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EVALUATION OF USING PROPIONIC ACID AND LIVE YEAST IN DIETS LOW IN PROTEIN AND ENERGY ON BROILER PERFORMANCE

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ABSTRACT: The aim of the present study was to determine the effect of dietary supplementation of either propionic acid (PA), live yeast (Saccharomyces cerevisae) (Sc) or their combination on the performance, carcass characteristics, some blood traits and economical efficiency (EEf) of broiler chicks. Two hundred and fourty unsexed day-old Cobb commercial broiler chicks were distributed randomly into eight treatments, each having three replicates of 10 chicks each. Eight dietary treatments were conducted including, (T1) control group which were fed the basal diet, (T2) control +0.2% (PA), (T3) control + 0.2% (Sc), (T4) control + (0.2% PA + 0.2% Sc), (T5) Control – low by 1.5% protein and 200 Kcal ME /Kg (LPLE), (T6) LPLE + 0.2% (PA), (T7) LPLE + 0.2% (Sc) and (T8) LPLE + (0.2% PA + 0.2% Sc). Results showed that birds fed diets with all additions achieved higher body weight gain BWG compared to control or LPLE. Results of feed intake (FI) showed significantly ($P \leq 0.01$) higher values in group T4 compared to all treatments. While, the lowest feed intake ($P \leq 0.01$) values were in groups T5, T6 and T7 compared to control. Feed conversion ratio (FCR) improved in all supplemented diets compared to those without supplementation. No significant effect was observed in the average values of giblets (liver, heart, gizzard), and abdominal fat, while all additions significantly ($P \leq 0.01$) increased the dressing percentage and total edible parts compared to control or LPLE. Dietary supplements of either PA, Sc or (PA + Sc) increased RBCs, Hb, PCV, WBCs, as compared to control group, but LPLE with different supplements insignificantly affect all hematological parameters as compared to LPLE. Total protein and globulin were significantly ($P \leq 0.01$) increased by using all supplements compared to control or LPLE. Total cholesterol and total lipids significantly ($P \leq 0.01$) reduced of the chicks fed supplements compared to control or LPLE. Addition of PA, SC and combination of them had significantly ($P \leq 0.01$) higher ND titers than control or LPLE. Addition PA, Sc and combination of them to LPLE recorded the best values of (EEf) and (REEf) compared to the other groups. In conclusion, the addition of PA or Sc either alone or in combination to LPLE broiler diet, could improve the performance, carcass characteristics and some blood traits and enhanced the immunity and proved to be a good substitute to antibiotic growth promoters in improving the performance of broiler chicken.

Keywords: Propionic acid - live yeast (Saccharomyces cerevisae) – Broilers - Performance.

INTRODUCTION

The use of antibiotic growth promoters (AGPs) in poultry feed was banned in 2006, although their beneficial roles in growth performance and disease prevention in poultry, due to the development of resistance in bacteria and presence of drug residues in meat Hashemi (2010). Efforts have been focused on the use of alternatives to AGPs such as organic acids and phytobiotics (Elagib et al., 2013). Organic acids and their blends (acetic acid, formic acid, lactic acid, propionic acid and isobutyric acid) can be used to enhance poultry production and performance through improvement of nutrient digestion and absorption by reducing enteric pathogenic microbial loads and intestinal pH in birds. Organic acids and their salts are generally considered as safe and have been affirmed to be used as natural feed additives in animal production. (Kamal and Ragaa, 2014). As alternatives to antibiotic growth promoters, organic acids (OA) have demonstrated positive results in poultry production, due to their potential to lower the intestinal pH and enhance the bacterial development against pH changes (Pirgozliev et al., 2008; Ao et al., 2009), thus providing better intestinal health for the bird to maximize its nutrient absorption. Additionally, using organic acids were reported to have several beneficial effects on feed conversion ratio, growth performance and enhancing mineral absorption (Král et al., 2011; Gálik and Rolinec, 2011 and Petruška et al., 2012). Yeast culture products containing Saccharomyces cerevisae, which are rich in enzymes, vitamins, and other nutrients, have many beneficial effects on animals such as growth rate, feed efficiency, egg production, and reproduction Dawson (1993). Lutful-Kabir (2009) noted that the mode of action of dry yeast in poultry includes: maintaining normal intestinal micro- flora by competitive exclusion and antagonism; altering metabolism by increasing digestive enzyme activity and decreasing bacterial enzyme activity and ammonia production; improving digestion and stimulating the immune system. Baurhoo et al. (2009) found that live yeast increased numbers of goblet cells in all sections of small intestine in broilers. The main function of goblet cells is the production of mucus, which was found to assist with transportation between lumen and epithelial cells and form an environment in which certain digestive process could occur (Smirnov et al., 2004). The mucus also protects the intestinal lining from damages (Smirnov et al., 2006). Eltazi et al. (2014) reported that using live yeast (Saccharomyces cerevisae) at levels of 0.1, 0.2 and 0.3% showed significantly ($P<0.05$) higher body weight gain and better feed conversion ratio than the control group. The aim of this study was to evaluate the effect of propionic acid (PA), live yeast (Saccharomyces cerevisae) (Sc) and their combination (PA + Sc) in diets low in protein and energy content on broiler performance, carcass characteristics, some blood traits and economical efficiency (EEf) of broiler chicken.

MATERIALS AND METHODS

Experimental birds and design: Two hundred and fourty unsexed day-old Cobb commercial broiler chicks were used in this experiment. Chicks were individually wing-banded, having nearly equaled live weights (43±0.27g) and randomly distributed into eight groups, each group contain 3 replicates of 10 birds each**.** Chicks were reared in floor pens as chicks of each replicate were housed in a pen (1square meter), and were allocated to the following dietary treatments:

1- Control
2- Control +0.2% propionic acid (PA).
3- Control + 0.2% live yeast (Saccharomyces cerevisae) (Sc).
4- Control + 0.2% (PA) + 0.2% (Sc).
5- Control – low 1.5% protein and 200 Kcal ME /Kg energy (LPLE).
6- LPLE + 0.2% (PA).
7- LPLE + 0.2% (Sc).
8- LPLE + 0.2% (PA) + 0.2% (Sc).All diets were used in mash form and formulated to meet the nutrient requirements of the Cobb commercial broiler according to NRC (1994). The composition and calculated analysis of diets are shown in Table (1). Propionic acid (PA) obtained from Al-Gomhoria Company for chemicals. Live yeast (Saccharomyces cerevisae $1x10^{11}$ cfu/gm) (Sc) obtained from general Pharma Company; Egypt. Chicks in all treatments were reared under similar hygienic and managerial conditions. All birds received feed and water ad libitum. Thebirds were vaccinated against Newcastle disease and infectious bronchitis on day 7 of age and against Gumboro on days 14 and 24 of age. Body weight (BW), feed intake (FI) and mortality rate (MR) were recorded biweekly and average body weight gains (BWG); feed conversion ratio (FCR) were calculated. Economical efficiency (EEf) was estimated during all period of experiment. EEf was calculated (net revenue divided by total feed costs). While net revenue was calculated as total revenue minus total feed costs. At the end of the experiment (42 day), three birds from each treatment were slaughtered to obtain the carcass and giblets (gizzard, liver and heart). Dressing percentage was then calculated relatively to live body weight by using the following equation: Dressing % = Carcass weight + Giblets weight/ Pre-slaughter weight*100

Two blood samples were taken from the brachial vein (one into heparinized tube to separate plasma and the other one into unheparinized tube to separate serum) of 3 birds/treatment. Fresh blood samples were used for determination of hemoglobin concentration (Hb), packed cell volume % (PCV), total erythrocytes count (RBCs), and total leucocytes count (WBCs). Mean Corpuscular Volume (MCV) was calculated = PCV × 10/ RBC's, Mean Corpuscular Hemoglobin (MCH) was calculated = Hb × 10/ RBC's and Mean Corpuscular Hemoglobin Concentration (MCHC) = HbX100/ PCV. All measurements conducted according to Clark et al. (2009). While, the second blood tube was centrifuged at 3000 rpm for 20 minutes. The separated plasma was stored at -20°C until assayed for blood traits included determine of ND virus antibody (Newcastle disease titers), total lipids (mg/dl), total protein (g/dl), albumin (g/dl), globulin (g/dl), total cholesterol (mg/dl), and liver enzymatic activity , being aspartate aminotransferase (AST) (mg/dl) and alanine aminotransferase (ALT) (mg/dl) using commercial kits.

Statistical Analysis:

Obtained data were statistically analyzed using linear models procedure described in SAS users guide (SAS, 2004). Differences among treatment means were tested using Duncan's multiple range test (Duncan's, 1955). One – way analysis model was applied for data obtained from the experiment:

$Y_{ij} = \mu + T_i + E_{ij}$

Where: Y_{ij} =Observations

µ =The overall mean
Ti =Effect of i^{th} treatments E_{ij} =Experimental error

RESULTS AND DISCUSSION

Productive performance:

Live body weight, body weight gain, feed intake, feed conversion ratio, and mortality rate:

Results in Table (2) shows the effect of the addition of propionic acid (PA) or live yeast (Saccharomyces cerevisae) (Sc) or their combination (PA + Sc) to basal control, or lower in protein and energy content (LPLE) diets on the productive performance of broiler chicks. The results indicated that BW at 2, 4 and 6 weeks of age was significantly (P≤0.01) higher in chickens received basal diet with PA, Sc or (PA+SC) as compared to either control (T1) or LPLE (T5). The highest increase was in T4 followed by T3 and T2. While, adding the (PA +Sc) to LPLE showed no significant effect compared to control. The same trend was observed for the average values of body weight gain (BWG) of experimental groups at the all periods of experiment. The results of the present study are in line with those obtained by Sheikh et al. (2011), Ghazalah et al. (2011), Hassan et al. (2016) and Hossain and Nargis (2016) who indicated that dietary supplementation of organic acids improved performance of broiler chickens as compared to the un-supplemented group. Results of averages FI values showed no significant differences between all groups at 14 day of age, except T5 and T7 which recorded the lowest values. At the interval of 15-28d, T3 and T4 achieved the highest increase in FI and T5 achieved the lowest FI, however, there were no significant differences among the other treatments. At the interval of 29-42d and 1-42 d of age, feed intake of birds received basal diet with PA , Sc or (PA+ Sc) were not significantly affected as compared to control. While, birds fed LPLE basal diet with PA (T6) or Sc (T7) recorded lower FI ,but those having (PA + Sc) (T8) did not significantly differ as compared to the control. Results indicated that FCR values were improved with all tested supplements. The best significant feed conversion ratio (FCR) was obtained by using PA, Sc and (PA + Sc) in all periods studied except for the period of 1-42 d as T4 achieved better FCR compared with all groups, while adding supplements to LPLE diet showed not significant effect compared to control. This result agrees with Abo El-Maaty (2017) who reported that the added organic acids (formic at levels 0.5, 1.0% and citric acid at levels 2, 3%) in duck diets had significantly lower FI and better FCR than other groups. Adil et al. (2010, 2011) found that chicks fed the diet supplemented with organic acids showed a significant (P ≤ .05) improvement in the FCR as compared to the control. The improvement in the FCR could be possibly due to better utilization of nutrients resulting in increased body weight gain in the birds fed organic acids in the diet. The improvement in FCR in this study could be possibly due to lower amount of feed intake as a result of better utilization of nutrients in the birds fed organic acid or live yeast in the diet. These results agreed with those obtained by Al-Kassi and Mohssen (2009) who reported that adding 2 g of propionic acid /kg broiler diets resulted in significant improvements in body weight gain, feed intake, and feed efficiency. This improvement may be due to that supplementation of organic acids in the diet for broiler could protect the chicks by competitive exclusion of food borne disease (La-Reguibe and Woodward, 2003), enhanced nutrient utilization, growth and feed efficiency (Denil et al., 2003) and reduction of viable bacterial cells (Skivanova and Marounek, 2007). It is well known that organic acids have specific antibacterial effect at low pH that may help to reduce overall bacterial numbers or modify distribution of bacterial species in the gut and increase nutritive value of the diet**.** With regard to the addition of live yeast (Sc), the results obtained herein are in harmony with the findings of Santin et al. (2001), Zhang et al. (2005), Gao and Qi (2008), Paryad and Mahmoudi (2008) who found that the addition of dietary (Sc) improved the body weight gain and feed conversion ratio of the broiler chicks. This improvement in body weight gain and feed conversion ratio may be attributed to culture yeast (Sc) content of yeast cells as well as metabolites such as peptides, organic acid, oligosaccharides, amino acids, flavour and aroma substances, and possibly some unidentified growth factors, which have been propose to beneficial performance responses in animal production (Gao and Qi 2008). Moreover, supplemented yeast increased digestion and absorption of nutrients (Abaza et al., 2008; Gao and Qi 2008), and improved the intestinal lumen health (Springet al., 2000; Paryad and Mohamoudi, 2008), which resulted in better performance. The improvement of nutrient utilization resulted from the addition of (Sc) may be due to Mannan Oligo saccharides (MOS) found in the yeast cell wall, which have been shown to improve nutrient utilization through stimulation of specific microbial populations in the gastro-intestinal tract (Kocher et al., 2004), and increased surface area resulting from longer villi (Santin et al., 2001; Zhang et al., 2005). Also, greater villus height increases the activities of enzymes secreted from the lips of the villi resulting in improving digestibility of nutrients (Hampson, 1986). Baurhoo et al. (2009) found that MOS also increased numbers of goblet cells in all sections of small intestine in broilers. The main function of goblet cells is the production of mucus, which was found to assist with transportation between lumen and epithelial cells and form an environment in which certain digestive process could occur (Smirnov et al., 2004). The mucus also protects the intestinal lining from damages (Smirnov et al., 2006). Also, these findings agree with Hadj Ayed et al. (2010) who found an increase in the relative body weights of chicks receiving a diet supplemented with yeast probiotic. Haj Ayed et al. (2004) found an improvement in broilers growth performances when the feed supplemented with a Saccharomyces cerevisae. These improvement may be due to that yeast (Sc) constitutes a considerable source in nutrients especially the B complex vitamins, amino acids and enzymes which serve to improve chickens health, according to Zhang et al. (2005); and Flickinger and Fahey (2002) ; improve intestinal microbial balance (Fuller, 1989) ; produce the digestive enzyme (Saarela et al., 2000). Mortality rate, except for the control (T1) 3.33±0.70, LPLE (T5) 2.22±0.57 and LPLE + PA (T6) 1.11±0.57 , there are no death cases in all treatments. The absence of death cases among the broilers might be due to antimicrobial in PA and Sc for stimulating the immune system (Toms and Powrie, 2001), reducing intestinal pH and release of bacteriocins (Rolfe, 2000), besides the good house management during the experiment. This result agrees with Eltazi et al. (2014) who reported that the broiler chicks which supplemented with dietary yeast (Sc) had significantly ($P<0.05$) lower mortality rate as compared to control group. The low mortality among the chick groups that fed on dietary (Sc) may be due to the ability of (Sc) to reduce disease infection (Line et al., 1997), through increasing concentration of commensally microbes or suppressing pathogenic bacteria in intestinal tract (Stanley et al., 2004).

Carcass characteristics:

The effect of dietary treatments on carcass, dressing, abdominal fat, liver, heart, gizzard, giblets and total edible parts in different groups are illustrated in Table (3). Dietary supplementation of either PA , Sc or (PA + Sc) had significantly higher percentages of dressing and total edible parts compared to control or LPLE. While, the dietary supplements did not significantly affect the relative abdominal fat, liver, heart and giblets. These results agree with those obtained by Denil et al. (2003) who reported that organic acids (mixture of propionic and formic acid) had no effect on the abdominal fat pad, abdominal fat percentage and liver weight compared to control. The results of carcass characteristics agree with Talebi et al. (2010) who reported that the added organic acids improved the relative weights of carcass, total edible parts and dressing of birds fed citric acid compared to the control group. Results are in harmony with Ghazalah et al. (2011) who reported that added dietary organic acid improved the relative weights of carcass, total edible parts and dressing of birds fed citric acid at 2 g/kg as compared to the control group. Also, agree with Abo El-Maaty (2017) who reported that the added organic acids (formic at levels 0.5, 1.0% and citric acid at levels 2, 3% in ducks diets) improved the total edible parts and dressing of birds compared to the control group.

Blood measurements

Hematological parameters

Results of hematological parameters are shown in Table (4). Results revealed that dietary supplementation of PA, Sc or (PA + Sc) increased RBCs, Hb, PCV, WBCs, as compared to control group. But, LPLE with different supplements had insignificant effect concerning all the hematological parameters as compared to LPLE. Moreover, birds fed the basal diet supplemented with (PA + Sc) had significantly higher RBCs, Hb, and PCV than other groups. This result agree with Zareshahneh et al. (2007; Nasiroleslami and Torki (2010) who found that supplementation of organic acids at 21 and 42 days of age significantly increased, PCV, RBC and WBC compared to control, these increases may be due to their antimicrobial interactions and stimulation of immune system resulting in enhanced immunity. Also, results agree with Abo El - Maaty (2017) who reported that the added organic acids (formic at levels 0.5, 1.0% and citric acid at levels 2, 3% in duck diets) increased RBCs, hemoglobin, PCV, WBCs as compared to control group. The value of mean corpuscular volume (MCV) was significantly ($P\leq0.01$) reduced by PA , Sc or (PA + Sc) compared to control. This result agrees with Ndelekwute et al. (2016) who reported that when acetic acid, citric acid, butyric acid and formic acid each at 0.25% level were added , the number of red blood cells was significantly higher in organic acid groups compared to control. But, showed that there were no significant differences (P>0.05) in the number of white blood cells, haemoglobin, mean corpuscular haemoglobin concentration and mean corpuscular volume. However, the results disagree with those of Banerjee (2007) who showed that hematological parameters (RBCs, hemoglobin, PCV, WBCs) were not significantly (P>0.05) affected as compared to control group.

Blood biochemical

The results of the estimated blood biochemical parameters as affected by dietary PA, Sc and PA + Sc are presented in Table (5). Total protein and globulin were significantly (P≤0.01) increased by using all supplements compared to control or LPLE. But combination of PA +Sc achieved higher values compared to other groups . This result agrees with Ghazalah et al. (2011) who reported that dietary organic acids exhibited relatively higher concentration of total protein and globulin as compared to the control birds, indicating that the immune response improved by addition of organic acids which might indicate that broiler chicks fed acidifiers-supplemented diets had better immune response and disease resistance. These results indicated that supplemental organic acid may improve the immune response, as globulin level has been used as an indicator of immune responses and source of antibody (Kamal and Ragaa ,2014). Results showed that either organic acid or live yeast inclusion to broiler feeds significantly reduced the total cholesterol and total lipids of the chicks fed supplements compared to control or LPLE. While PA +Sc achieved lower value compared to other groups. This reduction may be due to decreases in gut pH. Reduction in gut pH may interfere with the activities of microbial enzymes in the gut, thereby stimulating the bacterial cells to expend energy to expel the protons, leading to an intracellular accumulation (Young and Foegeding ,1993). Albumin and A/G ratio were significantly decreased in birds fed supplemented diets compared to the control group. Birds fed supplements had significantly, lower serum AST and ALT than control or LPLE groups. Furthermore, PA +Sc achieved lower value compared to other groups. This result is in harmony with those of Abo El - Maaty (2017) who found lower percentage of serum AST and ALT in ducks given organic acids than the control.

Newcastle disease (ND) titers antibody

Results in Table (6) showed that addition of organic acid (propionic acid), live yeast (Saccharomyces cerevisae) and combination of them in fed groups had significantly (P≤0.01) higher ND titers than control or LPLE group. While, the supplementing PA +Sc achieved higher ND titers than other groups. This result is in harmony with those of Shashidhara and Devegowda (2003) who suggested that, live yeast may be influencing systemic immunity. This effect on antibody titers might have been due to influence of the live yeast on immune system; improved intestinal absorption of some nutrients, such as Zn, Cu, and Se.

Economical Efficiency (EE)

Economical evaluation parameters of the experimental treatments in broiler diets in terms of feeding cost, net revenue, economical efficiency (EEf) and relative economical efficiency (REEf) of meat production are listed in Table (7). Results showed that adding PA, Sc or combination of them to LPLE recorded the best economical efficiency (EEf) and relative economical efficiency (REEf) values compared to the other groups. This result agreed with those obtained by Abaza et al. (2008) who reported that, addition of (Sc) at level 0.3% to broiler diet gave the better relative economic efficiency compared to the control diet. Also, results agree with Abo El - Maaty (2017) who reported that the added organic acids (formic at levels 0.5, 1.0% and citric acid at levels 2, 3% in ducks) had significantly better values of economical efficiency compared to the control group.

CONCLUSION

From the findings of current study, it could be concluded that addition of propionic acid (PA), live yeast (Saccharomyces cerevisae) (Sc) and their combination each at 0.2% level in broiler diets with low protein and energy could improve the performance, carcass characteristics, some blood traits, enhanced the immunity and achieved the best economical efficiency (EEf) and relative economical efficiency (REEf) at 42 days of age.

Table (1): Composition and calculated analysis of the experimental diets.

Ingredients	Control		Low protein and energy (LPLE)	
	Starter-Grower (1-28 day)	**Finisher (29-42 day)**	**Starter-Grower (1-28 day)**	**Finisher (29-42 day)**
Yellow corn	54.49	62.3	57.49	66.1
Soybean meal (44%)	34	25.3	28	24
Corn gluten (60%)	4	5	4	2
Wheat bran	---	---	6	3.4
Soy oil	3	2.9	---	----
Dicalcium Phosphate	1.7	1.7	1.7	1.7
Limestone	1.5	1.5	1.5	1.5
NaCl	0.3	0.3	0.3	0.3
Sodium Bicarbonate	0.37	0.36	0.37	0.36
Premix (V&M.) *	0.3	0.3	0.3	0.3
DL.Methionine	0.17	0.17	0.17	0.17
L-Lysine HCl	0.17	0.17	0.17	0.17
Total	100	100	100	100
Calculated analysis**				
CP%	22	19	20.5	17.5
ME(Kcal/Kg)	3000	3100	2800	2900
Crude fiber %	3.76	3.38	4.05	3.68
Crude fat %	5.68	5.75	2.95	3.05
Calcium %	1.07	1.05	1.07	1.05
Avail. Phosphorus %	0.46	0.45	0.46	0.45
Lysine%	1.20	1.07	1.20	1.04
Methionine %	0.56	0.54	0.56	0.50
Sodium %	0.23	0.23	0.23	0.23
Price / Ton (LE)	6930	6150	6660	5840

*Premix contain per 3 kg Vit. A 12000 000 IU, Vit. D3 4000 000 IU, Vit. E 40 000 mg, Vit. K3 4000 mg, Vit B1 3000 mg, Vit. B2 7700 mg, Vit. B6 6600 mg, Vit. B12 30 mg, Pantothenic acid 1800 mg, Niacin 4500 mg, Biotin 250 mg, Folic acid 1800 mg, Choline 600 mg, Selenium 150 mg, Copper 15000 mg, Iron 30000 mg, Manganese 100000 mg, Zinc 7500 mg, Iodine 1000 mg, Cobalt 150 mg and CaCo3 up to 3000 g.

** Analysis of ingredients calculated according NRC (1994).

Table (2): Effect of dietary supplementation on growth performance and mortality rate.

Treatment	T1	T2	T3	T4	T5	T6	T7	T8	SEM
IBW(g)	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	±0.27
Live body weight(g)									
14 day	369^{b}	402^{a}	413^{a}	422^{a}	303^{d}	334^{c}	337^{c}	351^{bc}	±4.63
28 day	953^{d}	1038^{c}	1077^{b}	1139^{a}	756^{e}	930^{d}	929^{d}	942^{d}	±7.40
42 day	1806^{c}	1955^{b}	1972^{b}	2092^{a}	1488^{f}	1723^{e}	1753de	1783^{cd}	±8.29
Live body weight gain(g)									
1-14 day	326^{b}	359^{a}	369^{a}	379^{a}	260^{d}	291^{c}	294^{c}	309^{bc}	±4.62
15-28 day	584^{d}	636^{bc}	664^{b}	717^{a}	452^{e}	596^{cd}	591^{d}	590^{d}	±8.52
29-42 day	854^{cd}	917^{ab}	895^{bc}	954^{a}	733^{f}	793^{e}	825de	842^{d}	±9.78
1-42 day	1764^{c}	912^{b}	1929^{b}	2049^{a}	1445^{f}	1681^{e}	1710de	1741^{cd}	±8.34
Feed intake(g/day)									
1-14 day	38^{abc}	39^{ab}	38^{abc}	39^{ab}	36^{c}	37^{abc}	36^{c}	37^{bc}	±0.41
15-28 day	80^{b}	79^{b}	81^{a}	82^{a}	77^{c}	79^{b}	80^{b}	80^{b}	±0.35
29-42 day	112^{ab}	113^{a}	112^{ab}	112^{ab}	110^{bc}	106^{e}	109^{cd}	108^{d}	±0.38
1-42 day	76^{bc}	77^{ab}	77^{ab}	78^{a}	75de	73^{f}	74^{ef}	76^{cd}	±0.28
Feed conversion ratio									
1-14 day	1.62^{cd}	1.52^{de}	1.44^{e}	1.43^{e}	1.96^{a}	1.80^{b}	1.73^{bc}	1.66^{bcd}	±0.03
15-28 day	1.91^{c}	1.74^{cd}	1.72^{d}	1.61^{d}	2.39^{a}	1.87^{bc}	1.89^{b}	1.89^{b}	±0.03
29-42 day	1.83^{bcd}	1.73^{de}	1.76^{cd}	1.65^{e}	2.11^{a}	1.86^{b}	1.84^{bc}	1.80^{bcd}	±0.02
1-42 day	1.82^{b}	1.69^{c}	1.68^{c}	1.59^{d}	2.17^{a}	1.82^{b}	1.82^{b}	1.83^{b}	±0.01
MR%*	3.33	00.00	00.00	00.00	2.22	1.11	00.00	00.00	±0.06

a, b,……f means in the same row with different superscripts are significantly different ($p \leq 0.01$).

T1=control, T2=control+0.2%propionic acid (PA), T3=control+0.2% live yeast(SC), T4=control+0.2% propionic acid (PA)+ 0.2% live yeast(SC), T5=low protein and energy (LPLE), T6= LPLE+0.2%PA, T7= LPLE+0.2%SC, T8=LPLE+0.2%PA+ 0.2%SC, IBW=initial body weight, *MR: Mortality rate.

Table (3): Effect of dietary supplementation on carcass characteristics.

Parameter	T1	T2	T3	T4	T5	T6	T7	T8	SEM
(LBW) (g)	1927^{b}	2088^{ab}	2040^{ab}	2117^{a}	1513^{e}	1753^{d}	1847^{d}	1873^{cd}	±38.79
Dressing%	69.52^{b}	71.81^{a}	72.20^{a}	72.25^{a}	65.60^{d}	67.27^{c}	67.47^{c}	68.28^{c}	±0.312
Abdominal Fat%	0.951	0.910	0.948	0.914	0.925	0.940	0.917	0.934	±0.014
Liver%	2.80	2.84	3.04	2.82	2.95	2.88	2.79	2.76	±0.061
Gizzard%	2.36	2.38	2.43	2.41	2.42	2.38	2.34	2.37	±0.031
Heart%	0.761	0.750	0.768	0.740	0.748	0.751	0.754	0.756	±0.014
Giblets%*	5.92^{ab}	5.97^{ab}	6.24^{a}	5.97^{ab}	6.12^{ab}	6.01^{ab}	5.89^{b}	5.89^{b}	±0.070
Total edible parts**	75.67^{b}	77.67^{a}	78.33^{a}	78.00^{a}	71.67^{d}	73.67^{c}	73.67^{c}	74.33^{bc}	±0.312

a, b,c, d means in the same row with different superscripts are significantly different ($p \leq 0.01$).
T1=control, T2=control+0.2%propionic acid (PA), T3=control+0.2% live yeast(SC), T4=control+0.2% propionic acid (PA)+ 0.2% live yeast(SC), T5=low protein and energy (LPLE), T6= LPLE+0.2%PA, T7= LPLE+0.2%SC, T8=LPLE+0.2%PA+ 0.2%SC.* Giblets = Liver + Gizzard + Heart, ** Total edible parts = dressing + giblets.

Table (4): Effect of dietary supplementation on hematological parameters.

Parameter	T1	T2	T3	T4	T5	T6	T7	T8	SEM
WBCs (10^3/mm^3)	257.93^{b}	267.97^{a}	267.97^{a}	272.67^{a}	249.77^{c}	250.77^{c}	252.50^{bc}	253.3^{bc}	±1.44
Hb (g/dl)	8.70^{c}	9.30^{b}	9.50^{ab}	9.97^{a}	8.13^{d}	8.30^{cd}	8.20^{cd}	8.43^{cd}	±0.12
RBCs (10^6/mm^3)	2.08^{c}	2.27^{b}	2.31^{ab}	2.39^{a}	2.03^{c}	2.10^{c}	2.06^{c}	2.09^{c}	±0.02
PCV (%)	28.33^{cd}	29.10^{bc}	29.83^{ab}	30.60^{a}	26.20^{e}	26.37^{e}	26.13^{e}	27.03^{de}	±0.29
MCV	135.99^{a}	128.43^{b}	128.93^{ab}	128.03^{b}	129.27^{ab}	125.76^{b}	126.89^{b}	129.36^{ab}	±1.53
MCH	41.76	41.04	41.07	41.70	40.13	39.59	39.81	40.35	±0.47
MCHC	30.71^{b}	31.96^{ab}	31.84^{ab}	32.57^{a}	31.04^{b}	31.48^{ab}	31.39^{ab}	31.20^{ab}	±0.29

a, b, c, d Means in the same row with different superscripts are significantly different ($p \leq 0.05$).WBCs= white blood cell count, RBCs=Red blood cell count, MCV= Mean Corpuscular Volume, MCH= Mean Corpuscular Hemoglobin, MCHC= Mean Corpuscular Hemoglobin Concentration, PCV=packed cell volume._T1=control, T2=control+0.2%propionic acid (PA), T3=control+0.2% live yeast (SC), T4=control+0.2% propionicacid (PA)+ 0.2% live yeast(SC), T5=low protein and energy (LPLE), T6= LPLE+0.2%PA, T7= LPLE+0.2%SC, T8=LPLE+0.2%PA+ 0.2%SC

Table (5): Effect of dietary supplementation on blood biochemical parameters.

Parameter	T1	T2	T3	T4	T5	T6	T7	T8	SEM
Total cholesterol(mg/dl)	187.67^{a}	162.33^{b}	162.33^{b}	128.33^{d}	193.00^{a}	160.33^{b}	158.67^{b}	140.00^{c}	±1.38
Total lipids (mg/dl)	533.33^{a}	471.00^{c}	475.00^{c}	423.33^{e}	518.33^{b}	449.33^{d}	444.67^{d}	421.67^{e}	±2.09
Total protein (g/dl)	2.66^{d}	3.51^{b}	3.90^{ab}	3.97^{a}	2.72^{cd}	3.06^{c}	3.04^{cd}	3.55^{b}	±0.08
Albumin (g/dl)	1.25^{ab}	1.12^{cd}	1.08^{ed}	1.01^{e}	1.32^{a}	1.24^{ab}	1.18^{bc}	1.07^{de}	±0.02
Globulin (g/dl)	1.42^{ef}	2.39^{c}	2.82^{ab}	2.97^{a}	1.39^{f}	1.82^{de}	1.86^{d}	2.48^{bc}	±0.08
A/G (g/dl)	0.88^{a}	0.48^{c}	0.38^{c}	0.34^{c}	0.95^{a}	0.68^{b}	0.64^{b}	0.43^{c}	±0.03
ALT (U/L)	4.92^{a}	4.59^{bc}	4.49^{c}	4.23^{d}	4.94^{a}	4.70^{b}	4.63^{b}	4.32^{d}	±0.01
AST (U/L)	70.66^{a}	57.32^{b}	50.29^{b}	29.35^{c}	73.20^{a}	57.82^{b}	51.54^{b}	33.58^{c}	±0.12

a, b, …f means in the same row with different superscripts are significantly different ($p \leq 0.01$).
T1=control, T2=control+0.2%propionic acid (PA), T3=control+0.2% live yeast (SC), T4=control+0.2% propionic acid (PA)+ 0.2% live yeast(SC), T5=low protein and energy (LPLE), T6= LPLE+0.2%PA, T7= LPLE+0.2%SC, T8=LPLE+0.2%PA+ 0.2%SC

Table (6): Effect of dietary supplementation on antibodies Newcastle disease (ND) at 42 days of age.

Parameter	T1	T2	T3	T4	T5	T6	T7	T8	SEM
ND titer At 42 days of age	3.87^{e}	4.91^{c}	4.94^{c}	5.42^{a}	3.82^{f}	4.83^{d}	4.85^{d}	5.13^{b}	±0.01

a, b,…f means in the same row with different superscripts are significantly different ($p \leq 0.01$).
T1=control, T2=control+0.2%propionic acid (PA), T3=control+0.2% live yeast (SC), T4=control+0.2% propionic acid (PA)+ 0.2% live yeast(SC), T5=low protein and energy (LPLE), T6= LPLE+0.2%PA, T7= LPLE+0.2%SC, T8=LPLE+0.2%PA+ 0.2%SC

Table (7): Effect of dietary supplementation on economical efficiency (EEf).

Variables	Feed intake cost(LE/kg)			Total revenue (LE/kg)	Net revenue (LE/kg)	EEf	REEf %
	(St-gr) cost	(Fin) cost	Total cost				
T1	11.37	10.40	21.77	45.16	23.39	1.07	100
T2	11.78	10.88	22.66	48.87	26.21	1.16	108
T3	11.78	10.67	22.45	49.31	26.86	1.20	112
T4	12.27	10.97	23.24	52.31	29.07	1.25	117
T5	9.76	9.26	19.02	37.21	18.19	0.96	90
T6	10.38	8.93	19.31	43.08	23.77	1.23	115
T7	10.18	9.61	19.79	43.83	24.04	1.21	113
T8	10.53	9.35	19.88	44.58	24.70	1.24	116

T1=control, T2=control+0.2%propionic acid (PA), T3=control+0.2% live yeast (SC), T4=control+0.2% propionic

acid (PA)+ 0.2% live yeast(SC), T5=low protein and energy (LPLE), T6= LPLE+0.2%PA, T7= LPLE+0.2%SC,

T8=LPLE+0.2%PA+ 0.2%SC.St-gr=starter-grower, fin=finisher, feed price= according to the price different ingredients available in the market (May 2018), sell price= according to the local market price (June 2018). EEf=Economical efficiency= (net revenue per unit/total feed cost). REEf=Relative economical efficiency, assuming that the control diets=100%.

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الملخص العربى

تقييم إستخدام حامض البروبيونيك والخميرة الحية فى علائق منخفضة فى البروتين والطاقة على الاداء الانتاجى لدجاج التسمين.

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الهدف من هذه الدراسة هو تقييم تأثير إضافة حمض البروبيونيك أو الخميرة الحية أو مزيج منهما الى علائق دجاج التسمين المنخفضة فى البروتين والطاقة على الأداء الانتاجى ، وخصائص الذبيحة ، وبعض صفات الدم والكفاءة الاقتصادية . تم توزيع 240 من كتاكيت التسمين التجارية عشوائياً الى ثماني مجموعات ، كل منها يحتوي على ثلاث مكررات بكل مكررة 10 كتاكيت. تم التغذية على 8 معاملات غذائية ، مجموعة (1) الكنترول ، مجموعة (2) كنترول + 0,2 ٪ حمض البروبيونيك، مجموعة (3) كنترول + 0,2% خميرة حية, مجموعة (4) كنترول + 0,2 ٪ حمض البروبيونيك + 0,2% خميرة حية, مجموعة (5) كنترول مع تقليل البروتين 1,5٪ وتقليل الطاقة 200 كيلو كالوري/كجم عليقة ، مجموعة (6) العليقة المنخفضة فى البروتين والطاقة + 0,2% حمض بروبيونيك ، مجموعة (7) العليقة المنخفضة فى البروتين والطاقة + 0,2% خميرة حية و مجموعة (8) العليقة المنخفضة فى البروتين والطاقة + 0,2% حمض بروبيونيك + 0,2% خميرة حية. أظهرت النتائج ان الطيور التي تغذت على كل الإضافات حققت أعلى زيادة فى وزن الجسم مقارنةً بالكنترول أو الكنترول منخفض البروتين والطاقة. وأظهرت النتائج ان الغذاء المستهلك زاد معنويا فى المجموعة (4) بالمقارنة بباقى المجموعات. ايضا انخفض الغذاء المستهلك فى المجموعات 5 و 6 و 7 بالمقارنة بباقى المجموعات ولاتوجد اى اختلافات معنوية بين المجموعة 8 والكنترول . تحسنت نسبة التحويل الغذائي في الطيور التى تغذت على كل الاضافات مقارنة بالكنترول اوالكنترول منخقض البروتين والطاقة. لم يلاحظ أي تأثير معنوى في خصائص الذبيحة (الكبد ، والقلب ، والقانصة) ، ودهن البطن بين كل المجموعات بما في ذلك الكنترول أو العليقة المنخفضة فى البروتين والطاقة في حين أن جميع الإضافات أثرت معنويا في نسبة التصافى و إجمالي الأجزاء الصالحة للأكل مقارنةً بالكنترول أو العليقة المنخفضة فى البروتين والطاقة. ادت اضافة حامض البروبيونيك أو الخميرة الحية أو مزيج منهما الى زيادة RBCs، Hb، PCV، WBCs، مقارنة بالكنترول. اظهرت النتائج زيادة معنوية فى البروتين الكلى والجلوبيولين وانخفاض معنوى فى الكولستيرول الكلى والليبيدات الكلية مع كل الاضافات مقارنة بالكنترول او الكنترول منخفض البروتين والطاقة. اظهرت كل الاضافات تأثيرا معنويا فى الاجسام المناعية لمرض النيوكاسل. سجلت الطيور التى تغذت على اضافة البروبيونيك او الخميرة او خليط منهما الى العليقة منخفضة البروتين والطاقة أفضل القيم لكل من الكفاءة الإقتصادية (EEf) والكفاءة الاقتصادية النسبية (REEf) مقارنة بالمجموعات الأخرى . بصفة عامة فإن اضافة حامض البروبيونيك او الخميرة الحية إما كلا على حده أو مزيج منهما الى علائق تقل فى محتواها من البروتين والطاقة يمكن ان يحسن الاداء الانتاجى وخصائص الذبيحة وبعض صفات الدم وتعزيز المناعة ويمكن ان يكون بديلا جيدا للمضادات الحيوية المستخدمة فى تحسين الاداء الانتاجى لدجاج التسمين.