Egyptian Poultry Science Journal

http://www.epsaegypt.com

ISSN: **1110-5623** (**Print**) **– 2090-0570** (**Online**)

EFFECT OF DIETARY SUPPLEMENTATION OF PREBIOTIC, BETAINE AND THEIR COMBINATION ON GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY, CARCASS CRITERIA AND CECUM MICROBIAL POPULATION OF DUCKS UNDER HOT ENVIRONMENTAL CONDITIONS

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Received: 10/02/2018 Accepted: 06/03/2018

ABSTRACT: An experiment was conducted to determine the effects of dietary supplementation of prebiotic, betaine and their combination in duck diets on growth performance, nutrient digestibility, carcass criteria and cecum microbial population of ducks under hot environmental conditions. Treatment groups were fed on a control diet, the control diet supplemented with prebiotic as Bio mannanoligosaccharides (Bio MOS, 1 g/kg), the control diet supplemented with Betaine (1.5 g/kg) and the control diet supplemented with a combination of Bio MOS (1 g/kg) and Betaine (1.5 g/kg). A total of 80 Mollar ducks (average weight = 620.91 g, 20 day of age) were randomly assigned into 4 equal treatment. Each treatment was sub-divided into 5 replicates pens (4 ducks per pen) for 35 day from 20th of April to 25th of May 2017 in open house. Supplementation of Bio MOS and Betaine, separately as well as combined, significantly improved growth performance and feed conversion ratio. Digestibility of crude protein and crude fiber had significantly increased by the three additions. Total count of E.coli bacteria had decreased significantly and the total count of lactobacillus bacteria had increased significantly in prebiotic and combination treatments. Carcass weight, dressing percentage, intestinal weight and live body weight had improved significantly by the three treatments comparison with control one, however, liver, heart, spleen, gizzard, cecum and head weight didn't affect by the additions.

Keyword: Prebiotic – Betaine – Performance - Carcass criteria - Microbial population - Ducks

INTRODUCTION

Heat stress (HS) is a condition that occurs when an animal is exposed to above optimal temperatures and humidity. Heat stress is a major problem that adversely affects on performance and physiological traits of poultry which induce many physiological, endocrine and productive responses (Khan et al., 2012). Heat stress is characterized by decreased feed consumption and body weight gain, reduced metabolic rate and intestinal microbial dys-biosis (Quinteiro-Filho et al., 2012). Therefore, HS alters lipid metabolism differently from what would be expected based upon calculated whole-body energy balance. Several intervention strategies have been proposed for alleviating the negative effects of heat stress in poultry, including environmental management, nutritional manipulation, as well as inclusion of feed additives in the diet, although the effectiveness of most of the interventions has been variable or inconsistent. Betaine is not present in large quantities in poultry feedstuffs such as corn and soybean, the dietary betaine supplementation is necessary to improve the productive performance and reduce the negative impact of heat stress on viability and immune response by improving cell osmoregulation (Attia et al., 2005). Betaine is a multi-nutritional agent that may help birds to resist poor management and heat stress (Awad et al., 2014). Other studies have indicated that betaine can cause improving growth, feed efficiency and breast yield (Rao et al. 2011), improved performance and dressing percentage under heat stress (Sayed and Downing, 2011). Many researches have been conducted to define and explore the importance of using prebiotics. Prebiotics are a general term refers to chemicals that induce the growth or activity of microorganisms (e.g., bacteria and fungi) that contribute to the well-being of their host (Schloss, 2014). Prebiotic should increase the number or activity of bifidobacteria and lactic acid bacteria , the importance of the bifidobacteria and the lactic acid bacteria is that these groups of bacteria may have several beneficial effects on the host, especially in terms of improving digestion including enhancing mineral absorption, and the effectiveness and intrinsic strength of the immune system (Seifert and Watzl, 2007). In some studies the ability of prebiotic to be used as alternative feed additive has already been proven and thus started to play a decisive role in nutrition of poultry. The benefits of mannanoligosaccharides (MOS) are based on specific properties, including modification of the intestinal micro-flora, reduction in turnover rate of the intestinal mucosa, and modulation of the immune system in the intestinal lumen, these properties have the potential to enhance growth rate, feed efficiency, and livability in poultry species (Parks et al., 2001). Nevertheless, the use of prebiotics in diets for poultry has been shown improvement in bird's immunity and increasing performance. We hypothesize that dietary supplementation of prebiotic and betaine improves the measures of performance due to its antioxidant and antibacterial activity. The aim of the present study implied an evaluation of the potential effects of dietary supplementation of prebiotic, betaine and their combination on growth performance, nutrient digestibility, carcass criteria and cecum microbial populations of ducks under hot environmental conditions.

MATERIALS AND METHODS

2.1. Experimental birds, design and feed preparation

The birds were housed in floor pens on deep litter in an experimental farm of the Agricultural Research Centre of the Agriculture Faculty, South Valley University, Qena, Egypt. A total of 80 Mollar ducks (average weight = 620.91 g, 20 day of age) were randomly assigned into 4 equal treatment. Each treatment was sub-divided into 5 replicates (4 ducks per pen). One of the groups served as a control and was given a commercial basal diet, whereas the other three groups were given the same diet further supplemented with Betaine (1.5 g/kg), prebiotic as Bio mannaoligosaccharides (Bio MOS**,** 1 g/kg) and a combination of Betaine (1.5 g/kg) and prebiotic (1 g/kg), respectively for 5 weeks (from 20-55 days of age). Replicates were equally distributed into the breeding room pens (100×90×80 cm^3). The experimental diets were formulated to meet and exceed the nutrients requirements of NRC (1994). The composition and nutrient content of the growing diet are shown in Table 1. The birds were fed on diets in mash form during the experiment period. First, the supplementations of betaine, prebiotic and the combination were mixed separately in 1 kg of the basal diet each and then they were added to 2 kg of the basal diet and mixed separately then they were added perfectly to the required feed amount for the prescribed experimental period. The average outdoor temperature and relative humidity during the experimental period were 44.0 °C and 35.2, respectively. The brooding temperatures (indoors) and relative humidity were 43.2 °C and 38.6, respectively during the experimental period of 5 weeks. The house had lighted for 24 h; from 20th of April to 25th of May 2017 in open house. All ducks were supplied with feed and water for ad libitum consumption. Animal housing and handling procedures during experimentation were in accordance with guidelines of the Institutional Animal Care and Ethics.

2.2. Performance variables

Feed consumption had recorded daily in all experiment trails from 20-55 day of age. Initial body weight recorded in 20 days of age then body weight recorded at 41 day of age and at 55 days of age. Mortality recorded daily. Daily body weight gain and feed conversion ratio were calculated during 20-41, 42-55, and 20-55 days of age.

2.3. Carcass criteria

At 55 day of age (end of the experiment), fifteen birds from each treatment representing the average body weight of such treatment was slaughtered (4 treatments × 15 birds = 60 birds). After slaughtering and bleeding the birds were scalded and feathers were plucked. Carcasses were eviscerated, heads and shanks were separated, and then the carcasses were chilled in a tap water for about 10 minutes. Eviscerated carcasses were individually weighted and dressing percentage was calculated (weight of carcass + giblets + abdominal fat/pre-slaughter weight *100). Percentage of liver, gizzard, spleen, heart, intestine, cecum and head were measured related to carcass weight.

2.4. Digestibility trail

The diet intake was measured and excreta were collected over a 3 days period for each duck. The fecal samples were dried in a forced air drying oven 60 C for 72 h and ground with a mill using a 1-mm screen for chemical analysis. A complete proximate analysis was made on the feed

sample and on all fecal samples representing total collections. The diet and fecal samples were analyzed for moisture by oven drying (930.15), ash by incineration (942.05), protein by Kjeldahl (984.13), and ether extract by Soxhlet fat analysis (920.39), Crude fiber was determined by the Wende method as described by the AOAC (2006). Gross energy was determined by Parr adiabatic bomb (Moline, IL, USA).

2.5. Microbial enumerations

Five birds (n = 5) from each treatment were randomly selected to count the colony forming units (CFU) of Escherichia coli and Lactobacillus spp. in cecum. The digesta samples were decanted into separate sterile plastic containers and thoroughly mixed. Ten grams of homogenized sample along with ten – fold serial dilutions using physiological NaCl-Trypton were poured into a stomacher bag and shaken vigorously for three minutes. The plate media used were MRS agar for Lactobacillus spp. Escherichia coli (E. coli) bacteria were enumerated by inoculating a 10-fold serial dilution of rinses onto E. coli Petrifilms (3 M Corporation, St. Paul, MN). Sterile saline (0.85%) was used for dilution in accordance with manufacturer's instructions. After incubation at 35°C for 24 h, typical E. coli colonies were counted.

2.6. Statistical analysis

Statistical analyses were performed using the GLM procedure of (SAS Institute, 2009, Version 9.2) using a one-way ANOVA according to the following model:

$yij = \mu + Tj + Ɛij$

where y =the dependent variables; μ =general mean; T =supplement effect and Ɛ =random error.

For performance data, pen was considered as a replicate experimental unit for the statistical analysis. The bacteriological data required log transformation before statistical analysis. Duncan multiple range test was used to compare means. Significance was declared at $P<0.05$; P-values less than 0.001 are expressed as "<0.001" rather than the actual value.

RESULTS

3.1. Productive performance

Supplementation of prebiotic, betaine or their combination showed significant ($P<0.001$) effect on duck-daily feed intake at 20-41, 42-55 and 20-55 days of age (Table 2). Body weight, body weight gain and feed conversion ratio had significantly ($P<0.001$) improved by the three treatments in comparison with control one during the three periods (20-41, 42-55 and 20-55 days of age). There was one mortality case in the second replicate of control treatment it resulted from heat stress. The death duck was at the 3rd week of age of which could be due to high temperature. The death bird symptoms after bird dissection were high body temperature, aspiration in the abdominal cavity, severe inflammation of the rectum, hemorrhagic spots inside air bags and appearance of a large clotted blood spot inside the abdominal cavity. The general health status of other ducks was good throughout the experimental periods. The effects of prebiotic alone and betaine alone as well as in combination significantly ($P<0.001$) increased the body weight, body weight gain and feed intake during periods of 20-41, 42-55 and 20-55 days of age. Feed conversion ratio was significantly improved ($P<0.001$) by supplementation of prebiotic alone, betaine alone or in

combination during 20-41, 42-55 and 20-55 days of age.

3.2. Nutrient digestibility

Dietary supplementation of prebiotic, betaine or their combination significantly ($P<0.005$) increased crude protein digestibility and significant increased ($P<0.001$) in crude fiber digestibility (Table 3). There were no significant ($P\geq0.05$) effects on dry matter and ether extract.

3.3. Carcass characteristics

The addition of prebiotic, betaine or their combination significantly ($P<0.001$) increased in live body weight, carcass weight, dressing% and intestine weight (Table 4). There were no significant ($P\geq0.05$) effects on the relative weight of liver, heart, spleen, gizzard, head and cecum.

3.4. Microbial enumerations

In the current study we have observed significant ($P<0.001$) decreased in the total count of E.coli bacteria and significantly ($P<0.01$) increased in the total count of lactobacillus bacteria by the single prebiotic supplementation (Figure 1 and 2). There were no significant ($P\geq0.05$) effects on the total count of E. coli or lactobacillus bacteria by single betaine supplementation. The combination of prebiotic and betaine leads to significant ($P<0.001$) decreased in on the total count of E.coli bacteria and significant ($P<0.05$) increase in the total count of lactobacillus bacteria.

DISCUSSION

As a result of scarcity of available reports on effect of prebiotic and betaine on ducks, comparison was done with other studies that used other poultry. The benefits of prebiotic are based on specific properties, including modification of the intestinal micro-flora, reduction in turnover rate of the intestinal mucosa, and modulation of the immune system in the intestinal lumen, these properties have the potential to enhance growth rate, feed efficiency, and livability in poultry species (Parks et al., 2001). These beneficial effects might be directly associated with improvements in duck performance. In the present study, the general health status of ducks was good during the experimental periods. In current study, the effects of prebiotic, betaine and their combination treatments were observed on body weight, daily feed intake and daily body weight gain and feed conversion ratio, while there was not an additive effect on mortality in the supplementations. The single supplementation of prebiotic to the ducks diet improved body weight, daily feed intake and daily body weight gain and feed conversion ratio. These results were in agreement with Toghyani et al. (2011) who reported that using 1g / kg MOS significantly ($P<0.05$) increased feed intake, body weight and feed efficiency on broiler chicks. Also Konca et al. (2009) reported that using of 1g / kg MOS to turkey diets significantly ($P<0.05$) increased feed intake and feed conversion ratio, while they found that the addition did not affect body weight and body weight gain during the trial ($P>0.05$). Adding MOS to broiler chicks had gave higher ($P<0.05$) body gain, feed intake and lower feed conversion ratio compared with the control under heat stress (Sohail et al., 2012). Likewise, Abdel-Raheem et al. (2011) reported that the addition of 2g/kg of MOS on broiler chicks in the starter diets and 0.5 g/kg of the grower diets significantly increased ($P<0.01$) feed intake and body weight, but mortality rate was numerically lower not statistically. Similar to the present study, Wang and Zhou (2007) conducted

an experiment on 60 Pekin meat ducks and used prebiotics (MOS) by 3000 mg/kg at age of 0 to 2 weeks and by 2500 mg/kg at the age of 3 to 7 weeks, they reported that the supplemented groups had significantly (P<0.01) higher body weight gain, feed intake and feed efficiency.

In the current study a single betaine supplementation resulted in significant increase in feed intake, body weight, feed conversion ratio and daily weight gain. These results are in agreement with Awad et al. (2014) who reported that betaine supplementation at 0.5, 1.0 and 1.5 g/kg to Domyati duckling's diet resulted in significant increase on body weight, body weight gain, feed intake and feed conversion ratio. Also Nofal et al. (2015) claimed that betaine supplementation in heat stress conditions by 0.1% or 0.2 % had significantly increased body weight, body weight gain and feed conversion ratio. Supplementation of betaine at 800 mg/kg to broilers diets significantly influenced on body weight gain at 21 d of age (P<0.01) and feed conversion efficiency at 42 d of age (P<0.05). Betaine supplementation at levels of 0.1%, 0.2% and 0.4 % with heat stress had a higher (P<0.01) feed intake, body weight gain and lower feed conversion ratio (Shaojun et al., 2015). In contrast to the current study Sakomura et al. (2013) reported that betaine supplementation at 0.05% and 0.075% in male broilers diet resulted in no significant effect on feed intake, body weight gain and feed conversion ratio.

In the current study the addition of prebiotic alone resulted in significant (P<0.001) increased in crude protein and crude fiber, but there was no significant effects on ether extract and dry matter. This may increase the ability of ducks to overcome the effects of heat stress. Similar to the present study Gultepe et al. (2011) reported that protein and carbohydrate digestibility were significantly (P<0.05) affected by supplementation of Bio MOS at 20 or 40 g/kg, lipid digestibility was not improved by adding two levels of Bio-Mos to diets (P> 0.05). On the other hand, Zhang et al. (2001) found that prebiotic as galactooligosaccharaides (GOS) supplementation at (1% and 2%) had no significant (P>0.05) effects on crude protein, crude fiber and dray matter. Likewise, dietary supplementation of fructooligosaccharaides (FOS) 6.8g/kg and 13.5g/kg did not significantly affect the digestibility of crude protein, ether extract, crude fiber and dry matter for Pigs (Houdijk et al., 1998).

Single betaine supplementation significantly (P<0.05) increased in crude protein, crude fiber and haven't any significant effects on dry matter or ether extract. These improvements could be due to betaine is a trimethyl derivative of the amino acid glycine. It is a methyl group donor, donating its labile methyl group (CH3), and plays an important role in the metabolism of protein and energy (Ratriyanto et al., 2009). Moreover, betaine has the potential to improve nutrient digestibility by improving the growth and survival of intestinal cells, as well as intestinal microbes (Kettunen et al., 2001). These results agree with Ratriyanto et al. (2017) who reported that betaine supplementation by 0.06 % and 0.12 % significant (P<0.05) increase in crude protein, crude fiber, but they have not any significant effects on dry matter. Also, Attia et al. (2016) reported that betaine supplementation by 1000 mg / kg to laying hen diet resulted in significant (P<0.001) improve in crude protein, and

there weren't any significant effects on crude fiber, dry matter and ether extract digestibility. Awad et al. (2014) found that betaine supplementation by 0.5, 1.0 and 1.5 g betaine /kg domyati ducks diet (24-wks-old) resulted in no significant effects on dry matter coefficient as well as ether extract as compared to the control, in contrast crude protein, nitrogen free extract and crude fiber coefficients were significantly improved for the groups fed 1.0 and 1.5 g B/kg diet as compared to those fed the control diet. Contrast to our study Ratriyanto et al. (2009**)** used combination of inulin and betaine by 0.2% and 0.4% respectively in piglets diet and they reported that ileal dry matter digestibility significantly (P<0.05) increased, but betaine supplementation did not affect ileal and total tract digestibility of ether extract and crude protein.

In the present study the addition of prebiotic only significantly (P<0.001**)** increased live body weight, carcass weight, dressing % and intestine weight. There were no significant effects on the weight of liver, heart, spleen, gizzard, head and cecum. These results are in agreement with Abdel-Raheem et al. (2011) who found that there is a significant increase (p<0.05) in the carcass weight and dressing % and there was no significant effects on weight of liver, heart, spleen, gizzard, and head. However, Konca et al. (2009) in their experiment found that the effects of adding MOS on carcass had no significant effect on carcass weight, breast, thigh, wing, liver, heart, gizzard, intestinal system or abdominal fat (P>0.05). Furthermore Wang and Zhou (2007) found that there were no significant increase in internal organs and breast yield. Similar to the present study Toghyani et al. (2011) reported that liver. pancreas, gizzard, heart, small intestine and cecum weights of broiler chicks were not markedly affected by prebiotic. Attia et al. (2015) reported that using MOS by 0.083 g/rabbit/day resulted in significantly (P<0.01) increased dressing, liver and lung percentages and significantly (P<0.01) reduced the pancreas, test and heart percentges.

In the current study, the effects of betaine alone were significant (P<0.001**)** increase in live body weight, carcass weight, dressing % and intestine weight, but there weren't any significant effects on the weight of liver, heart, spleen, gizzard, head, and cecum. These results are in line with Nofal et al. (2015) who reported that dietary betaine effects on carcass characteristics since carcass weight, dressing, thigh, breast and giblets percentages were improved significantly (P≤0.01) by betaine supplementation at levels of 0.1 or 0.2% than the control group. In contrast Sakomura et al. (2013) reported that betaine supplementation by 0.05 and 0.075% to male broilers diet resulted in no significant effect on carcass, breast yield and internal organs compared with negative control diet.

In the current study we observed significant (P<0.001) decrease in the total counts of E.coli bacteria and significant (P<0.01) increase in the total counts of lactobacillus bacteria by the single prebiotic supplementation (Figure 1 and 2). These results are similar to Geier et al. (2008**)** who found that using MOS at 5 g/kg and FOS at 5 g/kg broiler chickens diet resulted in significant increase in ileal Lactobacillus. The prebiotic treatment groups showed significantly higher lactobacillus levels and lower E. coli levels than did control treatment groups (Kim et al. 2011). Prebiotic

supplementation at the level of 0.22% increased lactobacilli and decreased E. coli populations in the ileal content of broilers (Choi et al. 1993). In contrast to our study Abdel-Raheem et al. (2012) reported that using MOS by 2 g/kg of the starter and 0.5 g/kg of the grower broiler chickens diets failed to elicit any significant (P>0.05) effect on the total lactobacilli and E coli colony counts at day 21 in the different parts of the small intestine (duodenum, jejunum, ileum and cecum). Bonos et al, (2010) used MOS by 1 and 2g/ kg in Japanese quail diet, they reported that there was no significant (P>0.1) effect was found by the addition on lactic acid bacteria, total aerobic bacteria and total account of E.coli or lactobacillus bacteria by single betaine supplementation. Ratriyanto et al. (2009) reported that dietary supplementation with combination of inulin and betaine by 0.2%, 0.4 respectively in piglets diet did not affect (P>0.05) the concentration of various microbial metabolites both at the ileal and faecal level. Eberhard et al. (2007) failed to show any beneficial effects of dietary inulin supplementation on the formation of microbial metabolites. Ding et al. (2018) claimed that using xylooligosaccharides (XOS) by 0.01, 0.02, 0.03, 0.04, or 0.05% significantly increased (P<0.01) the cecum count of Bifidobacteria and butyric acid concentrations, however, there were not effects on total bacteria count, Lactobacillus, and Escherichia coli in the cecum. In contrast, Suo et al. (2015) found that XOS supplementation did not affect (P>0.38) on the populations of Escherichia coli, Salmonella, Lactobacilli, or Bifidobacterium in the cecum.

In the present study using betaine alone did not have significant (P>0.05) effects total count of E.coli and Lactobacillus bacteria (Figure 1 and 2). These results are in agreement with Kets, et al. (1993) who found that betaine addition by 2Mm had no significant effects on survival rates of Lactobacillus plantarum after drying. In contrast to our study Ratriyanto et al. (2009) reported that using betaine and inulin by (0.2 and 0.4%) respectively in piglets diet had no significant (P>0.05) effect on the concentration of various microbial metabolites both at the ileal and faecal level. We have observed that the combination of prebiotic and betaine had significant decreased in the total count of E.coli bacteria and significant increase in the total count of lactobacillus bacteria, indicating, synergistic effect of prebiotic and betaine may help to control or reduce the growth of harmful bacteria and increased beneficial bacteria of ducks under hot environmental conditions. Dietary betaine and prebiotic may protect intestinal cells and intestinal microbes and believed to have a positive effect on the welfare and productivity of the host bird (Ratriyanto et al., 2009; Kim et al., 2011). Furthermore, betaine may be beneficial in improving the welfare of broiler chickens, subjected to heat stress (Egbuniwe et al., 2016).

CONCLUSIONS

In view of the above findings, it can be concluded that dietary prebiotic at 1g/kg diet, betaine at 1.5 g/kg diet, or their combination resulted in improving productive performance, nutrient digestibility, carcass yield and cecum microbial population of ducks, indicating a possible synergistic effect of prebiotic and betaine and could alleviate the negative impacts of hot environmental conditions.

ACKNOWLEDGEMENTS

This study was supported by Agriculture Research Center, Faculty of Agriculture, South Valley University, Qena, Egypt. Authors want to state that the products used in the present study should not be considered as an endorsement of those products and their use was solely for research purpose.

Conflict of interest

The authors declare no conflict of interest.

Table (1): Ingredients and chemical composition of basal diet (as-fed basis)

Ingredients (%)	**Grower diet**
Maize, ground	65.40
Rice bran	6.10
Soybean meal (44% CP)	16.61
Corn gluten meal (60% CP)	6.75
Vit & Min. Premix[a]	0.30
Sunflower oil	1.56
Dicalcium phosphate	1.60
Limestone	1.00
Salt	0.30
DL-methionine	0.16
L- lysine HCl	0.22
Total	100
Nutrient Analysis	
ME (MJ/kg diet)	12.22
Crude protein (g/kg)	186.0
Crude fiber (g/kg)	26.6
Ether extract (g/kg)	34.8
Calcium (g/kg)	9.00
Available phosphorus (g/kg)	4.60

[a] Supplied vitamin-mineral premix contents per kg: 2400000 IU vitamin A; 1000000 IU vitamin D; 800 mg vitamin K; 16000 IU vitamin E; 650 mg vitamin B1; 1600 mg vitamin B2; 1000 mg vitamin B6; 6 mg vitamin B12; 8000 mg niacin; 400 mg folic acid; 3000 mg pantothenic acid; 40 mg biotin; 3000 mg antioxidant; 80 mg cobalt; 2000 mg copper; 400 mg iodine; 1200 mg iron; 18000 mg manganese; 60 mg selenium; 14000 mg zinc.

Table (2): Effect of prebiotic, betaine and their combination on performance of ducks

Items	Treatments				SEM*	P-value
	Control	Pre	Bet	Pre+Bet		
Body weight, g						
Initial 20d	621	616	597	608	19.83	0.133
41 d	1644[b]	2054[a]	2130[a]	2104[a]	40.88	<0.001
55 d	2403[b]	3057[a]	3192[a]	3115[a]	82.83	<0.001
Body weight gain, g/d						
20-41 d	48.70[c]	68.49[b]	73.01[a]	71.25[b]	1.95	<0.001
42-55 d	50.53[c]	71.61[b]	75.91[a]	72.19[b]	3.83	0.001
20-55 d	49.71[c]	69.74[b]	74.17[a]	71.63[b]	2.26	<0.001
Feed intake, g/d						
20-41 d	206.18[a]	160.23[c]	171.80[b]	167.23[b]	5.55	0.001
42-55 d	228.79[a]	180.26[c]	186.46[b]	183.86[b]	7.16	0.006
20-55 d	221.76[a]	173.39[c]	182.99[b]	179.33[b]	5.46	<0.001
Feed conversion ratio						
20-41d	4.016[a]	2.338[b]	2.354[b]	2.342[b]	0.080	<0.001
42-55 d	4.780[a]	2.510[b]	2.396[b]	2.440[b]	0.321	0.001
20-55 d	4.440[a]	2.480[b]	2.460[b]	3.100[b]	0.324	0.001

[a-d] Means not sharing a common superscript in a row are significantly different (P<0.05).
Control: basal diet, Pre: Control with 1 g/kg prebiotic, Bet: control with 1.5 g/kg betaine, Pre+Bet: Control with combination of 1 g/kg prebiotic + 1.5 g/kg betaine.
*SEM; Standard error of the means

Table (3): Effect of prebiotic, betaine and their combination on nutrient digestibility of ducks

Items	Treatments				SEM*	P- value
	Control	**Pre**	**Bet**	**Pre+Bet**		
Crude protein	77.82	87.95	86.50	89.85	2.11	0.005
Ether extract	61.66	73.40	66.46	70.86	3.11	0.077
Crude Fiber	24.69	34.99	22.07	32.81	1.13	<0.001
Dry matter	93.14	89.49	88.5	92.74	2.67	0.530

[a-d] Means not sharing a common superscript in a row are significantly different (P<0.05).
Control: basal diet, Pre: Control with 1 g/kg prebiotic, Bet: control with 1.5 g/kg betaine, Pre+Bet: Control with combination of 1 g/kg prebiotic + 1.5 g/kg betaine.
*SEM; Standard error of the means

Table (4): Effect of prebiotic, betaine and their combination on carcass criteria of ducks

Items	Treatments				SEM*	P- value
	Control	Pre	Bet	Pre+Bet		
Live body weight,g	2731[b]	3233[a]	3194 [a]	3296.5 [a]	69.82	<0.001
Carcass weight, g	2276[b]	2805[a]	2741[a]	2938[a]	57.03	<0.001
Dressing %	83.06[b]	86.83[a]	85.89[a]	89.13[a]	0.783	<0.001
Liver %	2.38	2.19	2.11	2.24	0.162	0.690
Heart %	0.686	0.703	0.743	0.693	0.036	0.690
Gizzard %	2.30	2.36	2.54	2.40	0.094	0.320
Spleen %	0.090	0.100	0.120	0.099	0.200	0.760
Head %	3.755	4.060	4.120	3.930	0.106	0.080
Intestine %	2.63[b]	3.13 [a]	2.85 [a]	2.76 [a]	0.128	0.050
Cecum %	0.165	0.128	0.121	0.136	0.012	0.080

[a-d] Means not sharing a common superscript in a row are significantly different (P<0.05).
Control: basal diet, Pre: Control with 1 g/kg prebiotic, Bet: control with 1.5 g/kg betaine, Pre+Bet: Control with combination of 1 g/kg prebiotic + 1.5 g/kg betaine.
*SEM; Standard error of the means

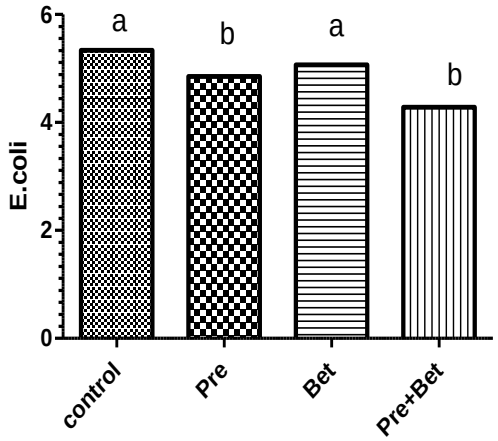

Figure 1. E. coli populations in response to supplementation of 1 g/kg prebiotic, 1.5 g/kg betaine or combination of 1 g/kg prebiotic and 1.5 g/kg betaine in broiler ducks. Letters on the bars a, b, denote the significant difference among the different treatments (P<0.05).

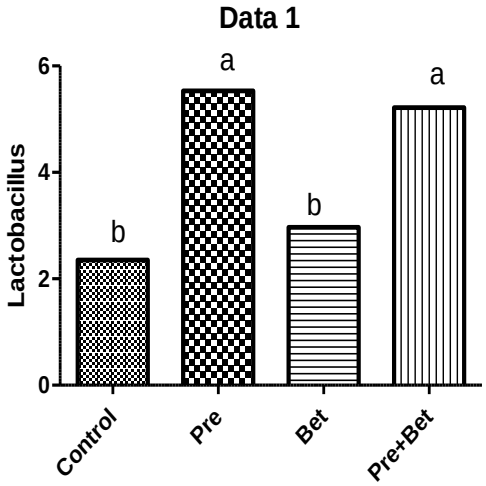

Figure 2. Lactobacillus spp. populations in response to supplementation of 1 g/kg prebiotic, 1.5 g/kg betaine or combination of 1 g/kg prebiotic and 1.5 g/kg betaine in broiler ducks. Letters on the bars a, b, denote the significant difference among the different treatments (P<0.05).

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الملخص العربي

تأثير الاضافات الغذائية من البريبيوتك والبيتان والخليط منهم على اداء النمو، هضم العناصر الغذائية، خواص الذبيحة، الميكروبيا الاعورية للبط تحت الظروف البيئة الحارة

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اجريت هذه التجربة لتحديد تاثير الاضافات الغذائية من البريبيوتك والبيتان والخليط منهم في تغذية البط على اداء النمو، هضم العناصر الغذائية، صفات الذبيحة، الميكروبيا الاعورية للبط تحت الظروف البيئة الحارة.
تم تغذية مجموعات المعاملات على عليقة كنترول (بدون اضافة).
العليقة الكنترول تم تزويدها بالبريبيوتك في صورة بايو مانواوليجوساكارايد Bio mannanoligosaccharides بمقدار (1 جم/ كجم علف)، بيتان Betaine بمقدار (1.5 جم / كجم علف) ، الخليط من البريبيوتك بمقدار (1جم / كجم) والبيتان بمقدار (1.5جم/كجم).
اضافة البريبيوتك والبيتان منفصلان وكذلك الخليط منهما ادى الى تحسين بشكل ملحوظ في اداء النمو ومعامل التحويل الغذائية والى تحسن ملحوظ في هضم الالياف والبروتين .
وجد ان التعداد الكلي لبكتريا الايشريشيا كولاي تناقص بشكل ملحوظ ووجدت زيادة معنوية في التعداد الكلي لبكتريا اللاكتوباسيليس في المجموعات المعاملة بالبريبيوتك والمعاملة الخليط من البريبيوتك والبيتان.
كما انه وجد تحسن ملحوظ في وزن الطيورالحية ووزن الذبيحة، وارتفاع نسبة التصافي وكذلك وزن الامعاء في المعاملات الثلاثة مقارنة بالمعاملة الكنترول (بدون اضافة)،على العكس لم تظهر اي زيادة معنوية في وزن الكبد والطحال و القلب والرأس والاعورين في اي من المعاملات.