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EFFECT OF DIETARY BETAINE SUPPLEMENTATION ON GROWTH PERFORMANCE AND CARCASS TRAITS OF DOMYATI DUCKLINGS UNDER SUMMER CONDITIONS

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ABSTRACT: A total number of 360 Domyati ducklings, one-day-old were randomly taken, weighed and divided into four treatments of equal three replicates each. The main objective of the present study was to investigate the effect of dietary betaine (B) supplementation at levels of 0 , 0.5 , 1.0 and 1.5 g/kg diet on growth performance, some blood parameters , serum constituents and carcass quality as well as economic efficiency during the studied growth period (1- 84 day of age) under summer conditions.

Dietary betaine supplementation resulted in a significant improvement in final body weight at 84 day of age and body weight gain during the whole experimental period (1-84 day) as compared to the control. Feed consumption was significantly decreased by supplementing different betaine levels, while, feed conversion ratio was significantly improved as compared to the control group during the overall experimental period. Viability of ducklings was significantly improved due to betaine treatment during the whole experimental period. Serum total protein and albumin (A) levels were significantly increased by supplementing different betaine levels, while, serum globulin (G) and A/G ratio were significantly improved by supplementing 1.0 and 1.5 g B/kg diet as compared to the control. Serum total lipids, triglycerides and total cholesterol constituents were significantly decreased by supplementing different betaine levels, whereas, triiodothyronine and thyroxin concentrations were not significantly affected as compared to the control group. Lymphocytes (L) count was significantly higher, whereas, heterophils (H) and H/L ratio were significantly decreased by supplementing different betaine levels as compared to the control group.

Key Words: Betaine, Domyati ducklings, growth performance, carcass traits and quality.

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Supplementing different betaine levels resulted in a significant increase in eviscerated carcass and total edible parts percentages, whereas, abdominal fat was significantly decreased as compared to the control group. Breast yield percentage was significantly improved by supplementing 1.5 g B/kg diet, whereas, skinless breast and thigh percentages were significantly improved by supplementing different betaine levels as compared to the control group. Skin percentage of thigh or total skin yield was significantly decreased by dietary betaine supplementation as compared to the control group. Protein content of both breast and thigh meat was significantly increased by supplementing different betaine levels, whereas, ether extract content was significantly decreased by supplementing 1.0 and 1.5 g B/kg diet as compared to the control group. Drip loss of carcass and thigh meat was significantly decreased by supplementing different betaine levels, while, it was not affected in breast meat compared to the control group. Economic efficiency and net return were improved by supplementing different betaine levels as compared to the control group during the whole experimental period. Dietary betaine supplementation up to 1.5 g B/kg diet could be used to maximize viability, growth performance, carcass traits and meat quality as well as economic efficiency of Domyati ducklings under summer conditions.

INTRODUCTION

Egyptian duck production was 42.0 thousand tons representing about 1.7% from the world production in 2006 (Soltan et al., 2014). It is becoming specialized and attention focused lately to increase meat production especially from local breeds (Kout El kolub et al., 2010; Awad et al., 2011). Domyati ducks is one of the local duck breeds which reared for diverse production situations and it's more favorable to the Egyptian consumer (Awad et al., 2014).

Generally, ducks are genetically predisposed to the fatness. Excessive carcass fat accumulation particularly in subcutaneous and visceral areas is one of the major concerns for ducks producers. This fat is generally undesirable for consumers and represents a waste product from ducks as well as it is unattractive to consumers who are concerned about the negative effects of saturated fat intake on health (Arslan et al., 2003).

Heat stress 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 causes many physiological changes such as acid-base imbalance (Imik et al., 2013), electrolytes imbalance (Borges et al., 2004) and increased respiration rate (Renaudeau et al., 2011), which lead to decreased performance (Quinteiro-Filho et al., 2012) and even increased mortality (Sandhu et al., 2012). Also, the effect of heat stress on birds involves two major factors: feed/nutrient intake and metabolic modifications (Lin et al. 2006). High environmental temperatures may cause water imbalance and osmotic change in cells from dehydration. It is known that changes in cell water volume can affect cell activity (Sahin et al., 2009).

Many feed additives have positive effects on heat stressed poultry. These additives include electrolytes and vitamins (Imik et al., 2013), as well as betaine (Attia et al., 2009). Because, 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 (Graham, 2002; Wang et al., 2004 and Attia et al., 2005). Thus, Betaine is a multi-nutritional agent that may help birds to resist poor management and heat stress (Awad et al., 2014). Additionally, it has many benefits in improving carcass yield (Neoh and Ng, 2012), increasing breast percentage and decreasing abdominal fat (Jahanian and Rahmani, 2008) as well as decreasing mortality rate (Lukic et al., 2012). Other studies have indicated that betaine can cause improved growth, feed efficiency and breast yield (Waldroup et al., 2006 and Rao et al., 2011), improved performance under heat stress and improved dressing percentage (Sayed and Downing, 2011). The objective of this study was to investigate the potential effect of dietary betaine supplementation to relief the adverse effects of heat stress on growth performance, meat quality and blood parameters as well as economic efficiency of local Domyati ducklings under summer conditions.

MATERIALS AND METHODS

This study was carried out at El–Serw Water Fowl Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. It was conducted in summer 2013. Three hundred and sixty-one-day-old unsexed Domyati ducklings were taken, weighed and distributed into four experimental groups. Each group contained 90 ducklings and equally subdivided into three replicates. Ducklings were reared under similar hygienic and managerial conditions. Feed and fresh water were available all the time through the experimental period. Ducklings were fed a starter diet from hatch up to 28 days and a finisher diet from 29 – 84 days of age. The composition and calculated analysis of the basal diets are shown in Table 1. Basal experimental diets were prepared and divided into four parts then supplemented with graded levels of betaine (0, 0.5, 1.0 and 1.5 g / kg diet) and fed to ducklings from one-day until 84 day of age.

Data collection and estimated parameters:

1. Body weight of ducklings was recorded at one day, 28, 56 and 84 days of age. Feed consumption and mortality were recorded weekly for each replicate during the experimental period. Body weight gain and feed conversion ratio were calculated through the periods 1– 28, 29–56, 57–84 and 1–84 days of age, whereas, viability percentage was calculated during the overall experimental period.
2. Blood serum biochemical analysis: At day 70, blood samples were collected in centrifugation tubes from the wing vein from three ducklings of each sex (male or female) per each treatment without anticoagulant and kept at room temperature for one hour to clot. The samples were centrifuged at 3500 rpm for 15 minutes to separate clear serum. After that, serum total protein, total lipids , triglycerides, total cholesterol, thyroxine (T_4) , triiodothyronine (T_3) and liver enzymes activities (AST and ALT) were calorimetrically determined using available commercial Kits.

3. Slaughter traits: At day 84, three ducklings of each sex (male or female) per each treatment group were randomly taken for slaughter test. Ducklings were fasted for 12 hours before slaughtering and individually weighed pre-slaughtering and post complete bleeding. Then, scalding, feather picking and evisceration were performed and different body parts, organs and abdominal fat were dissected and weighed. Relative carcass traits were expressed to live weight. Breast and thigh were cut (with or without skin) from the carcass and weighed, then their relative yields were expressed to carcass weight.
4. Drip loss: In order to determine drip loss for carcass parts, parts were placed in duly identified polyethylene bags, sealed at atmospheric pressure, and frozen for 48 hours at -4°C. After this time, parts were again weighed (Bridi et al., 2003). Drip loss was calculated as the difference between initial weight and final weight, and expressed as a percentage. Carcass drip loss was calculated as the drip loss of all carcass parts.
5. Meat chemical analysis: Breast and thigh meat (with skin) samples were taken, chopped, dried and used for chemical analysis according to the official methods (AOAC, 1995).
6. Economic efficiency and net return were calculated based on the prices of betaine (40 LE/ one kg) and one kg of live body weight (17.0 LE) prevailing during year 2013.
7. Statistical analysis: Data were analyzed by the analysis of variance according to SAS (2004) and significant differences among means were detected by the Duncan's Multiple Range Test (Duncan, 1955).

The following model was used:
$Y_{ij} = \mu + T_i + e_{iJ}$ where:
Y_{ij} = an observation, μ = overall mean,
T_i = effect of treatment (i=1, 2, 3, 4) and
e_{iJ} = Random error

RESULTS AND DISCUSSION

Growth performance:

Dietary betaine supplementation (B) had significant effect on live body weights of Domyati ducklings at 28, 56 and 84 days of age (Table 2). Supplementing different betaine levels had significantly heavier body weight of ducklings by 4.52 - 13.87 % as compared to the control group (un-supplemented) at 84 day of age. Body weight gain (BWG) of ducklings was significantly improved by supplementing 1.5 g B/kg diet at 1–28, 29–56 and 1-84 days of age as compared to the control group (Table 2). Generally, BWG was significantly improved by 4.59, 4.87 and 14.07 % for ducklings fed diets supplemented with 0.5, 1.0 and 1.5 g B/ kg diet, respectively as compared to the control during the overall experimental period (1-84 days of age). This improvement may be due to an increase in the serum concentrations of insulin-like growth factor-1 (IGF-1), which is known as a potent growth promoter in broilers (Zhan, 2000), or betaine had a major role to stimulate growth hormone secretion (Wang et al., 2004). Moreover, betaine may increase re-methylation of homocysteine through methionine synthase (Pillai et al., 2006) and methionine as well as choline sparing effects (Patil et al., 2007), or it may reduce energy expenditure (Moeckel et al., 2002), promote cell proliferation (Eklund et al., 2005) and made the birds able to retain water allowing more energy for growth (Jahanian and Rahmani, 2008). These results are in agreement with those obtained by Wang et al. (2004) who found that dietary betaine supplementation up to 1.5 g/kg had significantly increased live

body weight and weight gain during starter and grower periods of ducks. Farooqi et al. (2005) reported that dietary betaine supplementation (1.0 g/kg) resulted in more average body weight gain in broiler under heat stress. Also, dietary betaine supplementation had positive effects on live body weight of broiler (Hamidi et al., 2010 ; Sayed and Downing , 2011)) and turkey (Zayed, 2012) under heat stress. Similarly, Khattak et al. (2012) reported that betaine supplementation (1.2 g/kg) to broiler diet improved growth performance and decreased mortality rate under hot (30–41^{o}C) and humidity (45–93% RH) conditions. In contrary, Rafeeq et al., (2011); Lukic et al. (2012) showed that betaine supplementation had no positive effects on weight gain.

Feed consumption (g /duck/28 days) was significantly decreased by feeding diet supplemented with 1.5 g B/kg by about 12.45 and 16.19% as compared to the control during 29-56 and 57-84 days of age, respectively (Table 2). Also, it was significantly decreased by 6.95, 7.81 and 11.63 % for ducklings fed diet supplemented with 0.5, 1.0 and 1.5 g B/kg as compared to the control during the overall experimental period. These results are in disagreement with those obtained by Pirompud et al. (2005) who revealed no significant differences in feed intake of birds fed diet supplemented with betaine under tropical conditions. Also, El-Husseiny et al. (2007) reported that feed consumption of broilers was not significantly affected due to dietary betaine supplementation as compared to the control.

Feed conversion ratio was significantly improved as a result of dietary betaine supplementation during different experimental periods (Table 2). It was significantly improved by 10.96, 12.06 and 22.37 % for ducklings fed diet supplemented with 0.5, 1.0 and 1.5 g B/kg, respectively as compared to the control during the overall experimental period. This improvement may have been attributed to the involvement of betaine in protection of intestinal epithelium against osmotic disturbance, improvement of digestion and absorption conditions in the gastrointestinal tract (Konca and Kinkpinar, 2008). Moreover, betaine may be reduces energy expenditure for pumping ions in cells exposed to hyperosmotic media (Moeckel et al., 2002), or it may promote cell proliferation by using the spare energy (Eklund et al., 2005). Furthermore, betaine may be essential to support intestinal growth, function, increased cell proliferation and improves microbial fermentation activity, which in turn, may enhance nutrient digestibility (Ratriyanto et al., 2009). These results are in agreement with those obtained by Waldroup et al. (2006), Pillai et al. (2006), Honarbakhsh et al. (2007) and Rao et al. (2011) who reported that betaine supplementation resulted in improving feed efficiency. In addition, Enting et al. (2007) reported that betaine supplementation with 1.0 and 2.0 g/kg diet resulted in a significant improvement in feed conversion ratio as compared to the control. Attia et al. (2009) showed that supplementing 1.0 g betaine/kg diet resulted in a significant improvement in feed conversion ratio than the control

Viability rate (%) was significantly improved by 5.46 and 9.09 % of Domyati ducklings fed diet supplemented with 1.0 and 1.5 g B/kg compared with those fed the control diet, while it was insignificantly better by 3.63 % for the group fed 0.5 g B/kg diet during the whole experimental period (Table 2). These results may be due to the function of betaine which may serve to alleviate heat stress in ducklings, or it may suppress insulin-like growth factor binding protein-1 (IGFBP-1) secretion in the livers as an indicator of the reduction in

catabolic functions which resulting from stress, infection and immune deficiency (Jones and Clemmons, 1995) or it may be helped duodenal epithelial cells to maintain water balance under hyperosmotic conditions by reducing the water flux from the cells (Kettunen et al., 2001). These results are in agreement with those obtained by Zhan (2000) who reported that betafin (betaine) addition significantly improved the immune response and alleviated the adverse effects on body temperature. Also, Zayed (2012) reported that betaine supplementation by different levels to turkey diet resulted in the highest viability values. Khattak et al. (2012) reported that betaine supplementation (1.2 g/kg) to broiler diet decrease mortality under hot (30–41^{o}C) and humidity (45–93% RH) conditions.

Blood serum constituents:

Blood serum constituents of Domyati ducklings are presented in Table 3. All studied blood serum constituents were significantly affected due to dietary betaine supplementation except of triiodothyronine (T_3) and thyroxine (T_4). However, serum total protein and albumin were significantly increased by increasing dietary betaine supplementation as compared to the control, while globulin was significantly increased by feeding diet supplemented with 1.0 and 1.5 g B/kg only. Albumin / Globulin ratio (A/G) was significantly improved by feeding 1.5 g B/kg diet compared with those fed the control diet, whereas, it was insignificantly improved by feeding diet supplemented with 0.5 and 1.0 g B/kg. These results may be due to the function of betaine which may act to support an increase in muscle cell proliferation, increase availability of methionine, making it available for protein synthesis rather than being used as a methyl donor (Zhan, 2000). The improvement in serum total protein, albumin and globulin due to betaine supplementation indicating its role as a methyl donor for protein metabolism (Remus et al., 2004). These results are in agreement with those obtained by Mathews and Southern (2000) who found that dietary betaine supplementation increased plasma total protein and albumin of broilers under heat stress. Also, Rao et al. (2011) reported that betaine supplementation enhanced the concentrations of protein and globulin in serum of broilers.

Serum total lipids, triglycerides and total cholesterol were significantly decreased by supplementing different betaine levels to the diets (Table 3). The decrease values were 11.75, 18.70 and 25.76% in total lipids, 10.32, 14.49 and 21.55 % in triglycerides, and 8.87, 12.51 and 20.63%in total cholesterol for ducklings fed diet supplemented with 0.5, 1.0 and 1.5 g B/kg, respectively as compared to the control. These results may be due to betaine which plays a major role in lipid metabolism, which associated with an enhanced synthesis of methylated compounds in liver and muscle such as carnitine and creatine (Zhan et al., 2006). Carnitine is directed to the transport of long-chain fatty acids across the inner membrane of mitochondria where fatty acid oxidation takes place and it's regulate fat metabolism (Wang et al., 2004). Accordingly, increased hormone-sensitive lipase activity (Zhan et al., 2006) following dietary betaine supplementation which resulted in reducing lipid deposition (Eklund et al. 2005).These results are in agreement with those obtained by Jahanian and Rahmani (2008) who found that betaine enhanced lipase activity and decreased the concentration of plasma triglycerides and cholesterol in broilers and geese (Su et al., 2009) compared with control under hot summer condition.

On the other hand, liver enzymes (ALT and AST) were significantly

decreased by supplementing 1.0 and 1.5 g B/kg as compared to the control. This may be due to the decrease of serum triglycerides and cholesterol content. These results are similar to those obtained by Attia et al. (2005) who reported that supplementing 1.0 or 2.0 g betaine/ kg broiler diet during the starter-grower period (1 to 56 days of age) resulted in a significant decrease in serum alanine aminotransaminase (ALT), whereas, Zayed (2012) reported that liver enzymes AST and ALT were insignificantly decreased due to betaine supplementation to turkey diet.

Both serum T_3 and T_4 constituent were not significantly affected, although T_3/T_4 ratio was significantly higher by feeding diet supplemented with 1.5 g B/kg as compared to the control. These results are in the line with Tollba et al. (2007) who showed that T_3 (triiodothyronine) hormone concentration in blood serum was increased without significant effect due to dietary betaine supplementation under summer conditions. However, Zou et al. (1998) reported that the dietary betaine supplementation increase serum levels of some hormones such as luteinizing hormone, follicle-stimulating hormone, triiodothyronine, thyroxine, oestradiol and progesterone. It is of interest to mention that T_3/T_4 ratio is an indicator of peripheral conversion of T_3 to T_4 via monodeiodination process. In this concern, our study stated that about 23% of T_4 is converted to T_3 in the last treatment group (1.5 g B/ kg) compared with 20% for the control group. This may explain the observed improvement in productive performance of treated groups compared with those of the control.

Heamatological parameters:

Results of Table 3 show that heterophils and lymphocytes (%) and their ratio were significantly affected due to dietary betaine supplementation. However, white blood cells count (WBC) was not affected; it was tend to decrease as a result to dietary betaine supplementation compared with those of the control. Ducklings fed diets supplemented with 1.0 and 1.5 g B/kg had significantly the lowest value of heterophils by 25.75 and 34.66 % as compared to the control, whereas lymphocytes value was significantly higher by 5.94, 11.39 and 15.85% for ducklings fed diet supplemented with 0.5 , 1.0 and 1.5 g B/kg compared to the control, respectively. Heterophils/Lymphocytes ratio was significantly decreased by 10.0 , 30.0 and 44.0% for the groups fed diets supplemented with 0.5 , 1.0 and 1.5 g B/kg compared with the control, respectively. These results may be due to betaine supplementation which enhanced the lymphocyte proliferation (Rao et al., 2011). Also, betaine led to a decrease in hetrophile/lymphocyte ratio (H/L) and body temperature under heat stress (Khattak et al., 2012).

Carcass traits:

All studied carcass traits (expressed as percentages of LBW) of Domyati ducklings at 84 days of age were significantly affected due to betaine supplementation except for liver, heart and total giblets (Table 4). Eviscerated carcass was significantly improved by 8.34, 13.73 and 16.92 %, whereas, total edible parts was significantly higher by 8.15, 12.54 and 15.63 %, respectively for the groups fed diet supplemented with 0.5 , 1.0 and 1.5 g B/kg as compared to the control. It is worthy to note that abdominal fat percentage was significantly decreased by 25.0, 38.16 and 53.95% for the groups fed diets supplemented with 0.5, 1.0 and 1.5 g B/kg diet as compared to the control, respectively.

Dietary supplementation of betaine may influence carcass and parts weights

due to its methyl-group donor property, which would increase methionine, cystine and glycine for protein synthesis and also contribute to reduce fat deposition in the carcass through several metabolic routes (McDevitt et al., 2000). Also, the addition of betaine may produce lower viscera weight due to the osmolytic effect of betaine which helps maintained water and ion balance at a lower energy cost. The decrease in abdominal fat may be due to betaine which had a major effect on lipid metabolism as a result of enhancing carnitine synthesis in liver and muscle (Zhan et al., 2006) and lecithin synthesis (Sunderson and Mackinly, 1990) which were responsible for the transport of fatty acids to the mitochondria where fatty acid oxidation occurs, accordingly, lipid deposition were reduced (Eklund et al., 2005). Moreover, betaine may improve choline availability, thus providing more choline for synthesis of VLDL which prevents the deposition of fat in liver and accelerates the removal of fat from the liver (Yao and Vance, 1989). Also, betaine may reduce the mRNA level for fatty acid synthase and adipocyte type acid binding protein (Xing et al., 2011). These results are in agreement with those obtained by Waldroup et al. (2006) and Konca and Kinkpinar (2008) who reported that supplementing betaine to broiler's diet (1 g/kg) had significantly increased carcass dressing percentage at 42 days of age. Also, Jahanian and Rahmani (2008) and Neoh and Ng (2012) reported that dietary betaine supplementation improved carcass yield and decreased abdominal fat. In contrast, Esteve-Garcia and Mack (2000) and McDevitt et al. (2000) reported that abdominal fat was decreased, although the effect was not significant .

Carcass parts:

Relative weights of all carcass parts (expressed as percentages of eviscerated carcass weight) of Domyati ducklings at 84 days of age were significantly affected due to dietary betaine supplementation except of breast skin and thigh yield (Table 5). Breast yield was significantly improved by 10.48% for ducklings fed diet supplemented with 1.5 g B/kg, while, it was insignificantly higher by 4.33 and 6.15% for ducklings fed diet supplemented with 0.5 and 1.0 g B/kg as compared to those fed the control diet, respectively. Breast skinless yield was significantly improved by 7.76, 11.38 and 17.43 % for ducklings fed diet supplemented with 0.5, 1.0 and 1.5 g B/kg as compared to those fed the control diet, respectively. Thigh yield was improved by 6.00, 6.11 and 7.97% but without significant, whereas, thigh skinless yield was significantly higher by 20.82, 27.93 and 32.51 % for ducklings fed diet supplemented with 0.5, 1.0 and 1.5 g B/kg as compared to those fed the control diet, respectively. Dietary betaine supplementation resulted in a significant decrease in thigh skin percentage by 21.31 to 37.11 %, where this decrease was reached to 9.88% of breast skin without significant difference compared to the control. Generally, total skinless breast and thigh yield was significantly improved by 12.10, 16.87 and 22.43% by supplementing 0.5 , 1.0 and 1.5 g B/kg diet, whereas, total skin yield for breast and thigh was significantly decreased by 12.64 , 20.27 and 21.97% for the same groups, respectively.

These results may be due to the function of betaine which plays a major role to increase breast meat percentage by two primary metabolic roles, firstly as a methyl group donor and secondly as an osmolyte that assists in cellular water homeostasis (Konca and Kinkpinar, 2008). These results are in agreement with those obtained by Honarbakhsh et al. (2007) who revealed that dietary betaine (0, 0.075, 0.150 and 0.225%) supplementation

resulted in significant increase in breast weight percentage during grower and finisher periods. Enting et al. (2007) indicated that the addition of 1 and 2 g betaine /kg diet significantly increased breast meat percentage in male chickens from 17.44 to 18.21 and 18.30, respectively. Also, Waldroup et al. (2006) and Rao et al. (2011) reported that betaine supplementation improved breast yield under heat stress. Jahanian and Rahmani (2008) and Neoh and Ng (2012) reported that dietary betaine supplementation improved carcass yield and breast percentage as well as decreased abdominal fat.

Meat chemical analysis:

Results of meat chemical analysis of both breast and thigh for Domyati ducklings are presented in Table 6. Dry matter and ash contents of both breast and thigh meat were numerically increased by dietary betaine supplementation. Crude protein content of breast meat was significantly increased by 2.12, 1.99 and 4.37 % for ducklings fed diet supplemented with 0.5 , 1.0 and 1.5 g B/kg as compared to those fed the control diet, whereas it was significantly higher by 6.49, 3.80 and 5.66 % in thigh meat for the same groups, respectively. Ether extract content in breast meat was significantly decreased by 10.42 and 16.67 % for ducklings fed diet supplemented with 1.0 and 1.5 g B/kg as compared to those fed the control diet, whereas, it was significantly lower by 16.22 and 22.97% in thigh meat for the same groups, respectively. These results may be due to betaine supplementation which might result in a decrease in the lipogenesis rat of adipose tissue, resulting from a reduction in the activities and gene expression of lipogenic enzymes, as evidenced by the decrease in fatty acid synthase mRNA expression (Huang et al., 2008). Also, betaine plays a major role in lipid metabolism in organisms through carnitine synthesis (Zhan et al., 2006), it is indirectly involved in the synthesis of carnitine, which is required for transporting long chain fatty acids across inner mitochondrial membranes for oxidation. These results are in agreement with those obtained by Wang et al. (2004) who showed that betaine supplementation significantly decreased abdominal fat in meat ducks.

Drip losses (%) of whole carcass meat and thigh meat was significantly lower for ducklings fed diet supplemented with different betaine levels, whereas , it was not affected in breast meat as compared to those fed the control diet (Table 6). This may be due to betaine function which promoted high water retention in broilers exposed to cyclic heat stress (Mooney et al., 1998), and improved the cell ability to maintain its structure and function by regulating water in and out the cell (Kidd et al., 1997). This result is in agreement with those obtained by Hammer and Baltz (2002) who reported that betaine is considered to be the most effective osmoprotectant among other organic osmolytes such as glycine and glutamine.

Economic efficiency:

Calculations of economic efficiency were listed in Table 7. Economic efficiency (EE) values were 0.212, 0.394, 0.396 and 0.564 for Domyati ducklings fed diets supplemented with 0.0, 0.5, 1.0 and 1.5 g B/kg diets during the whole experimental period, respectively. Relative EE values were improved by 85.85, 86.79 and 166.04% for the groups fed 0.5, 1.0 and 1.5 g B/kg diet as compared to the control group, respectively. The improvement in total and net return may be due to decrease feed consumption and increase body weight per duckling. In accordance with the obtained results, similar results were reported by El-Husseiny et al. (2007) and

Patil et al. (2007) who observed that betaine supplementation to poultry diet resulted in a highly economic efficiency value as compared to the control group. Zayed, (2012) reported that economic efficiency was improved by feeding diet supplemented with 0.75 and 1.5 g B/kg diet for turkey under summer conditions.

CONCLUSION

Based on the present data, it is concluded that dietary betaine supplementation up to 1.5 g/kg had positive effects on growth performance, carcass traits, meat quality and economic efficiency for Domyati ducklings under Egyptian summer conditions.

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

Ingredients %	Starter (1-28 day)	Finisher (29-84 day)
Yellow Corn	61.70	70.70
Soybean meal (44 %)	34.55	25.50
Di-calcium phosphate	1.60	1.62
Limestone	1.45	1.48
Vit. & Min. premix[1]	0.30	0.30
NaCl	0.30	0.30
DL. Methionine	0.10	0.10
Total	100.0	100
Calculated Analysis [2]		
Crude protein %	20.01	16.72
ME (Kcal / kg)	2841	2941
Ether extract . %	2.86	3.07
Crude fiber %	3.94	3.07
Calcium (%)	1.04	1.03
Av. phosphorus (%)	0.44	0.43
Lysine %	1.17	0.92
Methionine %	0.45	0.40
Methio + Cyst %	0.78	0.69
Sodium	0.13	0.13
Price (LE/kg) [3]	2.926	2.792

1- Each 3 kg of the Vit and Min. premix manufactured by Agri-Vit Company, Egypt contains: Vitamin A 10 MIU, Vit. D 2 MIU, Vit E 10 g, Vit. K 2 g, Thiamin 1 g, Riboflavin 5 g, Pyridoxine 1.5 g, Niacin 30 g, Vit. B12 10 mg, Pantothenic acid 10 g, Folic acid 1.5 g, Biotin 50 mg, Choline chloride 250 g, Manganese 60 g, Zinc 50 g, Iron 30 g, Copper 10 g, Iodine 1g, Selenium 0. 10 g, Cobalt 0.10 g. and carrier CaCO3 to 3000 g..

2- According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001).

3- Price of one kg (LE) at time of experiment for different ingredients : yellow corn , 2.20 ; Soy bean meal, 3.80; Di-calcium Phosphate,10.0 ; limestone, 0.10 ; Vit&Min.,25.0 ; Nacl,1.0 and Meth.,40.0 .

Table (2): Effect of dietary betaine supplementation on growth performance of Domyati ducklings during growth period.

Age (day)	Betaine, g/kg				Sig.
	0.0	0.5	1.0	1.5	
Body weight (g /duck)					
One- day	38.1±0.9	38.3±0.3	39.5±0.2	39.2±0.1	NS
28	649.9±17.7 ^{b}	660.3±20.9 ^{b}	714.0±42.0 ^{ab}	793.3±03.3 ^{a}	0.05
56	1524.8±32.3 ^{c}	1582.4±31.9 ^{bc}	1662.3±7.8 ^{b}	1766.7±17.6 ^{a}	0.01
84	2028.7±15.7 ^{c}	2120.3±9.1 ^{b}	2127.8±39.3 ^{b}	2310.0±10.0 ^{a}	0.01
Body weight gain (g/ duck / 28 days)					
1-28	611.8±18.4 ^{b}	622.0±20.8 ^{b}	674.5±41.9 ^{ab}	754.1±3.2 ^{a}	0.05
29-56	875.0±19.8 ^{b}	922.1±26.5 ^{ab}	948.3±41.3 ^{ab}	973.3±18.6 ^{a}	0.05
57-84	503.9±36.4	537.9±25.2	465.5±40.1	543.3±21.9	NS
1-84	1990.7±16.1 ^{c}	2082.0±9.3 ^{b}	2087.6±38.8 ^{b}	2270.8±9.9 ^{a}	0.01
Feed consumption (g /duck/28 days)					
1-28	1594.8±46.9	1560.0±34.3	1568.4±58.3	1626.7±29.6	NS
29-56	3312.5±147.1 ^{a}	3034.9±72.8 ^{ab}	3012.4±76.2 ^{ab}	2900.0±54.0 ^{b}	0.05
57-84	4175.9±40.7 ^{a}	3817.0±29.6 ^{b}	3793.2±146.6 ^{b}	3500.0±45.0 ^{c}	0.01
1-84	9083.2±140.8 ^{a}	8451.8±70.4 ^{b}	8374.0±253.2 ^{b}	8026.7±29.6 ^{b}	0.01
Feed conversion ratio (g. feed /g BW gain)					
1-28	2.61±0.04 ^{a}	2.51±0.06 ^{a}	2.34±0.08 ^{b}	2.16±0.05 ^{b}	0.01
29-56	3.79±0.03 ^{a}	3.29±0.14 ^{ab}	3.19±0.21 ^{ab}	2.98±0.06 ^{b}	0.05
57-84	8.29±0.52 ^{ab}	7.10±0.31 ^{ab}	8.22±0.43 ^{a}	6.46±0.27 ^{b}	0.05
1-84	4.56±0.03 ^{a}	4.06±0.07 ^{b}	4.01±0.05 ^{b}	3.54±0.03 ^{c}	0.01
Viability, %					
1-84	89.43±2.15 ^{c}	92.68±0.00 ^{bc}	94.31±81.3 ^{ab}	97.56±1.41 ^{a}	0.05

BW =body weight , NS= non-significant.

a,b : means in the same row bearing different superscripts are significantly different ($P \leq 0.05$)..

Table (3): Effect of dietary betaine supplementation on some serum constituents and blood heamatological parameters of Domyati ducklings.

Parameters	Betaine, g/kg				Sig.
	0.0	0.5	1.0	1.5	
Serum constituents					
Total protein (g/ dl)	4.59±0.05^{d}	4.82±0.04^{c}	5.16±0.07^{b}	5.39±0.09^{a}	0.01
Albumin (g/ dl)	2.27±0.03^{d}	2.43±0.05^{c}	2.62±0.02^{b}	2.80±0.05^{a}	0.01
Globulin (g/ dl)	2.33±0.03^{b}	2.39±0.04^{b}	2.54±0.07^{a}	2.59±0.05^{a}	0.01
A/G	0.98±0.02^{b}	1.02±0.04^{ab}	1.03±0.03^{ab}	1.08±0.01^{a}	0.05
Total lipids (mg/dl)	726.7±15.6^{a}	641.3±7.51^{b}	590.8±12.6^{c}	539.5±17.7^{d}	0.05
Triglycerides (mg/dl)	107.42±1.69^{a}	96.33±1.12^{b}	91.85±1.67^{c}	84.27±0.98^{d}	0.01
Total cholesterol (mg/dl)	157.85±2.73^{a}	143.85±0.87^{b}	138.10±1.06^{c}	125.29±0.80^{d}	0.01
AST (U/ dl)	31.93±4.62 ^{a}	30.07±1.76 ^{a}	21.97±2.19 ^{b}	21.67±3.84 ^{b}	0.05
ALT (U/ dl)	25.09±4.51 ^{a}	24.80±4.36 ^{a}	18.33±0.89 ^{b}	17.67±3.19 ^{b}	0.05
T_3 (ng/ ml)	4.58±0.16	4.78±0.13	4.68±0.19	4.91±0.08	NS
T_4 (ng/ ml)	22.70±0.34	22.61±1.08	21.44±0.80	21.62±0.73	NS
T_3/ T_4	0.20±0.01^{b}	0.21±0.01^{ab}	0.22±0.003^{ab}	0.23±0.01^{a}	0.05
Blood heamatological parameters					
WBC (x10^3/mm^3)	31.67±0.88	30.00±0.58	29.67±1.20	30.33±1.20	NS
Heterophils, %	33.67±0.58^{a}	28.67±0.88^{a}	25.00±0.88^{b}	22.00±0.58^{c}	0.01
Lymphocyte, %	67.33±0.88^{d}	71.33±0.67^{c}	75.00±0.58^{b}	78.00±0.58^{a}	0.01
H/L	0.50±0.002^{a}	0.40±0.01^{b}	0.33±0.01^{c}	0.28±0.01^{d}	0.01

NS= non-significant .

a,b c, d, :means in the same row bearing different superscripts are significantly different ($P \leq 0.05$).

Table (4): Effect of dietary betaine supplementation on some carcass parameters* for Domyati ducklings at 84 day of age.

Items	Betaine, g/kg				Sig.
	0.0	0.5	1.0	1.5	
LBW (g)	2233.0±96.3	2225.0±92.0	2300.0±53.2	2285.0±61.6	NS
Carcass parameters, %					
Eviscerated carcass	62.13±2.55^{c}	67.31±0.79^{b}	70.66±0.34^{ab}	72.64±1.27^{a}	0.01
Liver	2.17±0.15	2.08±0.13	2.00±0.10	1.89±0.08	NS
Gizzard	3.16±0.15^{ab}	3.36±0.15^{a}	2.81±0.15^{b}	3.00±0.06 ^{ab}	0.05
Heart	0.68±0.03	0.72±0.03	0.78±0.08	0.73±0.01	NS
Total giblets	5.63±0.22	5.97±0.16	5.60±0.20	5.71±0.13	NS
Total edible parts	67.76±2.73^{c}	73.28±0.85^{b}	76.26±0.39^{ab}	78.35±1.36 ^{a}	0.01
Abdominal fat	1.52±0.24^{a}	1.14±0.08^{b}	0.94±0.08^{bc}	0.70±0.04^{c}	0.01

* Expressed as % of LBW ; LBW = Live body weight.

a,b,c :means in the same row bearing different superscripts are significantly different ($P \leq 0.05$).

NS= non significant.

Table (5): Effect of dietary betaine supplementation on carcass parts* for Domyati ducklings at 84 day of age.

Items		Betaine, g/kg				Sig.
		0.0	0.5	1.0	1.5	
Evisc. carcass (g)		1520.0±83.7	1549.2±90.0	1537.5±89.4	1595.8±97.5	NS
Carcass parts, %						
Breast	Yield [1]	47.82±1.57^{b}	49.89±1.85^{ab}	50.76±3.40^{ab}	52.83±3.54^{a}	0.05
	Skinless[2]	35.68±1.74^{c}	38.45±2.56^{b}	39.74±3.42^{ab}	41.90±2.04^{a}	0.01
	Skin	12.14±0.96	11.44±1.26	11.02±1.23	10.94±1.80	NS
Thigh	Yield [1]	27.34±0.83	28.98±3.03	29.01±1.48	29.52±2.42	NS
	Skinless[2]	17.72±1.38^{b}	21.41±2.67^{a}	22.67±1.04^{a}	23.48±2.70^{a}	0.01
	Skin	9.62±0.94^{a}	7.57±1.04^{b}	6.33±1.41^{bc}	6.05±7.41^{c}	0.01
Total skinless breast and thigh yield		53.40±2.85^{c}	59.86±3.52^{b}	62.41±3.41^{ab}	65.38±2.73^{a}	0.01
Total skin yield		21.76±1.54^{a}	19.01±1.75^{ab}	17.35±1.57^{bc}	16.98±2.21^{c}	0.01

* Expressed as % of eviscerated carcass weight

1- Yield = meat with bone and skin ; 2- Skinless = yield without skin

a,b,c :means in the same row bearing different superscripts are significantly different ($P \leq 0.05$).

NS= non significant.

Table (6): Effect of dietary betaine supplementation on meat chemical analysis for both breast and thigh and drip loss of Domyati ducklings diets at 84 day of age.

Parameters		Betaine, g/kg				Sig.
		0.0	0.5	1.0	1.5	
Dry matter	Breast	25.31±0.16	26.40±0.26	26.26±0.86	26.64±0.30	NS
	Thigh	26.05±1.24	26.84±0.30	26.76±0.40	26.92±0.63	NS
Protein	Breast	71.84±0.27^{c}	73.36±0.72^{b}	73.27±0.33^{b}	74.98±0.22^{a}	0.01
	Thigh	67.37±1.98^{c}	71.74±0.55^{a}	69.93±1.48^{b}	71.18±2.09^{a}	0.01
Ether extract	Breast	12.00±0.00^{a}	11.50±0.58^{ab}	10.75±0.14^{bc}	10.00±0.29^{c}	0.05
	Thigh	18.50±2.60^{a}	17.50±0.87^{ab}	15.50±0.58^{c}	14.25±2.17^{c}	0.05
Ash	Breast	7.38±0.13	7.89±0.47	7.69±0.23	8.35±0.05	NS
	Thigh	7.12±0.47	7.32±0.10	7.79±0.03	7.58±0.71	NS
Drip loss of meat (%)						
Breast		1.34±0.35	1.17±0.24	1.08±0.38	0.99±0.12	NS
Thigh		2.83±0.49^{a}	0.87±0.13^{b}	1.05±0.16^{b}	0.51±0.17^{b}	0.01
Carcass		1.89±0.32^{a}	1.03±0.185^{b}	1.02±0.05^{b}	0.81±0.28^{b}	0.05

a,b,c :means in the same row bearing different superscripts are significantly different ($P \leq 0.05$). NS= non significant.

Table (7): Effect of dietary betaine supplementation on economical efficiency of Domyati ducklings at marketing ages.

Items	Betaine, g/kg			
	0.0	**0.5**	**1.0**	**1.5**
Price of one duckling at one day (LE)[2]	2.00	2.00	2.00	2.00
Total starter diet consumed (kg/duck)	1.895	1.560	1.568	1.627
Total finisher diet consumed (kg/duck)	7.488	6.852	6.806	6.400
Total feed consumed (kg/duck)	9.383	8.412	8.374	8.027
Total feed consumed cost (LE/duck) [1]	26.45	23.70	23.59	22.63
Total betaine consumed (g/duck)	0.00	4.21	8.37	12.04
Total betaine cost (LE) [2]	0.00	0.17	0.33	0.48
Total cost (LE)	28.45	25.86	25.93	25.11
Final body weight (kg)	2.029	2.120	2.128	2.310
Price of one kg BW (LE) [2]	17.0	17.0	17.0	17.0
Total return (LE)	34.49	36.05	36.18	39.27
Net return (LE)	6.04	10.18	10.26	14.16
EE [3]	0.212	0.394	0.396	0.564
Relative EE %[4]	100.00	185.85	186.79	266.04

L.E = Egyptian pound

1-According to price at the experimental time.

2-local price of duckling1-d-old =2.0 LE; one kg of body weight = 17.0 LE; one kg of betaine = 40 LE at the experimental time.

3- EE = economic efficiency = (Net return LE / Total cost LE).

4-Relative EE = assuming EE of the control equals 100%

REFERENCES

AOAC. (1995). Official Methods of Analysis. 16th ed. Assoc. Off. Anal. Chem., Washington, DC.

Arslan, C.; M. C. Itil and M. Saatc (2003). Effects of L-carnitine administration on growth performance, carcass traits, blood serum parameters and abdominal fatty acid composition of ducks. Arch. Anim. Nutr., 57 : 381 – 388.

Attia, Y.A.; R. A. Hassan; M.H. Shehatta and S.B. Abdel-hady (2005). Growth, carcass quality and serum constituents of slow growing chicks as affected by Betaine to diets containing 2. Different levels of methionine. Inte. J. Poult. Sci., 4:856-865.

Attia, Y. A.; R. A. Hassan and E. M. Qota (2009). Recovery from adverse effects of heat stress on slow-growing chicks in the tropics 1: effect of ascorbic acid and different levels of betaine. Trop. Anim. Health and Prod., 41: 807-818.

Awad, A. L.; M.A.A. Hussein; A.I.A. Ghonim and M.G. Kasim (2011). Effect of dietary inclusion level of distillers dried grains with solubles on growth performance of Domyati ducklings. . Egypt Poult. Sci., 31: 65 -75.

Awad, A.L.; H. N. Fahim ; A.F. Ibrahim and M.M. Beshara (2014). Effect of dietary betaine supplementation on productive and reproductive performance of domyati ducks under summer conditions. Egypt. Poult. Sci., 34 :453-474.

Borges, S. A.; A.V.F. Da Silva; A. Majorka; D.M. Hooge and K.R. Cumming (2004). Physiological responses of broiler chickens to heat stress and dietary electrolyte balance (sodium plus potassium minus chloride, milliequivalents per kilogram). Poult. Sci., 83: 1551-1558.

Bridi, A.M.; S. Nicolaiewsky; J.M. Rübensam; M.C. Both andJ.F.P. Lobato (2003). Efeito do genótipo halotano e de diferentes sistemas de produção na qualidade da carne suína. Rev.a Brasileira Zoot. , 32:942-950.

Duncan, D.B.(1955). Multiple range and multiple F tests. Biometrics, 11:1-42.

Eklund, M., E. Bauer; J. Wamatu and R. Mosenthin (2005). Potential nutritional and physiological functions of Betaine in livestock. Nut. Res. Rev., 18: 31-48 .

El-Husseiny, O.M.; M.A. Abo-El-Ella; M.O. Abd-Elsamee and Magda, M. Abd-Elfattah (2007). Response of broilers performance to dietary betaine and folic acid at different methionine levels. Inte. J. of Poult. Sci., 6 : 515-523

Enting, H.; J. Eissen; J. De Los Mozos; A.G. Del Álamo and P.P. De Ayala (2007). Betain improves broiler chicken performance and carcass quality under heat stress conditions. In: Proceedings of the 16th European Symposium on Poultry Nutrition, Strasbourg, France. PP: 297- 300 .

Esteve-Garcia, E. and S. Mack (2000). The effect of dl-methionine and betaine on growth performance and carcass characteristics in broilers. Anim. Feed Sci. Technol., 87: 85-93 .

Farooqi, H.A.G.; M.S. Khan; M.A. Khan; M.Rabbani; K. Pervez and J.A. Khan (2005). Evaluation of Betaine and vitamin C in alleviation

of heat stress in Broiler. Int. J. Agri. Biol., 5: 744- 746.

Feed Composition Tables for Animals and Poultry Feedstuffs Used in Egypt (2001). Technical Bulletin No.,1, Central Lab. For Food and Feeds (CLFF) Ministry of Agric. Res. Cent. Egypt.

Graham, H.(2002). Betaine-Combating heat stress in poultry. Afma Matrix, December, 15, 16 –17.

Hamidi, H.; R. Jahanian and J. Pourreza (2010). Effect of dietary betaine on performance, immunocompetence and gut contents osmolarity of broilers challenged with a mixed coccidial infection. Asian J. of Anim. and Vet. Adv., 5: 193-201.

Hammer, M. A. and J. M. Baltz. (2002). Betaine is a highly effective organic osmolyte but does not appear to be transported by established organic osmolyte transporters in mouse embryos. Mol. Reprod. Develop., 62:195-202.

Honarbakhsh, S.S.; M. Zaghari and M. Shivazad (2007). Can exogenous betaine be an effective osmolyte in broiler chicks under water salinity stress? Asian- Australasian J. of Anim. Sci., 20:1729-1737.

Huang, Q.C.; Z.R. Xu ; X.Y. Han and W.F. Li (2008). Effect of dietary betaine supplementation on lipogenic enzyme activities and fatty acid synthase mRNA expression in finishing pigs. Anim. Feed Sci. Tech., 140: 365-375.

Imik, H.; O. Kaynar; S. Ozkanlar; R. Gumus; H. Polat and Y. Ozkanlar (2013). Effects of vitamin c and α-lipoid acid dietary supplementations on metabolic adaptation of broilers to heat stress. Revue Méd. Vét., 164: 52-59.

Jahanian, R. and H.R. Rahmani (2008). The effect of dietary fat level on the response of broiler chicks to betaine and choline supplement. J. of Biol. Sci. 8:362-367.

Jones, J. I. and D. R. Clemmons (1995). Insulin-like growth factors and their binding proteins: biological actions. Endocr. Rev., 16:3-34.

Kettunen, H.; S. Peuranen and K. Tihonen (2001). Betaine aids in the osmoregulation of duodenal epithelium of broiler chicks, and affects the movement of water across the small intestinal epithelium in vitro. Comp. Biochem. Physiol., 129A: 595-603.

Khan, R.; S. Naz; Z. Nikousefat ; M. Selvaggi V. Laudadio and V. Tufarelli (2012). Effect of ascorbic acid in heat stressed poultry', Worlds Poult. Sci., 68: 477–489.

Khattak, F.; T. Acamovic; N. Sparks; T. Pasha; M. Joiya; Z. Hayat and Z. Ai (2012). Comparative efficacy of different supplements used to reduce heat stress in broilers', Pakistan J. of Zool., 44: 31–41.

Kidd, M. T.; P. R. Ferket and J. D. Garlich (1997). Nutritional andosmoregulatory functions of betaine. World's Poult. Sci. J., 53:125- 139.

Konca, Y. and F. Kinkpinar (2008) Effect of Betaine on performance carcass, bone and blood characteristics of Broilers during natural summer temperature. J. of Anim. and Veter. Adv., 7: 930-937.

Kout Elkloub, M. El. Moustafa; A. L. Awad and A. I. A. Ghonim (2010). Response of Domyati ducklings to diets containing different levels of metabolizable energy and crude protein: 1- During growth period. Egypt Poult. Sci. J., 30: 535 -564.

Lin, H.; H.C. Jiao; J. Buyse and E. Decuypere (2006). Strategies for preventing heat stress in poultry, World's Poult. Sci. J., 62: 71 –85.

Lukic, M.; Z. Jokic; V. Petricevic ; Z. Pavlovski ; Z. Skrbic and L. Stojanovic (2012). The effect of full substitution of supplemental methionine with betaine in broiler nutrition on production and slaughter results. J. Anim. Sci. Biotech., 28: 361-368 .

Matthews, J.O. and L.L. Southern (2000). The effect of dietary betaine in Eimeria acervulina-infected chicks. Poult. Sci., 79: 60-65.

Mcdevitt, R.M.; S. Mack and I.R. Wallis (2000). Can betaine partially replace or enhance the effect of methionine by improving broiler growth and carcase characteristics. British Poult. Sci., 41:473-80.

Moeckel, G.W.; R. Shadman; J.M. Fogel and S.M.H. Sadrzadeh (2002). Organic osmolytes Betaine, sorbitol and inositol are potent inhibitors of erythrocyte membrane ATP ases. Life Sci., 71: 2413-2424.

Mooney, M.; T. Belay and R.G. Teeter (1998). Effect of betaine on loss of corporal water. In: Proceedings of the International Poultry Scientific Forum: Southern Poultry Science Society and Southern Conference on Avian Diseases, 1998, Atlanta, GA, Proceedings… Atlanta. 1998.

Neoh, S. B. and L.E. Ng (2012). Betaine hcl improves carcass yield in broilers. In: 23rd Annual Australian Poultry Science Symposium. PP: 69 .

Patil, S. V.; A. S. Ranade; M. B. Patil; D. N. Desai; P. E. Avari and S. B. Kawitkar (2007). Use of betaine in broiler ration. J. of Bombay Vet. College., 15 (1/2): 39-41.

Pillai, P. B.; A.C. Fanatico; K.W. Beers; M.E. Blair and J.L. Emmert (2006). Homocysteine remethylation in young broilers fed varying levels of methionine, choline, and betaine. Poult. Sci., 85: 90-95 .

Pirompud, P.; S. Attamangkune; C. Bunchasak and A. Promboon (2005). Effect of feeding betaine to broilers reared under tropical conditions on performance and carcass traits. Proceedings of 43rd Kasetsart University Annual Conference, Thailand, 1-4 February, 2005. Subject: Animals., 254-261.

Quinteiro-Filho, W. M.; A.V. Gomes ; M.L., Pinheiro; A. Ribeiro; V. Ferraz-de-Paula; C.S. A. Ferreira ; A.J. Ferreira and J. Palermo-Neto (2012). Heat stress impairs performance and induces intestinal inflammation in broiler chickens infected with salmonella enteritidis. Avian Pathol., 41: 421-427.

Rafeeq, M.; T.N. Pasha; N. Rashid; B. Hilal and I. Shahzad (2011). Effect of supplementation of methionine, betaine and choline on the performance of broiler chicken in early life fed methionine deficient ration. J. Anim. Physiol. Anim. Nutr., 21: 778-780 .

Rao, S. V. R.; M.V.L.N. Raju; A.K. Panda; P.S. Ria and A.G.S. Sunder (2011). Effect of supplementing betaine on performance, carcass traits and immune responses in broiler chicken fed diets containing different concentrations of methionine. Asian-Aust. J. Anim. Sci., 24: 662- 669 .

Ratriyanto A.; R.Mosenthin; R Bauer and M. Eklund (2009). Metabolic osmoregulatory and nutritional functions of betaine in monogastric

animals. Asian-Aust. J.Anim.Sci., 22:1461-1476.

Remus, J. C.; E.E.M. Pierson and M. Hruby (2004). The evaluation of betaine and enzymes in coccidian challenged broilers, XXII Poultry Congress, Istanbul, Turkey 8–13 June.

Renaudeau, D.; A. Collin ; S. Yahav; V. de Basilio; J.L. Gourdine and R.J. Collier (2011). Adaptation to hot climate and strategies to alleviate heat stress in livestock production Anima, l 1: 1-22.

Sahin, K.; O. Kucuk ; A. Hayiril and S. Prasad (2009). Role of dirtary Zinc in heat stressed poultry. Poult. Sci., 88: 217-2183 .

Sandhu, M. A.; F.Q. Mirza; F. Afzal and N. Mukhtar (2012). Effect of heat stress on cellular and humoral immunity and its cure with α-tocopherol in meat type birds. Livest. Sci., 148: 181- 188.

SAS Institute. (2004). SAS User's Guide: Statistics. Edition 9.1 . SAS Institute Inc., Cary, NC.

Saunderson, C. L. and J. MacKinlay (1990). Changes in bodyweight, compositio and hepatic enzyme activities in response to dietary methionine, betaine and choline levels in growing chicks. Br. J. Nutr., 63:339-349.

Sayed, M. A. M. and j. Downing (2011). The effects of water replacement by oral rehydration fluids with or without betaine supplementation on performance, acid-base balance, and water retention of heat-stressed broiler chickens. Poult. Sci., 90: 157-167

Soltan, M.E.; A.A. Enab; G.M. Gebriel and M.S. Kandil (2014). Meat production efficiency of two lines of Pekin ducks under two different feeding systems. Minufiya J. Agric. Res., 39:521-535.

Su , S.Y.; M.V. Dodson; X.B. Li; Q.F. Li; H.W. Wang and Z. Xie (2009). The effects of dietary betaine supplementation on fatty liver performance, serum parameters, histological changes, methylation status and the mRNA expression level of Spot14α in Landes goose fatty liver. Comparative Biochemistry and Physiology, Part A 154: 308–314.

Tollba, A. A. H.; S. A. M. Shabaan and A. Z. Wagdy (2007). Improvement of Fayoumi laying hens performance under hot climate conditions: 2-Betaine, folic acid and choline. Egypt. Poult. Sci., 27: 21-35.

Waldroup, P. W.; M. A. Motl ; F. Yan and C. A. Fritts (2006). Effect if betaine and choline on response to methionine supplementation to broiler diets formulated to industry standards. J. Appl. Poult. Res., 15:58-71.

Wang, Y; Z. XU and J. Feng (2004). The effect of Betaine and methionine on growth performance and carcass characteristics in meat duck. Anim. F. Sci. Tech., 116: 151-159.

Xing, J.; L. Kang and Y. Jiang (2011). Effect of dietary betaine supplementation on lipogenesis gene expression and CpG methylation of lipoprotein lipase gene in broilers', Molecular Biology Reports, 38: 1975–1981.

Yao, Z. and D. E. Vance (1989). Head group specificity in the requirement of phosphatidylcholine biosynthesis for very low density lipoprotein secretion from cultured hepatocytes. J. Biol. Chem., 264:11373- 11380.

Zayed, S.M.A. (2012). Physiological studies on turkeys. M. Sci. Thesis, Fac. Agri., Mansoura Univ., Mansoura, Egypt.

Zhan, X.A. (2000). Studies on growth-promoting mechanism of betaine in broiler chickens. Acta Agric. Zhejiangensis, 12: 209–212.

Zhan , X. A. ; J. X. Li ; Z. R. Xu and R. G. Zhao (2006). Effects of methionine and beatine on growth performance carcase composition and metabolism of lipids in male broilers. British Poult. Sci., 47 : 576- 580 .

Zou, X. T.; Y. L. Ma and Z. R. Xu (1998). Effects of betaine and thyroprotein on laying performance and approach to mechanism of the effects in hens. Acta Agric. Zhejiang., 10:144-149.

الملخص العربي

تأثير إضافة البيتايين للعليقة على أداء النمو وصفات الذبيحة لكتاكيت البط الدمياطي تحت ظروف الصيف

عوض لطفي عوض، أحمد فرج إبراهيم ، هاني نبيل فهيم ، ملاك منصور بشاره
معهد بحوث الإنتاج الحيواني ـ مركز البحوث الزراعية ـ وزارة الزراعة ـ الدقي ـ جيزة

استخدم فى هذه الدراسة عدد ٣٦٠ كتكوت بط دمياطي عمر يوم تم وزنهم وتقسيمهم إلى أربعة مجموعات تجريبية فى ثلاث مكررات متساوية لكل مجموعة لدراسة تأثير إضافة مستويات مختلفة من البيتايين هى صفر ، ٠,٥ ، ١,٠ ، ١,٥ جم / كجم للعليقة خلال فترة النمو على أداء النمو وصفات الذبيحة وجودة اللحم وبعض مقاييس الدم والكفاءة الاقتصادية تحت ظروف الصيف. حيث قسمت العليقة المستخدمة إلى أربعة أجزاء ليضاف إلي كل منها أحد المستويات المستخدمة من البيتايين وتم تقديمها للمجموعات التجريبية خلال فترة التجربة (١ - ٨٤ يوم). تم تسجيل وزن الجسم وكمية العليقة المأكولة وعدد النافق ، كما تم إجراء اختبار ذبح لتقدير بعض مقاييس الذبيحة، و تم أخذ عينات من لحم الصدر والفخذ لتقدير محتواة من البروتين والدهون، كما تم أخذ عينات دم لتقدير صورة الدم وكذلك تم أخذ عينات سيرم للدم لتقدير محتواه من البروتين الكلى واللبيدات الكلية والكولسترول الكلى ثم تم حساب الكفاءة الاقتصادية خلال الفترة الكلية للتجربة (١-٨٤ يوم).

وتوضح النتائج ما يلي :-

لوحظ تحسن معنوى في وزن الجسم عند ٨٤ يوم وكذلك معدل الزيادة فى الوزن خلال الفترة الكلية للتجربة نتيجه لإضافة البيتايين للعليقة. كما لوحظ انخفاض معنوي فى كمية العليقة المأكولة وكذلك تحسن معنوى فى الكفاءة الغذائية خلال الفترة الكلية للتجربة مقارنة بالكنترول . لوحظ ارتفاع محتوى السيرم معنويا من البروتين الكلى والألبيومين باضافة المستويات المختلفة من البيتايين للعليقة بينما ارتفع محتواه من الجلوبيولين ونسبة الألبيومين الى الجلوبيولين معنويا باضافة ١,٠ و ١,٥ جم بيتايين للعيقة مقارنة بالكنترول. لوحظ انخفاضا معنويا فى محتوى السيرم من اللبيدات الكلية والجليسريدات الثلاثية والكوليسترول باضافة المستويات المختلفة من البيتايين للعليقة. لوحظ ارتفاع عدد الخلايا الليمفاوية معنويا بينما انخفض عدد الخلايا المتعادلة ونسبة الخلايا المتعادلة إلى الليمفاوية في دم الكتاكيت التي تغذت على العلائق المضاف لها البيتايين مقارنة بالكنترول .

إضافة البيتايين بمستوياته المختلفة أدى إلى تحسن معنوى لنسبتى الذبيحة المفرغة ومجموع الأجزاء المأكولة بينما انخفض دهن البطن معنويا مقارنة بالكنترول. كما تحسنت نسبة الصدر معنويا باضافة ١,٥ جم بيتايين/كجم عليقة بينما تحسنت نسبتى الصدر والفخذ منزوع الجلد معنويا باضافة المستويات المختلفة من البيتايين للعليقة مقارنة بالكنترول كما لوحظ انخفاض نسبة الجلد للفخذ ومحصول الجلد الكلى بالمعاملات. لوحظ ارتفاع محتوى لحم الصدر والفخذ معنويا من البروتين باضافة المستويات المختلفة من البيتايين بينما انخفض محتواهما من المستخلص الاثيرى باضافة ١,٠ و ١,٥ جم بيتايين للعيقة مقارنة بالكنترول. لوحظ انخفاض نسبة الفقد فى الذبيحة والفخذ معنويا باضافة مستويات البيتايين المختلفة للعليقة. تحسنت الكفاءة الاقتصادية وصافى العائد بالتغذية على العلائق المضاف لها المستويات المختلفة من البيتايين مقارنة بالكنترول خلال الفترة الكلية للتجربة (١-٨٤ يوم).

وقد خلصت الدراسة إلى إمكانية إضافة البيتايين لعلائق كتاكيت البط الدمياطي بمستوى ١,٥ جم / كجم لتحسين أداء النمو و صفات الذبيحة وجودة اللحم والكفاءة الاقتصادية تحت ظروف الصيف .