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INFLUENCE OF PROBIOTIC, PREBIOTIC AND/OR YEAST SUPPLEMENTATION IN BROILER DIETS ON THE PRODUCTIVITY, IMMUNE RESPONSE AND SLAUGHTER TRAITS

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ABSTRACT

A total of 630 Arbor Acres broiler chicks one-day old were used to study the effect of probiotic, prebiotic and/or yeast supplementation on the productive performance, immune response and slaughter traits. Chicks were divided randomly into 6 treatments and housed at deep litter in an open house system. Each treatment replicated 3 times (35 chicks per replicate). Treatments were as follows: T1 (control; chicks fed corn-soy basal diet) and in the other treatments diets were supplemented with 1g probiotic/kg diet as Lactobacillus acidophilus (T2), 1g yeast/kg diet as Saccharomyces cervisiae ($5x10^{12}$ CFU/g); (T3),1g prebiotic/kg diet as mannan-oligosaccharide (T4), 1g probiotic+1g prebiotic/kg diet (T5) or 1g yeast+1g prebiotic/kg die (T6). Results indicated that body weight, body weight gain, feed consumption and feed conversion ratio were improved and mortality rate was decreased in response to dietary biological feed additives. Body weight at 42 days of age was significantly heavier by about 29.5, 21.2, 12.4, 11.3 and 9.9% than control in the T6, T5, T4, T3 and T2, respectively. Moreover, all biological additives caused a significant increment in the count of erythrocytes, leukocytes, lymphocytes, heterophils, H/L ratio and the antibody titer against SRBC's. Dressing, internal organs and immune organs relative weights at 42 days of age were significantly improved by using biological feed additives. For all traits, the best values were obtained in T6 followed by T5. Also, T6 gave the best relative economical efficiency (14.70% more than control group). It could be recommended from this study that supplementation the biological additives to broiler diet from 0 to 42 days of age, as above mentioned, has a positive effect on the productivity, immune response, slaughter traits and the economical efficiency.

Keywords: Probiotic, Prebiotic, Yeast, Broiler Performance, Immune response

INTRODUCTION

Recently, supplementing broiler diets with non-feed additives may be an alternative way to improve protein utilization, digestion and promote broiler performance. The continuous search for maximum feed efficiency in modern poultry production has been considered to be a critical point in broiler rearing. Therefore, probiotics has been used as natural biological non-feed additives which have beneficial effects to poultry by improving its intestinal microbial balance to stimulate the processes of digestion and absorption of nutrients *(Pelicano et al., 2002)*.

Practically, the addition of probiotic to broiler diets has been shown to be responsible for improved growth and feed conversion ratio *(Kalavathy et al., 2003)*. Regarding prebiotic, it has been defined as non-digestible feed ingredients, which are growth substrates, especially directed towards potentially beneficial bacteria already existing in caecum and colon. Several studies have shown that the addition of prebiotics to broiler diet improved performance through improving gut microflora balance *(Xu et al., 2003 and Pelicano et al., 2004)*. In respect to yeast, it is a bio-stimulator and immunomodulator which containing live bacterial cultures, that can regulate and optimize the ratios among the different types of micro-organisms in the digestive system, preventing upsets and exerting a stimulating affect on the disintegration and absorption of the nutrient substances *(Balevi et al., 2000)*. Newly, manufactures are producing live yeast (*Saccharomyces cervisiae)* commercially as growth promoter to avoid the adverse effects of stressful environmental conditions. Results of *Santin et al. (2003)* revealed that yeast can improve immune activity of birds and reduce the toxic effects of aflatoxin.

The present work was conducted to study the effects of using probiotic, prebiotic and/or yeast as biological feed additives in broiler diets on productive performance, immune response and slaughter traits. Also, evaluating economical efficiency as net revenue per unit of total feed costs was undertaken.

MATERIALS AND METHODS

The present study was carried out in Poultry Research Farm, Animal Production Department, Faculty of Agriculture, Cairo University from April to May, 2009 for 6 weeks life span. A total of 630 Arbor Acres broiler chicks one-day old were used to study the effect of dietary probiotic, yeast and prebiotic on the productive performance, immune response and carcass yield. At one-day old, chicks were wing banded and divided randomly, into 6 equal treatments 105 chicks each in 3 replicates with 35 chicks for each. **Treatments are specified as follows:**

1- T1: served as control group and fed corn-soybean basal diet.

2- T2: chicks were fed the basal diet as *Lactobacillus acidophilus* (1g/kg diet).

3- T3: chicks were fed the basal diet supplemented with 1g yeast per kg diet as *Saccharomyces cervisiae* ($5x10^{12}$ CFU/g).

4- T4: chicks were fed the basal diet supplemented prebiotic as mannan-oligosaccharide (1g/kg diet).

5- T5: chicks were fed the basal diet supplemented with 1g probiotic+1g prebiotic per kg diet.

6- T6: chicks were fed the basal diet supplemented with 1g yeast+1g prebiotic per kg diet.

All chicks were housed on deep litter in an open house system divided into 18 floor pens (6 treatments x 3 replicates). Birds were fed starter diet (22.27% crude protein and 3058 ME Kcal/kg) during the first 3 weeks then switched to finisher diet (19.20% crude protein and 3172 ME Kcal/ kg) from 3 to 6 weeks of age (Table 1). Birds were exposed to 23 hours daily and reared in environmental conditions. Feed and water were provided *ad-libtum* throught the whole experimental period. Both body weight and feed consumption were recorded biweekly and mortality was recorded daily.

Three chicks per each replicate were injected at 35 and 42 days of age intravenously with 1 ml of 7% suspension of sheep red blood cells (SRBC'S). Seven days later, blood samples were collected and centrifuged. Sera were frozen until the measurements of the antibody titer against SRBC'S were determined as humoral immune response according to *Van der Zijpp et al. (1983) and Bachman and Mashaly (1986)*. At 42 days of age, 3 chicks per replicate were randomly chosen weight, slaughtered and eviscerated. Internal and immune organs were weighted and carcass traits were measured.

After slaughtering, fresh blood samples were collected to determine the hematological picture for counting the red blood cells (RBC's) and white blood cells (WBC's) according to *Wintroba (1967)*. Lymphocytes and heterophils were counted according to *Haddad and Mashaly (1990)*. Also, small intestine samples were collected to count, examine and define their bacterial content using the procedure of *A.O.A.C. (1995)*.

Table (1): Composition and calculated analyses of basic diets.

Ingredients	**Starter diet (%)**	**Finisher diet (%)**
Yellow corn	52.03	61.38
Soya bean meal (44%)	29.60	22.50
Corn gluten meal (60%)	7.00	6.10
Vegetable oil	4.00	4.00
Wheat bran	2.80	2.60
Bone meal	3.30	2.15
Limestone	0.14	0.14
Premix *	0.30	0.30
NaCl (salt)	0.50	0.50
L-lysine-HCL	0.18	0.18
DL- Methionine	0.15	0.15
Total	100	100
Calculated values **		
Crude protein (%)	22.27	19.20
ME (Kcal/Kg)	3058	3172
Crude fiber (%)	3.80	3.32
Ether extract (%)	6.50	6.73
Calcium (%)	0.92	0.73
Available P (%)	0.48	0.40
Lysine (%)	1.22	1.05
Methionine (%)	0.55	0.49
Methionine + Cystine (%)	0.92	0.81

*** Supplied per Kg diet: Vit.A, 12000 IU; vit D3, 2000.000 IU; Vit.E, 10 mg; Vit.K, 2 mg; Vit.B_1, 1mg; Vit.B_2, 5mg; Vit.B_6, 1.5 mg; Vit.B_{12}, 10µg; Nicotinic acid 30mg; Folic acid 1mg; Pantothenic acid 10mg; Biotin 50µg; Choline chloride 500mg; Copper 10mg; Iron 30mg; Manganese 60mg; Zinc 50mg; Iodine 1mg; Selenium 0.1mg and cobalt 0.1mg.**

**** According to *NRC (1994)*.**

Economical efficiency of production was calculated from the input-output analysis of the money, based on the differences in both growth rate and feeding costs. The value of the economical efficiency was calculated as net revenue per unit of total feed costs. The prices of experimental diets and live body weight were calculated according to the prices of the local Egyptian market at the time of experiment.

All results were statistically analyzed as one-way analysis of variance by using the General Linear Model (GLM) adapted to micro computer of statistical analysis system *(SAS, 1999)*. Differences between means were tested by multiple range tests according to *Duncan (1955)*.

RESULTS AND DISCUSSION

I. Productive performance traits:

a. Live body weight and body weight gain:

Results in (Table, 2) indicated that the addition of the tested biological additives in broiler diet from 0 to 42 days of age improved both body weight and body weight gain during the experimental period compared to the control. Weight at 42 days of age was significantly heavier by about 29.5, 21.2, 12.4, 11.3 and 9.9% than control in the T6, T5, T4, T3 and T2, respectively. Body weight gain from 0 to 42 days of age exhibited also the same trend. The best values of both traits were recorded by using yeast+prebiotic (T6) followed by probiotic+prebiotic in diet (T5), then prebiotic (T4), yeast (T3) and probiotic (T2). An improvement in productive performance were obtained also by using *Lactobacillus* (*Dilworth and Day, 1978 and Jernigan et al., 1984*), Lacto-sacc (*Gippert and Bodrogi, 1992 and Ali, 1994)*, Yea-sacc and Fermacto (*Omar, 1996*), Yoghurt (*El-Deeb and Makled, 1993*), butter milk (*Ghazalah and Ibrahim, 1998*) for broiler diets and yeast culture (*Ali et al,. 2000*) for Japanese quail diets. Lactic acid bacteria help to maintain an optimum low pH to inhibit growth of undesirable bacteria *(Alltech Bio-Technology Center Announcement, 1989)*.

Ali (1999) obtained 5.1% improvement in live body weight at 7 weeks of age when broiler chicks were fed *Aspergillus* supplemented diet. The improving of probiotic was explained by the favorable effects that provide live yeast culture and natural lactic acid producing bacteria to the chick's digestive tract, where the live yeast culture stimulates fiber digestion to guard against digestive upset. *Santin et al. (2001)* reported a significant increase in weight gain when birds fed 0.2% cellular wall from *Saccharomyces cervisiae* (Mannan-oligosaccharide). Similar result was found by *El-Sheikh et al. (2008)* who used manna-oligosaccharides (MOS) at 21 days of age. *Vytautas et al. (2006)* explained that the positive results of prebiotic on body weight and weight gain may be attributed to that additive may help to maintain the microflora balance of the intestinal tract of chicken resulting in a more efficient use of nutrients from feed, more intensive processes of protein metabolism and subsequently in better health.

b. Feed consumption and feed conversion:

Data in (Table, 3) indicated that feed intake was significantly higher in T5, T6, T4, T3 and T2 than in T1 by 13.71, 13.43, 11.38, 8.52 and 3.09%, respectively. Also, feed conversion from (0-42 days of age) was improved, in which the best values were in order for T6, T5, T2, T3 and T4 compared to the control one. In agreement with our results, *Madkour et al. (2008)* reported that using probiotic and prebiotic in broiler diet improved significantly both feed consumption and feed conversion from 0-42 days of age. *March (1979)* suggested that these improvement by probiotic may be due to that intestinal pH may alter both microbial population and nutrient absorption and this may improve efficiency of feed utilization. Also, *Sellars (1991)* reported that probiotic presence high numbers of *Lactobacilli* that increase the motility of gut content and improve nutrient availability or absorption which leads to improve efficiency of feed utilization. *Haddadin et al. (1996)* reported that the change of microbial in bird's intestine might enhance their health and improve feed consumption by using probiotics. Moreover, *Tomasik and Tomasik (2003) and Kirkpinar et al. (2004)* stated that prebiotics belong to a group of indigestible dietary carbohydrates improved feed conversion. Also, *EL-Nagmy et al. (2007)* stated that probiotic addition in broiler diet lead to improve growth rate. In addition, recently, *Tollba and Mahmoud (2009)* found that feed intake increased by 5.32% at normal temperature (23°C) and by 7.97% at high temperature (38°C), when chicks fed diets with probiotic (biogen) at 2g/kg of feed. Similar results were obtained by *Kalavathy et al. (2003) and Tollba et al. (2004)*.

c. Mortality rate:

Cumulative mortality rate from 0 to 42 days of age is presented in Table (4). Results indicated a depression in mortality rate to 3.81, 10.46, 8.76, 6.49 or 5.56% in T6, T5, T4, T3 or T2 compared to 13.27% in control one, respectively. The result was agreed with those reported by *Hussein and El-Ashry (1991), Rashwan et al. (1993), Tawfeek et al. (1993) Omar (1996) and Alm Eldein (2002)* who stated the addition of probiotic decreased mortality rate. *Watkins and Miller (1983)* attributed the reduction of mortality rate in *Lactobacillus acidophilus* treatments to the inhibitory effects of probiotic towards enteric micro-organisms. This effect was due to the alteration of pH through acid production, and changes the oxidation-reduction potential through its production of metabolites, by making the environment less conductive for organisms requiring oxygen *(Hamdy et al., 2oo9)*. *Abd El-Samee (2001)* reported that the common pathogenic bacteria like *E.coli, Salmonella and Clostradia* which caused bacterial diseases such as diarrhea, enteritis and/or mortality could be prevented when probiotic was used.

II. Immunological traits:

a. Blood hematological picture:

Results in (Table, 5) declared significant increase in counts of erythrocytes, leukocytes, lymphocytes, heterophils and H/L ratio in biological additives treatments than control ones. However, values were better in T6, T5, T4, T3 than T2.

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The result agrees with that reported by *Zulkifli et al. (2000)* who stated an enhancement of immunity that might be expected corresponding to adding probiotic.

Tollba and El-Nagar (2008) obtained significant increase in counts of erythrocytes, leukocytes, lymphocytes due to feeding dietary biogen (bacteria concentration as probiotic) compared with control diet. *Tollba and Mahmoud (2009)* reported a significant increase in counts of erythocytes, leukocytes, lymphocytes, eosinophils and basophils, but not in heterophils, by feeding ditary biogen at normal and high temperature compared to the control ones.

b. Humoral immune response:

The same trend was observed also for immune response that presented in Table (5). Significantly high primary and secondary immune response which represented as the antibody titer against SRBC's at 35 and 42 days of age were found in biological additive treatments than control ones. In general, T6 was better than T5, T4, T3 and T2. Similar result was reported by *Malzone et al. (2000) and Shashidhara and Devegowda (2003)* who observed a significant increase in the antibody titers against SRBC's for birds fed 0.05% MOS compared to control ones. Similarly, *Watkins et al. (1982) and Zulkifli et al. (2000)* stated that the immune response of broilers was increased when chicks fed diet containing *Lactobacillus* cultures. The effect of antibody titers may be due to the influence of the MOS on immune system and/or the improvement occurred in the intestinal absorption for nutrients, such as: Zn, Cu and Se. In addition, it might be attributed to the reduction of the pathogenic bacteria load in the intestine which preventing the acute immune response against such bacteria *(Finucane, et al., 1999 and Spring et al., 2000). Ferket et al. (2002)* showed that the immune modulation could also be improved by stimulating gut-associated and systemic immunity as a non-pathogenic antigen providing an adjuvant like effect.

On the other hand, *Al-Homidan and Fahmy (2007)* did not indicate significant effect of yeast culture on antibody titer against SRBC's in broilers. Also, *Hassan and Ragab (2007)* reported insignificant increase in primary and secondary antibody titer against SRBC's of laying hens fed MOS in diet.

III. Bacteria enumeration and microbial status:

As shown in (Table, 6) adding the biological additives improved significantly (P≤0.05) the number of the intestinal microbial. So lactobacillus number in T2 and T5 as well as yeast amount in T3 and T6 were significantly increased than control ones. It can be summed, that using biological additives caused beneficial effects that improve intestinal microbial balance, as well as stimulated growth processes and improved productive performance (Tables 2 and 3) and decreased mortality rate (Table 4). In this connection, *Kamra and Pathak (1996)* reported that yeast culture (*Saccharomyces cervisiae)* improved the digestibility of crude protein and crude fiber fractions, thereby increasing the availability of nutrients for animal productively *(Kruase et al., 1989 and Bradley et al., 1994)* or indirectly via change in the gut microflora in favour of the activities of fiber degrading micro-organisms especially cellulolytic bactria and subsequently decreasing non-starch polysaccharides contents (NSP's) in the gut *(Miles, 1993)*. Furthermore, probiotics produce lactic acid which alter the pH of chicken gut making it improper media for harmful bacteria such as salmonella and pathogenic species of *E. coli (Leesson and Major, 1990)*, improve nutrient availability and absorption *(Sellars, 1991)*, stimulate appetite *(Nahashon et al, 1994)*, produce digestive enzymes *(Lee and Lee, 1990)*, and improve intestinal microbial balance *(Fuller, 1989)*.

Table (6): Counts of some intestine pathogenic bacteria of Arbor Acres broiler chicks fed diets with different biological additives from 0 to 42 days of age.

	Experimental treatments					
Traits / Items	Control	Probiotic	Yeast	Prebiotic	Probiotic + Prebiotic	Yeast + Prebiotic
Total count ($x10^6$)	2.14^{b} ±0.82	18.00^{a} ±2.31	9.63^{ab} ±1.77	9.10^{ab} ±1.02	4.64^{b} ±1.86	6.53^{b} ±2.79
Yeast ($x10^3$)	5.93^{b} ±1.93	-	59.00^{a} ±4.73	-	-	27.20^{ab} ±19.63
Lactobacillus ($x10^3$)	5.87^{b} ±1.17	406.67^{a} ±93.51	-	-	7.70^{b} ±0.57	-

a,b Means within rows with different superscripts are significantly different (P≤0.05).

IV. Carcass traits:

Values in (Table, 7) stated that all studied traits (except abdominal fat) were significantly higher in chicks fed biological additives than control ones. However, values were higher in T6, T5, T4, T3 than T2. Similar results were reported by *Rashwan et al. (1993), EL-Gendi et al. (2000) and Madkour et al. (2008)* whom obtained significantly improved values for dressing%, internal and immune organs at 6 weeks of age in broilers fed biological probiotic and prebiotic than control ones. Moreover, probiotic treatments improved carcass weight *(Alm Eldein, 2002)* and carcass % *(Yusrizal and Chen, 2003)*.On the other hand, *Ali (1999)* reported insignificant improvement in carcass weight, total edible parts for broilers fed probiotic diets compared with control.

Concerning, abdominal fat (Table 7), it decreased by about 36.1, 33.1, 29.0, 26.6 and 24.9% in T6, T5, T4, T3, T2 than control ones, respectively. This result agrees with *Ali (1999) and Yusrizal and Chen (2003)* who found that abdominal fat reduced with biological additives.

V. Economic efficiency:

Data in (Table, 8) indicated that both net revenue and economical efficiency increased in biological additives treatments than control ones. Relative economical efficiency% showed an improvement by about 14.70, 11.18, 7.62, 1.26, and 0.25% in T6, T3, T2, T5 and T4 than control, respectively. The result agrees with *Namra (2006)* who suggested that incorporation of 0.15 % baker's yeast in diet of quail layers apparently exhibited better amelioration in feed cost /egg than the control group.

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Hassan and Ragab (2007) stated that MOS supplementation into layer diets improved economical efficiency and relative economical efficiency of laying hens than those fed the control diet. *Tollba and Mahmoud (2009)* indicated that addition of probiotic (biogen) at 2g/ kg of broiler diets increased significantly economical efficiency by 26.13% at normal temperature (23°C) and 3.74% at high temperature (38°C).

It could be concluded that the biological additives to broiler diet improved all productive traits, immune response and carcass yield. For all studied traits, the best values were obtained for chicks fed on yeast + Prebiotic diet. Also, it gave the best relative economical efficiency%.

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تأثير اضافة منشطات الن م و البيولوجية لعلائق بداري التسمين علي الإنتاجية والإستجابة المناعية وصفات الذبح

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تم استخدام عدد 630 كتكوت أربورايكرز لدراسة تأثير أضافة المنشطات البيولوجية فى العلف على معدل الانتاج والإستجابة المناعية وخصائص الذبيحة. قُسمت الكتاكيت عند عمر يوم عشوائيا الى 6 مجموعات وكل مجموعة اشتملت علي 3 مكررات بكل مكرر 35 طائر، وكانت المجاميع كما يلى:

١ - المجموعة الأولى = الكنترول تغذت بها الكتاكيت على العليقة الاساسية بدون اضافات.

٢ - المجموعة الثانية = أُضيف الى العليقة الاساسية مادة البروبيوتيك بمعدل 1جم/كجم علف.

٣ - المجموعة الثالثة = أُضيف الى العليقة الاساسية مادة الخميرة يحتوي علي 5×10^{12} *CFU* بمعدل 1جم/كجم علف.

٤ - المجموعة الرابعة = أُضيف الى العليقة الاساسية مادة البريبيوتيك بمعدل 1جم/كجم علف.

٥ - المجموعة الخامسة = أُضيف الى العليقة الاساسية مادة البروبيوتيك + البريبيوتيك بمعدل 1جم لكل منهما/كجم علف.
٦ - المجموعة السادسة = أُضيف الى العليقة الاساسية مادة الخميرة + البريبيوتيك بمعدل 1جم لكل منهما/كجم علف.

أظهرت النتائج أن استخدام الأضافات البيولوجية بالمعدلات المذكورة سالفاً فى العلف أدى الى تحسن وزن الجسم والزيادة الوزنية واستهلاك العلف والكفاءة التحويلية وصفات الذبح، كما أدي إلي خفض معدلات النفوق. كذلك أدت الإضافات البيولوجية لعلائق بداري التسمين الى زيادة عدد خلايا كرات الدم الحمراء والبيضاء بأنواعها المختلفة، كما أدت إلى زيادة مستوي الأجسام المناعية ضد كرات الدم الحمراء للأغنام في المناعة الأولية والثانوية كمؤشر لتحسن المناعة والإستجابة المناعية. أوضحت النتائج أيضاً أن أفضل معاملة هى المعاملة السادسة (أضافة الخميرة مع البريبيوتيك للعلف) كما انها أعطت أعلى كفاءة اقتصادية. لذا توصي النتائج باضافة المنشطات البيولوجية لعلائق بداري التسمين لما لها من أثر إيجابي علي تحسين الإنتاجية والمناعة وصفات الذبح و كذلك الكفاءة الإقتصادية.

قام بتحكيم البحث

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Table (2): Live body weight (g) and body weight gain (g) of Arbor Acres broiler chicks fed diets with different biological additives from 0 to 42 days of age (Means±SEM).

Traits / Age	Experimental treatments					
	Control	**Probiotic**	**Yeast**	**Prebiotic**	**Probiotic + Prebiotic**	**Yeast + Prebiotic**
Live body weight (g)						
One day	44.26±0.05	44.31±0.02	44.37±0.02	44.37±0.01	44.33±0.01	44.38±0.04
14 days	276.50^{d}±4.96	285.58^{cd}±1.94	297.09^{bc}±3.34	300.83^{b}±3.80	308.50^{ab}±3.51	319.82^{a}±4.39
28 days	897.46^{e}±8.79	964.20^{d}±2.67	977.12^{cd}±5.70	990.43^{c}±3.23	1014.45^{b}±6.86	1038.41^{a}±5.91
42 days	1779.94^{e}±2.90	1956.36^{d}±16.37	1981.26^{cd}±15.01	2000.72^{c}±10.20	2157.98^{b}±5.59	2305.06^{a}±10.20
Body weight gain (g)						
0-14 days	231.90^{d}±6.46	241.59^{cd}±2.15	252.72^{bc}±3.35	256.46^{b}±3.79	264.16^{ab}±3.51	275.34^{a}±4.46
15-28 days	619.89^{d}±6.12	677.45^{c}±1.74	679.18^{c}±2.87	688.87^{c}±1.29	705.38^{b}±3.71	717.35^{a}±4.48
29-42 days	882.46^{d}±3.63	994.81^{c}±11.55	1005.71^{c}±8.56	1012.80^{c}±7.33	1145.31^{b}±8.72	1266.50^{a}±2.01
0-42 days	1734.90^{e}±5.07	1912.65^{d}±14.98	1936.84^{cd}±15.03	1956.27^{c}±10.22	2113.63^{b}±5.54	2260.68^{a}±6.81

[a,b,c,d,e] **Means within rows with different superscripts are significantly different (P≤0.05).**

Table (3): Feed consumption (g/bird/day) and feed conversion ratio (g feed/g gain) of Arbor Acres broiler chicks fed diets with different biological additives from 0 to 42 days of age (Means±SEM).

Traits / Age	Experimental treatments					
	Control	**Probiotic**	**Yeast**	**Prebiotic**	**Probiotic + Prebiotic**	**Yeast + Prebiotic**
Feed consumption (g/chick/day)						
0-14 days	27.13^{b}±1.01	29.34^{a}±0.41	29.82^{a}±0.44	29.36^{a}±0.58	30.47^{a}±0.39	30.72^{a}±0.54
15-28 days	85.97^{b}±0.51	86.28^{b}±0.45	87.98^{ab}±0.31	87.69^{ab} ±1.25	88.39^{ab}±1.00	90.14^{a}±0.18
29-42 days	112.60^{d}±0.97	121.12^{c}±3.82	131.00^{b}±2.34	134.87^{ab}±1.49	139.44^{a}±1.36	141.04^{a}±0.73
0-42 days	77.79^{c}±1.61	80.19^{c}±1.37	84.42^{b}±1.21	86.64^{ab}±0.67	88.46^{a}±0.97	88.24^{a}±0.92
Feed conversion (g feed/g gain)						
0-14 days	1.63^{bc}±0.09	1.70^{a}±0.08	1.65^{b}±0.07	1.60^{c}±0.05	1.61^{c}±0.09	1.56^{d}±0.10
15-28 days	1.94^{a}±0.07	1.78^{bc}±0.06	1.81^{b}±0.09	1.78^{bc}±0.07	1.75^{c}±0.06	1.75^{c}±0.08
29-42 days	1.79^{b}±0.13	1.70^{c}±0.10	1.82^{ab}±0.12	1.86^{a}±0.08	1.70^{c}±0.08	1.56^{d}±0.09
0-42 days	1.88^{a}±0.08	1.76^{c}±0.06	1.83^{b}±0.04	1.86^{ab}±0.03	1.75^{c}±0.04	1.64^{d}±0.05

[a,b,c,d,e] **Means within rows with different superscripts are significantly different (P≤0.05).**

Table (4): Mortality rate (%) of Arbor Acres broiler chicks fed different biological additives in diets from 0 to 42 days of age.

	Experimental treatments					
Traits / Age	Control	Probiotic	Yeast	Prebiotic	Probiotic + Prebiotic	Yeast + Prebiotic
0-7 days	1.63±1.25	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.54±0.54
8-14 days	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	1.90±1.90	0.00±0.00
15-21 days	6.13±3.17	1.93±0.97	2.03±1.09	1.63±1.44	1.03±0.94	1.37±1.37
22-28 days	0.97±0.97	1.23±1.23	1.80±0.38	1.40±0.74	2.63±1.28	0.00±0.00
29-35 days	1.27±1.27	0.70±0.70	0.83±0.83	2.83±1.52	2.10±1.72	0.00±0.00
36-42 days	3.27±1.88	1.70±0.40	1.83±0.13	2.90±1.41	2.80±0.67	1.90±0.25
0-42 days	13.27^{a}±1.42	5.56^{bc}±0.81	6.49^{bc}±0.74	8.76^{abc}±2.60	10.46^{ab}±2.50	3.81^{c}±1.78

[a,b,c,d,e] Means within rows with different superscripts are significantly different (P≤0.05).

Table (5): Blood hematological picture and the antibody titer against SRB'C of Arbor Acres broiler chicks fed different biological additives from 0 to 42 days of age (Means±SEM).

	Experimental treatments					
Traits / Items	Control	Probiotic	Yeast	Prebiotic	Probiotic + Prebiotic	Yeast + Prebiotic
Blood hematological picture at 42 days of age						
RBC's ($x10^6/mm^3$)	2.86^{d}±0.01	3.23^{c}±0.01	4.02^{b}±0.01	4.26^{b}±0.01	5.03^{a}±0.15	5.03^{a}±0.01
WBC's ($x10^3/mm^3$)	19.73^{f}±0.07	23.34^{e}±0.33	25.57^{d}±0.59	28.50^{c}±0.10	31.06^{b}±0.25	34.56^{a}±0.44
Lymphocyte (L; %)	51.02^{b}±0.31	55.32^{ab}±0.38	49.85^{b}±0.72	59.27^{ab}±0.40	61.37^{ab}±0.60	65.32^{a}±0.56
Heterophils (H; %)	23.10^{e}±0.21	25.32^{d}±0.34	27.20^{d}±0.42	30.68^{c}±0.25	33.57^{b}±0.34	37.14^{a}±0.67
H/L ratio	0.45±0.01	0.46±0.01	0.55±0.09	0.52±0.01	0.55±0.01	0.57±0.01
Antibody titer against SRB'C						
Primary response at 35 days	41.40^{c}±0.36	44.33^{bc}±0.77	46.15^{b}±1.35	47.26^{b}±1.21	48.38^{ab}±0.35	51.47^{a}±0.64
Secondary response at 42 days	183.12^{e}±2.09	206.63^{d}±1.15	243.28^{b}±1.02	245.16^{b}±0.29	234.26^{c}±0.56	255.44^{a}±0.47

[a,b,c,d,e,f] Means within rows with different superscripts are significantly different (P≤0.05).

Table (7): Slaughter traits at 42 days of age of Arbor Acres broiler chicks fed diets with supplemental different biological additives from 0 to 42 days of age (Means±SEM).

Items / Traits	Experimental treatments					
	Control	Probiotic	Yeast	Prebiotic	Probiotic + Prebiotic	Yeast + Prebiotic
Carcass (g)	971.11[e]±12.63	1126.67[d]±11.79	1156.67[d]±21.79	1211.11[c]±13.17	1331.11[b]±11.36	1464.44[a]±19.66
Carcass (%)	54.83[e]±0.55	57.13[d]±0.33	58.17[cd]±0.55	59.26[c]±0.37	60.98[b]±0.35	62.33[a]±0.25
Dressing (%)	59.20[e]±0.60	61.75[d]±0.36	62.82[cd]±0.57	63.98[c]±0.43	65.86[b]±0.45	67.37[a]±0.26
Liver (%)	2.55[d]±0.04	2.63[cd]±0.02	2.65[bcd]±0.05	2.68[bc]±0.04	2.77[ab]±0.05	2.88[a]±0.03
Heart (%)	0.40[b]±0.02	0.43[ab]±0.02	0.43[ab]±0.02	0.44[ab]±0.02	0.47[a]±0.03	0.48[a]±0.01
Gizzard (%)	1.42[c]±0.03	1.56[b]±0.02	1.57[b]±0.02	1.60[b]±0.03	1.64[ab]±0.04	1.68[a]±0.02
Total Giblets (%)	4.38[d]±0.08	4.62[c]±0.05	4.66[bc]±0.07	4.72[bc]±0.10	4.88[ab]±0.11	5.03[a]±0.06
Abdominal fat (%)	1.69[a]±0.03	1.27[b]±0.02	1.24[b]±0.03	1.20[bc]±0.04	1.13[cd]±0.05	1.08[d]±0.03
Edible part (%)	60.89[e]±0.62	63.03[d]±0.38	64.06[cd]±0.58	65.18[c]±0.46	66.98[b]±0.50	68.45[a]±0.28
Intestine (%)	4.90±0.06	4.93±0.04	5.02±0.14	5.02±0.11	5.16±0.08	5.17±0.03
Thymus (%)	0.18[c]±0.02	0.24[bc]±0.03	0.26[abc]±0.03	0.27[ab]±0.03	0.29[ab]±0.03	0.33[a]±0.02
Bursa (%)	0.16[c]±0.02	0.17[bc]±0.02	0.18[b]±0.02	0.18[b]±0.02	0.21[a]±0.02	0.22[a]±0.01
Spleen (%)	0.12[b]±0.02	0.14[ab]±0.02	0.14[ab]±0.02	0.14[ab]±0.02	0.16[ab]±0.01	0.19[a]±0.01

[a,b,c,d,e] **Means within rows with different superscripts are significantly different (P≤0.05).**

Table (8): Economical efficiency of Arbor Acres broiler chicks fed diets supplemented with different biological additives at 42 days of age.

Items	Traits	Experimental treatments					
		Control	Probiotic	Yeast	Prebiotic	Probiotic + Prebiotic	Yeast + Prebiotic
Feed	Total intake (kg/chick)	3.27	3.37	3.55	3.64	3.72	3.71
	Price/kg (L.E)	2.06	2.10	2.07	2.09	2.19	2.16
	Total feed cost (L.E)	**6.73**	**7.07**	**7.34**	**7.61**	**8.14**	**8.01**
Meat	Wight gain (kg/chick)	1.73	1.91	1.94	1.96	2.11	2.26
	Price/kg (L.E)	11.50	11.50	11.50	11.50	11.50	11.50
	Total Revenue (L.E)	**19.90**	**21.97**	**23.31**	**22.54**	**24.27**	**25.99**
Net Revenue (L.E)		13.17	14.89	15.97	14.93	16.13	17.98
Economical efficiency		195.69	210.60	217.57	196.18	198.15	224.46
Relative economical efficiency (%)		100	107.62	111.18	100.25	101.26	114.70

Net Revenue = Total Revenue - Total feed cost
Economic efficiency = Net Revenue / Total feed cost x 100
Relative economical efficiency (%) assuming the control treatment equal= 100%.