليقة قاعدية + ٠,٣ جم بيتامنايز/ كجم (T5). أوضحت النتائج المتحصل عليها عدم تأثير كافة مؤشرات الأداء الإنتاجي لبدارى التسمين (وزن الجسم الحي المبدئى والنهائى، معدل الوزن المكتسب اليومي، استهلاك العلف اليومي ومعامل التحويل الغذائى معنوياً بالمعاملات الغذائية طوال الفترة التجريبية. بالإضافة إلى عدم تأثير جميع الصفات المقاسة للذبيحة بالمعاملات الغذائية. محتوى بلازما الدم من البروتينات الكلية، حمض اليوريك، الكالسيوم، الفوسفور، ونشاط إنزيم ألكالين فوسفاتيز إختلف معنوياً فيما بين المجموعات. مؤشرات عظم الساق (قوة الكسر، الكثافة، دليل المتانة و دليل سيدور) لم تتأثر معنوياً بالمعاملات الغذائية. أوضحت معدلات الكفاءة الإقتصادية النسبية تفوق الطيور المغذاة (T2) أو (T3) على مجموعة الكمنترول، أما المعاملات (T4) و (T5) فقد سجلت أقل كفاءة إقتصادية. لذلك فإن إضافة فورمات صوديوم أو حمض الفورميك إلى العلائق القاعدية لبدارى التسمين أدى إلى تحسن الكفاءة الاقتصادية بدون التأثير على الأداء الإنتاجي وصفات الذبيحة والحالة الصحية لهذه الطيور.

الكلمات الدالة: إضافات الاعلاف، الاداء، الهيكل، الكفاءة الاقتصادية.