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Utilization of Dried Whole Eggs Processed by Different Methods with or Without Growth Promoting Mixture on Performance and Lymphoid Organs of Broiler Chicks

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Abstract: Rejected eggs were collected and dried at 55°C. Thereafter, Dried Whole Eggs (DWE) were processed by different methods e.g. freezing for 48 h at -18°C, freezing with boiling for 15 min at 100°C or autoclaving for 20 min at 120°C with a pressure of 1 kg/cm². The DWE processed by different methods were fed to broiler chickens during 3-41 d of age at 0, 3.5 and 7.0%. Diets were fed without or with Growth Promoting Mixture (GPM) containing probiotic 0.5 g, Vit C 0.5, black pepper 0.5 g, red pepper 0.5 g/kg diet), thus there were fourteen experimental treatments. Growth was not affected by level of DWE and/or processing way, while GPM significantly increased growth. Feed intake significantly increased by autoclaving, whilst inclusion of DWE at either level significantly decreased feed intake and there was a significant interaction between DWE level and processing method for feed intake. DWE at either 3.5 or 7% significantly improved FCR similarly. Moreover, GPM supplementation improved Feed Conversion Ratio (FCR) within each level. Supplementation of GPM significantly increased absolute and relative weight of bursa, while the opposite trend was shown in thymus parameters. Abdominal fat, plasma total protein, albumin significantly decreased although plasma total lipids significantly increased due to GPM supplementation. Abdominal fat significantly decreased, and plasma total lipids significantly increased due to autoclaving, whilst freezing with boiling increased plasma cholesterol. Heart and pancreas significantly increased, however skin colour significantly decreased due to inclusion of frozen with boiled DWE. Increasing DWE level resulted in significant linear increase in heart and pancreas, whilst skin colour significantly decreased due to 3.5% DWE and GPM supplementation. Plasma cholesterol exhibited a significant linear increase with increasing DWE level.

Key words: Dried whole eggs, growth promoting mixture, broiler performance, lymphoid organs, biochemical constituents of blood

INTRODUCTION

Egg by-products such as outcomes from breaking facilities and rejected eggs are known to be rich in fat, maternal antibodies, protein, bioactive nutrients and lysozyme (Schaafsma *et al.*, 2000; Anton *et al.*, 2006; Sparks, 2006). The antimicrobial effects of eggs included lysozyme which has an antiviral and anti-inflammatory, ovomucin which inhibits haemagglutination by viruses and has a cytotoxic effect on cultured cells, ovoinhibitor which has a trypsin inhibitor activity that inhabits bacterial and fungal serine proteinases and chymotrypsin and cystatin which has an antimicrobial, antiviral and an insecticidal effects (Burley and Vadehra, 1989; Davis and Reeves, 2002). Furthermore, the chicken egg is a good source of several bioactive components such as ovotransferrin as an iron-fortified product which has bactericidal properties against acute enteritis in infants. Moreover,

egg components such as lysozyme, avidin, phosvitin, and other biochemical substances are beneficial for human well-being (Sparks, 2006). Scialic acid and scialoligosaccharides are being isolated from eggs on a commercial scale in Japan (Stadelman, 1999). Scialoligosaccharides are a significant constituent of mother's milk and is likely the first line of defense against pathogens, viruses, and toxins. A preparation of egg yolk scialoligosaccharides was reported to inhibit rotavirus both *in vitro* and *in vivo*. Rotavirus is a major pathogen of infectious gastroenteritis of infants. Eggs contain antibodies against all challenges to which hen has been exposed and this is attractive since they do not cause inflammatory responses they can provide protection against enteric infections (Burley and Vadehra, 1989; Davis and Reeves, 2002). The egg yolk is a reservoir of antibodies with many proven uses as well as many theoretical applications (Li-Chan, 1998;

Anton *et al.*, 2006; Sparks, 2006). Hen's egg yolk IgY has been extensively applied to many diagnostic, prophylactic and therapeutic uses (Mime and Yoshimasu, 1998). One controversial aspect of the antibiotic resistance aim is whether the routine feeding of antibiotics to farm animals contributes to the increase of antibiotic-resistant *bacterial* strains.

A world egg production estimated at 67.455 million tonnes of table eggs was produced during 2002 (FAO, 2009). It is our estimation that ~ 10% of world egg production is not sellable and thus, there are valuable amount of this byproducts. Dried egg powder may be an alternative to antibiotics due to its high content of antimicrobial proteins and eggs antibodies and may thus fed to large flocks, without negative effects on performance of chickens (El-Deek *et al.*, 2011; El-Deek and Al-Harhi, 2009). Burley and Vadehra (1989) and Davis and Reeves (2002) concluded that avian egg is a rich source of high protein quality, fatty acids and several nutrients such as folic acid, choline, iron, selenium and vitamins A, B, D, E and K and antioxidant carotenoids, lutein and zeaxanthin as also pigments, and could fed as an excellent nutrient source for chickens with expecting positive effects.

European countries have banned the routine usage of antibiotics in chicken feeds since 2006 (Nasir and Grashorn, 2008). However, this banning of antibiotics would leave poultry producers with an increase in losses, presenting producers with few strategies to control disease and pathogens (Cavazzoni *et al.*, 1998). Alternative to antibiotic growth promoters in animal nutrition are prebiotics, probiotics, symbiotic, photobiotic, enzyme and organic acids (Nasir and Grashorn, 2008). In this regard, eggs are rich source of vitamins except for Vit C (Burley and Vadehra, 1989; Anton *et al.*, 2006). Although, chickens can synthesis Vit C from glucose, its needs increased during stress production condition (Sahin *et al.*, 2003; Attia *et al.*, 2009a). Probiotics are natural growth promoters that affect gut ecology in the favor of beneficial bacteria rather than harmful pathogens, which shown to improve growth of broiler chickens (Pelicia *et al.*, 2004; Awad *et al.*, 2006). Black pepper (*piper nigrum*) contains an alkaloid compound (piperine) active against *Fungi*, *Lactobacillus*, *Micrococcus*, *E. coli* and *E. faecalis* and with major antidiarrheal effects (Cowan, 1999). Al-Harhi (2002) found that spices mixture of cardamom, cumin, hot and black pepper significantly improved egg mass, egg weight, yolk colour and decreased percentage egg weight loss of egg stored in the refrigerator for one month. Furthermore, they suggested that using mixture of different feed additives is more potential than using single one due to different mode of action of different active substances. El-Husseiny *et al.* (2002) and Abdo *et al.* (2003) showed that plasma total lipid and cholesterol significantly decreased of red pepper fed-broilers

compared to the control. This work aimed to investigate the effect of different dietary levels of dried whole eggs processed by different methods with or without growth promoters mixture on the performance, lymphoid organs, carcass characteristics and plasma constituents of broiler chickens during 3-41 d of age.

MATERIALS AND METHODS

Birds, husbandry and experimental design: Rejected eggs were collected and processed by different methods and then were dried at 55°C. Dried Whole Eggs (DWE) were processed by different methods e.g. freezing for 48 h at -18°C, freezing as previously mentioned and thereafter boiled for 15 min at 100°C or autoclaving for 20 min at 120°C with a pressure of 1 kg/cm². The frozen with boiled eggs and the autoclaved one were cut to small slight before drying. All processed eggs were then set in galvanized metal dishes (50 x 60 x 3 cm) and dried at 55°C for 36 h. After drying, the DWE were finally ground, passed through a 2 mm filter, packed in plastic bags and stored at 18°C until analysis and used in the diet formulation.

The DWE processed by different methods were included in broiler diets at 0, 3.5 and 7.0%. Diets were fed without or with growth promoting mixture {GPM; probiotic (a probiotic containing 2.3 x 10⁹ CFU/g *Bacillus licheniformis* and 2.3 x 10⁸ CFU/g *Bacillus subtilis* spores in equal rates, at a level of 0.5 g/kg from days 1 to 42 (Bio-Plus 2B®, Chr. Hansen A/S, Horsholm, Denmark); 0.5 g, Vit C 0.5, black pepper 0.5 g and red pepper 0.5 g/kg diet}, thus there were fourteen experimental {(2 DWE levels x 3 processing method x 2 GPM supplementation + 2 control diets (DWE free-diet fed with or without GPM)} fed during 3-41 d of age. Each treatment was replicated 5 times of 5 unsexed chicks each, resulted in a total of 350 chicks of Ross strain.

The proximate chemical composition of DWE processed by different methods was carried out according to AOAC (1990) whereas Ca and P were determined according to Sendroy (1944) and Gomorri (1942), respectively. Gross energy of the DWE was determined using an adiabatic oxygen bomb calorimeter (Parr Instrument Company, Moline, IL). The ME was estimated at 80% of GE according to Patrick and Schaible (1981) and NRC (1994). While amino-acid profiles were determined according to Moore *et al.* (1958). The DWE sample was confirmed salmonella free before including in the broiler diets.

Criteria of responses: Chicks were weighted at 3, 24 and 41 d of age whereas feed intake and FCR were calculated at 3-24, 25-41 and 3-41 d of age. Mortality was daily recorded. At the last day of the experiment, five chicks were slaughtered from each treatment to determine carcass characteristics and lymphoid organs e.g. Bursa of Fabricius, spleen and thymus. Absolute

Table 1: Ingredients profiles, calculated and chemical composition of the experimental diets

| Ingredient profile (%) | DWE in the broiler diets (%) | | | | | | |
|---|------------------------------|--------|-------------------|------------|--------|-------------------|------------|
| | 3.5 | | | 7.0 | | | |
| | 0 | Frozen | Frozen and boiled | Autoclaved | Frozen | Frozen and boiled | Autoclaved |
| Yellow com | 55.00 | 56.3 | 56.5 | 56.3 | 57 | 57 | 57 |
| Soybean meal, 44% | 34.70 | 32.0 | 32.0 | 32.0 | 29.0 | 29.0 | 29.0 |
| Vegetable oil | 5.0 | 3.2 | 3.0 | 3.2 | 1.6 | 1.3 | 1.7 |
| Di-Ca-phosphate | 1.70 | 1.45 | 1.5 | 1.5 | 1.2 | 1.3 | 1.3 |
| Limestone | 1.40 | 0.35 | 0.30 | 0.30 | 0.0 | 0.0 | 0.0 |
| DL-Methionine | 0.20 | 0.11 | 0.12 | 0.12 | 0.03 | 0.04 | 0.03 |
| L-lysine | 0.23 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix ¹ | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Antioxidant | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Antitoxin | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| DWE ² | 0.00 | 3.5 | 3.5 | 3.5 | 7 | 7 | 7 |
| Filler | 0.97 | 2.29 | 2.28 | 2.28 | 3.37 | 3.56 | 3.17 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Chemical nutritional characteristics (%) | | | | | | | |
| ME (MJ kg diet) ² | 3066 | 3065 | 3066 | 3062 | 3060 | 3056 | 3062 |
| Crude protein ³ | 20.2 | 20.1 | 20.3 | 20.2 | 20.4 | 20.3 | 20.2 |
| Lysine ² | 1.26 | 1.26 | 1.28 | 1.28 | 1.42 | 1.48 | 1.47 |
| Methionine ² | 0.51 | 0.51 | 0.51 | 0.52 | 0.52 | 0.51 | 0.51 |
| Methionine + Cystine ² | 0.84 | 0.92 | 0.93 | 0.93 | 1.01 | 1.01 | 1.00 |
| TSAA: lysine ratio | 67 | 73 | 73 | 73 | 71 | 68 | 68 |
| Calcium ² | 1.02 | 1.02 | 1.01 | 1.00 | 1.29 | 1.32 | 1.31 |
| Available Phosphorus ² | 0.45 | 0.45 | 0.45 | 0.46 | 0.45 | 0.46 | 0.46 |

¹Vit+Min mixture provides per kilogram of diet: vitamin A, 12000 IU; vitamin E, 20 IU; menadione, 1.3 mg; Vit. D₃, 2500 ICU; riboflavin, 5.5 mg; Ca pantothenate, 12 mg; nicotinic acid, 50 mg; choline chloride, 600 mg; vitamin B₁₂, 10 µg; vitamin B₆, 3 mg; thiamine, 3 mg; folic acid, 1.0 mg; d-biotin, 50 µg. Trace mineral (milligrams per kilogram of diet): Mn, 80; Zn, 60; Fe, 35; Cu, 8; Se, 0.02. ²Calculated values were according to NRC (1994) text book values for feedstuffs, ³Determined values were according to AOAC (1990), ³DWE = Dried Whole Eggs, ME = Metabolizable Energy Value. TSAA = Methionine + Cystine²

weight and index of lymphoid organs to body weight (weight of organs/body weight)*1000 and relative weight of spleen were calculated.

Five blood samples per group were collected in heparinized tubes at 41 d of age for colourimetric determination of biochemical constituents of blood plasma. Blood plasma was separated by centrifugation at 1510 g for 10 min and stored -18°C until analyses. Blood plasma total protein (g/dl; Weichselbaum, 1946; Henry *et al.*, 1974), albumin concentration (g/dl; Dumas *et al.*, 1971), globulin concentration (g/dl ml) was calculated as the difference between total protein and albumin, total lipids (g/dl ml; Frings and Dunn, 1970) total cholesterol (mg/dl; Watson, 1960) were determined using commercial kits. A colour broiler fan with Caroplyll® red and Carophyll® yellow was used to measure skin colour (DSM, www.Dsmnutritionalproducts.com).

Statistical analysis: Data were analyzed using the GLM procedure of SAS® (SAS, 1996) using three ways ANOVA in the presence of the negative and positive control. All the percentages were converted as log₁₀ to normalize data distribution. Duncan's New Multiple Range Test (Duncan, 1955) was utilized to test mean differences at p≤0.05.

Table 2: Chemical and amino-acid analysis (%) of tested samples of DWE

| DWE | Frozen | | |
|--------------------------------|--------|------------|------------|
| | Frozen | and boiled | Autoclaved |
| Moisture | 3.05 | 2.86 | 3.73 |
| Crude protein | 38.2 | 38.1 | 37.0 |
| Crude fat | 26.1 | 28.6 | 26.7 |
| Ash | 33.3 | 31.7 | 31.2 |
| Gross energy (kcal/g) | 6.45 | 6.87 | 6.35 |
| Metabolizable energy (kcal/g)* | 5.16 | 5.50 | 5.08 |
| Ca (%) | 13.3 | 13.4 | 13.1 |
| P. (%) | 1.5 | 1.3 | 1.4 |
| Methionine | 2.96 | 2.68 | 2.77 |
| Methionine plus cystine | 5.08 | 5.55 | 5.59 |
| Lysine | 7.40 | 7.81 | 7.69 |

DWE = Dried Whole Eggs

RESULTS

Chemical analyses of dried whole eggs: The chemical analyses of DWE is shown in Table 2. The results showed that CP level ranged from 37.0-38.2%, crude fat ranged from 26.1-28.6, ash ranged from 31.2-33.3%, ME ranged from 5.08-5.50 kcal/g egg. The value of Ca and P ranged from 13.1-13.3 and from 1.3-1.5%, respectively. The corresponding values for methionine, methionine plus cystine and lysine ranged from 2.68-2.96%, 5.08-5.59 and 7.40-7.81%, respectively.

Growth performance: Table 3 demonstrates the effect of various treatments on growth performance of broilers. Processing method did significantly affect growth during only 3-24 d of age in which chicks fed frozen DWE had better growth than those fed frozen with boiled or those autoclaved. This effect was diminished from the next period and from the whole period.

During only 3-24 days of age, DWE at 3.5% significantly increased (10.1%) growth of broilers compared to the control group although difference between 7% DWE and the control and 3.5% DWE groups were not significant. However, 7% level had numerically higher (5.7%) growth than the control group. There was no significant effect of level of DWE on the growth of broiler chicks during the following periods and the entire experimental period.

A significant positive growth promoting effect of GPM was shown during later stage of growth period (24-41 d of age) and for the whole period (3-41 d of age). No significant interaction between processing method, DWE level and/or GPM was obtained at all ages.

Feed intake was significantly affected by processing methods during 25-41 and 3-41 d of age, with autoclaving method increased feed intake by 4.3 and 3.1%, respectively compared to frozen with boiled method. Meanwhile, chicks fed frozen DWE consumed intermediate amount of feed. In addition, there was a significant decrease (~5.1%) in feed intake due to 3.5 and 7% DWE level compared to the control level.

GPM had a significant positive effect (2.8%) on feed intake during only the 1st period that was diminished afterwards. There was no significant two-way and three-way interaction between processing way, DWE level and/or GPM. During only 25-41 d of age, broiler chickens fed frozen DWE had better (~4.9%) FCR than those fed frozen with boiled or those autoclaved. However, this effect diminished for the whole experimental period.

DWE at either 3.5 or 7% significantly improved FCR similarly throughout the experimental period and this reached 8.1% for the whole period compared to the control group. However, the difference between 7% DWE and the control was not significant during only the 1st experimental period. A significant positive improving influence (2.8%) of GPM on FCR was shown during only the whole experimental period (3-41 d of age), showing a collective effect of the numerical improvement during the previous periods. No significant two or three-way interaction was traced at all age.

Lymphoid organs: Table 4 demonstrates the effect of different treatments on lymphoid organs of broilers. Both bursa of Fabricius and thymus weights and index as well as spleen percentage were not significantly affected by DWE processing methods and level of DWE. GPM significantly increased bursa absolute weight and index although significantly decreased thymus absolute weight and index meanwhile no significant effect was

shown on spleen percentage. No significant two and three-way interaction was shown of the criteria of the lymphoid organs although the three-way effect was significant for only spleen percentage. Obviously, GPM significantly increased percentage spleen from chicks fed 3.5% DWE processed by freezing, freezing with boiling and autoclaving by 21.4, 33.3 and 88.9%. However, the effect of GPM on 7% DWE fed chicks depending on method of processing as an increase (38.5%) was shown of the frozen with boiled group and a decrease (44.4%) of the autoclaved group. No effect of GPM was shown of the control group and those fed 7% frozen DWE as well.

Carcass characteristics and inner organs: Table 5 demonstrates the effect of different treatments on carcass parameters and inner organs of broilers. Most of carcass criteria and inner organs were not significantly affected by processing way expect for a significant decrease in the abdominal fat due to autoclaving and significant increase in percentage of the heart and the pancreas due to freezing with boiling. Also, a significant increase was noticed of the skin colour due to autoclaving.

DWE level had a significant influence on dressing percentage, abdominal fat, heart, pancreas and skin colour. DWE significantly decreased linearly percentage dressing, whereas 3.5% DWE significantly increased percentage abdominal fat and skin colour. On the other hand, 7% DWE significantly increased percentage heart and pancreas. GPM significantly decreased percentage dressing and abdominal fat although significantly increased skin colour. No significant interaction was observed between various processing ways, DWE level and/or GPM on carcass characteristics and inner organs.

Biochemical constituents of blood plasma: Table 6 reveals the effect of various treatments on biochemical constituents of blood plasma of broilers. DWE processed by autoclaving significantly increased plasma total lipid although frozen with boiled significantly increased plasma cholesterol, although processing method did not affect plasma total protein and its fractions. There was a significant decrease in the total plasma protein at 7% DWE and the albumin at 3.5% and an increase in the plasma globulin at both inclusion levels of DWE compared to the control. Plasma globulin of 3.5% DWE was significantly higher than that of the 7% level. There was also a significant linear increase in the plasma total cholesterol with increasing the DWE level. However, 3.5% DWE significantly decreased the plasma total lipid. GPM supplementation significantly decreased the plasma total protein and the albumin while increasing significantly the plasma total lipid and did not affect the plasma globulin and the total cholesterol.

Table 3: Growth performance of broiler chicks fed different levels of dried whole eggs processed by different methods with or without growth promoting mixture

| Treatment | Initial body weight | Body weight gain (g) | | | | Feeding Intake (g/chicks) | | | | FCR (g feeding/g gain) | | | |
|--|---------------------|----------------------|-----------|-----------|-----------|---------------------------|-----------|------------|------------|------------------------|----|--|--|
| | | 3-24 | 25-41 | 3-41 | 3-24 | 25-41 | 3-41 | 3-24 | 25-41 | 3-41 | | | |
| Processing method | | | | | | | | | | | | | |
| Frozen | 113±1.2 | 741±21.7 | 1145±27.6 | 1886±52.2 | 1404±17.7 | 2374±25.3 | 3878±21.6 | 1.89±0.116 | 2.14±0.101 | 2.06±0.107 | | | |
| Frozen with boiled | 112±1.2 | 723±23.8 | 1045±30.9 | 1768±36.5 | 1454±17.3 | 2347±24.3 | 3801±20.9 | 2.01±0.118 | 2.25±0.102 | 2.15±0.112 | | | |
| Autoclaved | 111±1.1 | 730±20.4 | 1096±26.5 | 1828±75.0 | 1472±15.2 | 2447±24.0 | 3919±19.6 | 2.02±0.107 | 2.24±0.116 | 2.15±0.108 | | | |
| P-value | NS | ** | NS | NS | NS | ** | ** | NS | * | NS | | | |
| DWE level (%) | | | | | | | | | | | | | |
| 0.0 | 108±1.7 | 678±21.5 | 1108±32.3 | 1785±32.3 | 1457±12.7 | 2619±24.7 | 4075±18.7 | 2.15±0.118 | 2.36±0.128 | 2.28±0.123 | | | |
| 3.5 | 111±0.65 | 746±19.7 | 1082±28.9 | 1828±55.3 | 1490±14.7 | 2376±24.6 | 3866±19.7 | 1.99±0.122 | 2.20±0.105 | 2.11±0.112 | | | |
| 7 | 111±0.61 | 717±20.3 | 1108±26.5 | 1825±67.2 | 1463±18.8 | 2403±24.0 | 3866±21.6 | 2.04±0.105 | 2.18±0.107 | 2.12±0.108 | | | |
| P-value | NS | ** | NS | NS | NS | ** | ** | ** | ** | ** | | | |
| Growth promoting supplementation | | | | | | | | | | | | | |
| - | 111±0.55 | 731±21.2 | 1058±25.9 | 1789±65.7 | 1454±15.0 | 2431±25.0 | 3885±20.0 | 1.99±0.143 | 2.30±0.112 | 2.17±0.114 | | | |
| + | 112±0.60 | 717±22.7 | 1135±30.8 | 1852±66.7 | 1494±18.5 | 2413±24.0 | 3907±21.3 | 2.08±0.109 | 2.13±0.100 | 2.11±0.106 | | | |
| P-value | NS | NS | * | * | ** | NS | NS | NS | NS | * | | | |
| Interaction between DWE, processing method and growth promoting supplementation | | | | | | | | | | | | | |
| DWE¹ | | | | | | | | | | | | | |
| 3.5 | | | | | | | | | | | | | |
| Frozen | | | | | | | | | | | | | |
| - | 113±2.3 | 741±22.3 | 1065±18.2 | 1807±45.9 | 1459±14.2 | 2397±28.1 | 3856±21.2 | 1.97±0.143 | 2.25±0.096 | 2.13±0.121 | | | |
| + | 110±2.1 | 749±21.3 | 1216±28.9 | 1964±41.7 | 1519±15.3 | 2479±21.6 | 3997±18.9 | 2.03±0.112 | 2.04±0.087 | 2.04±0.102 | | | |
| Frozen with boiled | | | | | | | | | | | | | |
| - | 114±2.3 | 758±22.5 | 1021±33.6 | 1777±54.6 | 1482±18.3 | 2224±25.2 | 3716±21.8 | 1.97±0.131 | 2.18±0.112 | 2.09±0.121 | | | |
| + | 111±2.1 | 737±19.8 | 1034±30.0 | 1771±49.9 | 1455±16.7 | 2220±25.3 | 3675±21.1 | 1.97±0.121 | 2.15±0.092 | 2.08±0.106 | | | |
| Autoclaved | | | | | | | | | | | | | |
| - | 111±1.6 | 754±15.8 | 1072±29.3 | 1826±69.4 | 1476±11.2 | 2518±23.1 | 3994±17.2 | 1.96±0.131 | 2.35±0.121 | 2.19±0.125 | | | |
| + | 111±2.2 | 724±16.7 | 1084±33.2 | 1825±70.4 | 1541±12.3 | 2419±24.1 | 3960±18.2 | 2.08±0.082 | 2.23±0.119 | 2.17±0.105 | | | |
| Frozen | | | | | | | | | | | | | |
| - | 110±2.0 | 726±19.9 | 1084±30.2 | 1810±75.1 | 1407±11.6 | 2280±24.2 | 3887±17.9 | 1.94±0.087 | 2.10±0.111 | 2.04±0.098 | | | |
| + | 119±2.3 | 748±23.3 | 1214±33.1 | 1962±46.3 | 1631±29.7 | 2339±27.1 | 3970±28.4 | 2.18±0.121 | 1.93±0.108 | 2.02±0.113 | | | |
| Frozen with boiled | | | | | | | | | | | | | |
| - | 112±2.8 | 771±27.9 | 1060±25.2 | 1831±60.3 | 1527±16.5 | 2538±23.1 | 4065±19.8 | 1.98±0.107 | 2.40±0.089 | 2.22±0.097 | | | |
| + | 110±2.5 | 630±24.8 | 1083±34.8 | 1693±41.4 | 1344±17.7 | 2407±23.7 | 3751±20.7 | 2.13±0.113 | 2.26±0.113 | 2.22±0.111 | | | |
| Autoclaved | | | | | | | | | | | | | |
| - | 110±1.9 | 677±18.8 | 1018±18.8 | 1685±69.2 | 1347±18.1 | 2380±26.5 | 3738±22.3 | 1.99±0.109 | 2.35±0.145 | 2.21±0.122 | | | |
| + | 112±3.0 | 748±30.2 | 1209±25.0 | 1958±90.8 | 1521±19.1 | 2462±22.1 | 3983±20.6 | 2.03±0.085 | 2.04±0.078 | 2.03±0.085 | | | |
| Control (-) | | | | | | | | | | | | | |
| - | 108±4.7 | 693±19.5 | 1088±31.5 | 1867±11.6 | 1467±11.6 | 2672±24.2 | 4138±17.9 | 2.12±0.112 | 2.46±0.126 | 2.22±0.117 | | | |
| + | 113±3.2 | 663±23.5 | 1127±33.2 | 1847±13.8 | 1447±13.8 | 2565±25.1 | 4012±19.5 | 2.18±0.123 | 2.28±0.129 | 2.17±0.124 | | | |
| Interactions | | | | | | | | | | | | | |
| GPM² PM | | | | | | | | | | | | | |
| GPM ² DWE level | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | | |
| PM ² DWE level | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | | |
| GPM ² PM ² DWE level | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | | |

¹Dried whole eggs, ²Processing method, ³Growth promoters mixture, ⁴Means within a column under the same treatment bearing different superscripts are significantly different. * = p<0.05. ** = p<0.01. NS = Not Significant. FCR = Feed Conversion Ratio

Table 4: Lymphoid organs of 41 d old broiler chicks fed different levels of dried whole eggs processed by different methods with or without growth promoting mixture

| Treatment | Bursa (g) | Bursa index | Thymus (g) | Thymus index | Spleen (%) | | |
|--|--------------------------|--------------------------|-------------------------|--------------------------|------------|-------------|------------|
| Processing method | | | | | | | |
| Frozen | 2.81±0.26 | 146.2±14.22 | 5.38±0.20 | 279.2±11.86 | 0.15±0.01 | | |
| Frozen with boiled | 2.63±0.23 | 144.2±13.60 | 5.33±0.14 | 296.0±16.71 | 0.15±0.01 | | |
| Autoclaved | 2.87±0.26 | 145.3±11.39 | 5.23±0.17 | 269.2±9.92 | 0.14±0.01 | | |
| P-value | NS | NS | NS | NS | NS | | |
| DWE levels (%) | | | | | | | |
| 0.0 | 2.30±0.21 | 130.4±6.23 | 5.60±0.12 | 314.3±9.32 | 0.14±0.005 | | |
| 3.5 | 2.81±0.13 | 151.9±7.57 | 5.40±0.09 | 293.4±8.31 | 0.14±0.006 | | |
| 7 | 2.93±0.12 | 146.9±5.75 | 5.30±0.07 | 267.9±4.95 | 0.14±0.005 | | |
| P-value | NS | NS | NS | NS | NS | | |
| Growth promoting supplementation | | | | | | | |
| - | 2.64 ^b ±0.13 | 139.1 ^b ±7.3 | 5.48 ^a ±0.09 | 291.1 ^a ±8.50 | 0.13±0.006 | | |
| + | 3.09 ^a ±0.12 | 159.6 ^a ±6.13 | 5.21 ^b ±0.07 | 270.2 ^b ±4.90 | 0.15±0.005 | | |
| P-value | ** | * | * | * | NS | | |
| Interaction between DWE, processing method and growth promoting supplementation | | | | | | | |
| DWE¹ | Proc.² | Supp.³ | | | | | |
| 3.5 | Frozen | - | 2.95±0.65 | 163.0±38.51 | 6.00±0.49 | 326.7±24.82 | 0.14±0.04 |
| | | + | 2.63±0.46 | 128.7±24.07 | 5.27±0.21 | 257.1±13.04 | 0.17±0.02 |
| | Frozen with boiled | - | 2.65±0.79 | 154.9±44.68 | 5.58±0.42 | 344.6±60.23 | 0.12±0.01 |
| | | + | 2.43±0.21 | 130.7±15.75 | 5.38±0.22 | 288.7±20.16 | 0.16±0.02 |
| | Autoclaved | - | 2.60±0.77 | 133.6±29.46 | 5.48±0.45 | 295.4±32.49 | 0.09±0.008 |
| | | + | 3.07±0.59 | 166.0±33.24 | 5.05±0.12 | 271.2±11.00 | 0.17±0.02 |
| 7 | Frozen | - | 2.60±0.74 | 133.4±34.43 | 5.30±0.30 | 276.7±20.10 | 0.15±0.01 |
| | | + | 3.07±0.33 | 159.6±220.44 | 4.97±0.43 | 256.2±23.05 | 0.15±0.01 |
| | Frozen with boiled | - | 2.08±0.11 | 105.4±10.18 | 5.43±0.34 | 271.4±6.91 | 0.13±0.01 |
| | | + | 3.35±0.31 | 185.9±12.89 | 4.98±0.09 | 279.5±20.17 | 0.18±0.03 |
| | Autoclaved | - | 2.38±0.28 | 121.7±8.22 | 5.35±0.29 | 276.9±6.78 | 0.18±0.02 |
| | | + | 3.45±0.38 | 160.0±10.38 | 5.03±0.45 | 233.3±8.14 | 0.10±0.01 |
| | Control (-) | | 2.30±0.21 | 130.4±6.23 | 5.60±0.12 | 314.3±9.32 | 0.14±0.02 |
| | Control (+) | | 2.53±0.39 | 141.0±9.63 | 5.38±0.36 | 294.3±10.23 | 0.14±0.03 |
| Interactions | | | | | | | |
| GPM* PM | | | NS | NS | NS | NS | NS |
| GPM* DWE level | | | NS | NS | NS | NS | NS |
| Processing method* DWE level | | | NS | NS | NS | NS | NS |
| GPM* process methods* DWE level | | | NS | NS | NS | NS | * |

¹Dried whole eggs. ²processing method. ³Growth promoters supplementation.

^{abc}Means within a column under the same treatment bearing different superscripts are significantly different.

* = p<0.05. ** = p<0.01. NS, Not Significant

No significant two way interaction was quoted in plasma biochemical constituents. There was a significant three-way interaction between level of DWE, processing method and the supplementation of GPM on most of the biochemical constituents expect for plasma cholesterol level. GPM significantly increased plasma total protein and globulin of group fed 3.5% frozen with boiled DWE and albumin of 7% frozen with boiled DWE and globulin of 3.5 and 7% autoclaved DWE and 7% frozen DWE. GPM decreased total lipids of the most of the experimental groups, while increasing plasma total lipid of groups fed 7% frozen or 3.5 and 7% autoclaved DWE.

DISCUSSION

Processing ways: The purpose of using various processing ways was to investigate its effect on the nutritive and the microbiological properties. Processing way had small effect on nutrient profiles of DWE (Table 2) although some differences could be quoted in CP, crude fat, GE and ME between different methods (Table 2). In general, the autoclaved method showed the lowest

nutrient profile and this coincided with the highest moisture content. This could be attributed to the effect of degree and length of temperature exposure on protein and amino acids or pressure involved in the autoclaving process.

The superiority of growth (3.3 and 6.7%) and FCR (4.2%) of chickens fed frozen DWE compared to frozen with boiled and autoclaved may indicate better safety and nutritional values of frozen method on nutrient availability and recovery of bioactive components of eggs. In this regard, the total protein efficiency trial (data not shown) indicated that frozen DWE had significantly better value (2.9^a) than the frozen with boiled (2.5^b) and the autoclaving method (2.3^c). High temperature and/or high pressure during boiling and autoclaving may negatively affect availability of protein and vitamins (Fontaine *et al.*, 2007).

The hypertrophy in pancreas of group fed frozen with boiled DWE compared to frozen or autoclaved indicates higher trypsin inhibitor of ovoinhibitor of eggs white protein (Davis and Reeves, 2002). Whereas, the

Table 5: Carcass, inner organs and skin colour of 41 d old broiler chicks fed different levels of dried whole eggs processed by different methods with or without growth promoting mixture

| Treatment | Dressing (%) | Abdominal fat (%) | Liver (%) | Heart (%) | Pancreas (%) | Skin colour score | | |
|--|--------------------------|--------------------------|-----------|--------------------------|--------------------------|-------------------------|-----------|-----------|
| Processing method | | | | | | | | |
| Frozen | 67.2±0.34 | 0.78 ^a ±0.08 | 3.68±0.18 | 0.89 ^b ±0.05 | 0.26 ^b ±0.01 | 3.75 ^b ±0.21 | | |
| Frozen with boiled | 67.2±0.65 | 0.80 ^a ±0.10 | 4.02±0.17 | 1.08 ^a ±0.08 | 0.32 ^a ±0.01 | 3.50 ^a ±0.13 | | |
| Autoclaved | 68.1±0.73 | 0.65 ^b ±0.05 | 3.62±0.16 | 0.92 ^{ab} ±0.06 | 0.26 ^b ±0.01 | 4.25 ^a ±0.11 | | |
| P-value | NS | ** | NS | ** | ** | ** | | |
| DWE levels (%) | | | | | | | | |
| 0.0 | 70.2 ^a ±0.93 | 0.64 ^a ±0.05 | 2.99±0.12 | 0.82 ^a ±0.05 | 0.26 ^b ±0.03 | 4.00 ^b ±0.11 | | |
| 3.5 | 69.7 ^b ±0.83 | 0.75 ^a ±0.04 | 3.55±0.10 | 0.91 ^b ±0.04 | 0.28 ^a ±0.008 | 4.43 ^a ±0.09 | | |
| 7 | 68.2 ^c ±0.25 | 0.60 ^b ±0.03 | 3.73±0.08 | 1.02 ^b ±0.03 | 0.34 ^a ±0.02 | 3.93 ^b ±0.12 | | |
| P-value | ** | ** | NS | * | ** | ** | | |
| Growth promoting supplementation | | | | | | | | |
| - | 69.8 ^a ±0.80 | 0.73 ^a ±0.04 | 3.60±0.09 | 0.96±0.03 | 0.33 ± 0.01 | 4.14 ^a ±0.11 | | |
| + | 68.1 ^b ±0.30 | 0.63 ^b ±0.03 | 3.68±0.10 | 0.97±0.03 | 0.30 ± 0.01 | 4.21 ^a ±0.12 | | |
| P-value | ** | ** | NS | NS | NS | ** | | |
| Interaction between DWE, processing method and growth promoting supplementation | | | | | | | | |
| DWE¹ | Proc.² | Supp.³ | | | | | | |
| 3.5 | Frozen | - | 68.3±0.80 | 1.15±0.09 | 3.13±0.14 | 0.76±0.06 | 4.00±0.10 | |
| | | + | 67.4±0.70 | 0.72±0.06 | 3.96±0.54 | 0.82±0.10 | 0.24±0.02 | 5.00±0.09 |
| | Frozen with boiled | - | 69.1±1.29 | 1.07±0.28 | 3.86±0.51 | 1.04±0.21 | 0.27±0.02 | 4.00±0.11 |
| | | + | 68.2±0.72 | 0.93±0.06 | 3.98±0.18 | 0.85±0.13 | 0.38±0.03 | 4.00±0.12 |
| | Autoclaved | - | 70.3±1.82 | 0.78±0.06 | 3.10±0.26 | 0.68±0.04 | 0.22±0.03 | 4.00±0.08 |
| | | + | 68.3±0.58 | 0.55±0.09 | 3.70±0.17 | 0.95±0.08 | 0.26±0.03 | 4.00±0.11 |
| 7 | Frozen | - | 68.2±0.27 | 0.80±0.16 | 3.86±0.18 | 1.04±0.03 | 0.23±0.02 | 3.00±0.09 |
| | | + | 68.8±0.68 | 0.46±0.09 | 3.78±0.41 | 0.95±0.10 | 0.30±0.05 | 3.00±0.10 |
| | Frozen with boiled | - | 68.4±1.03 | 0.70±0.11 | 3.67±0.36 | 1.26±0.13 | 0.31±0.03 | 3.00±0.08 |
| | | + | 69.0±0.35 | 0.49±0.06 | 4.29±0.29 | 1.18±0.16 | 0.34±0.05 | 3.00±0.11 |
| | Autoclaved | - | 68.6±1.08 | 0.72±0.12 | 3.89±0.27 | 1.18±0.09 | 0.31±0.02 | 4.00±0.09 |
| | | + | 69.0±0.88 | 0.57±0.05 | 3.79±0.48 | 0.86±0.12 | 0.25±0.03 | 5.00±0.13 |
| | Control (-) | | 70.2±0.98 | 0.64±0.05 | 2.99±0.12 | 0.82±0.05 | 0.26±0.03 | 4.00±0.11 |
| | Control (+) | | 70.7±0.83 | 0.89±0.10 | 3.05±0.23 | 0.73±0.09 | 0.23±0.04 | 5.00±0.12 |
| | Interactions | | | | | | | |
| | GPM* PM | | NS | NS | NS | NS | NS | |
| GMP* DWE level | | NS | NS | NS | NS | NS | | |
| Processing method* DWE level | | NS | NS | NS | NS | NS | | |
| GPM* process methods* DWE level | | NS | NS | NS | ** | ** | | |

¹Dried whole eggs. ²Processing method. ³Growth promoters supplementation.

^{a-c}Means within a column under the same treatment bearing different superscripts are significantly different.

* = p<0.05. ** = p<0.01. NS, Not Significant

increase in skin colour and the decrease in abdominal fat showing pigmentation content of egg yolk was higher, while ME was lower due to autoclaving.

Level of dried whole eggs: The significant increase in growth of broilers during early stage of growth due to inclusion of DWE at 3.5% indicated that this level is adequate. This effect may be due to better digestibility and availability of nutrients, bactericidal effect and the bioactive components of eggs. The diminishing of the effect afterwards might be due to maturation and stabilization of the ecology of the GIT and improving enzyme secretion.

The significant improvement (7.21%) in FCR due to inclusion of 3.5 or 7% DWE compared to the control group might be attributed to the numerical increase in growth and the significant decrease in feed intake (Table 3). Similar results were reported by El-Deek *et al.* (2011); El-Deek and Al-Harhi (2009) and Junquera *et al.* (1985) who found that growth and FCR was inferior for broilers fed DWE powder at 20%.

The decrease in feed intake from 25-41 and 3-41 d of age may be due to the calorogenic effect of DWE as rich fat source (NRC, 1994; Attia *et al.*, 2009b) although this decrease did not affect growth during these periods and contributed to the significant improvement in FCR.

Eggs may improve early post hatching performance of growing chicks due to high availability of nutrients and bioactive components (Schaafsma *et al.*, 2000; Davis and Reeves, 2002). Furthermore, Schmdit *et al.* (1992) showed that the usage of egg byproducts in animal nutrition significantly reduced the survival rate of the pathogenic bacteria of *Escherichia coli* and *Salmonella typhimurium* from 87.3-80.9% when incubated with lysozyme increased growth of animals fed these eggs byproducts.

Eggs may be used as a feedstuff and/or as an alternative growth promoter due to its high quality protein, UFA and several nutrients such as folic acid, choline, iron, selenium and vitamins A, B, D, E and

Table 6: Plasma biochemical constituents of 41 d old broiler chickens fed different levels of dried whole eggs processed by different methods with or without growth promoting mixture

| Treatment | Total protein (g/dl) | Albumin (g/dl) | Globulin (g/dl) | Total lipid (mg/dl) | Cholesterol (mg/dl) | | |
|--|--------------------------|--------------------------|-------------------------|---------------------------|---------------------------|-------------|-------------|
| Processing method | | | | | | | |
| Frozen | 2.88±0.11 | 2.19±0.14 | 0.69±0.08 | 294.0 ^b ±41.1 | 145.9 ^b ±5.44 | | |
| Frozen with boiled | 2.68±0.07 | 1.79±0.11 | 0.89±0.16 | 266.1 ^c ±34.5 | 180.9 ^a ±7.34 | | |
| Autoclaved | 2.76±0.11 | 2.12±0.15 | 0.63±0.07 | 471.9 ^a ±70.5 | 159.9 ^{ab} ±5.75 | | |
| P-value | NS | NS | NS | * | ** | | |
| DWE level (%) | | | | | | | |
| 0.0 | 2.88 ^a ±0.08 | 2.42 ^a ±0.08 | 0.46 ^c ±0.12 | 468.6 ^a ±48.5 | 142.5 ^c ±4.12 | | |
| 3.5 | 2.80 ^{ab} ±0.05 | 1.98 ^b ±0.07 | 0.81 ^a ±0.07 | 327.8 ^b ±24.9 | 151.3 ^b ±3.17 | | |
| 7 | 2.75 ^b ±0.05 | 2.04 ^{ab} ±0.07 | 0.71 ^b ±0.05 | 426.6 ^a ±52.2 | 161.9 ^a ±3.90 | | |
| P-value | ** | ** | ** | ** | ** | | |
| Growth promoting supplementation | | | | | | | |
| - | 2.85 ^a ±0.05 | 2.15 ^a ±0.07 | 0.70 ± 0.06 | 318.2 ^b ± 24.2 | 155.4±4.03 | | |
| + | 2.70 ^b ±0.05 | 1.88 ^b ±0.06 | 0.83 ± 0.05 | 436.2 ^a ± 57.2 | 157.8± 3.15 | | |
| P-value | ** | ** | NS | ** | NS | | |
| Interaction between DWE level, processing method and growth promoting mixture supplementation | | | | | | | |
| DWE¹ | Proc.² | Supp.³ | | | | | |
| 3.5 | Frozen | - | 3.41±0.08 | 2.72±0.13 | 0.69±0.21 | 308.5±77.7 | 120.5±3.75 |
| | | + | 2.67±0.08 | 1.96±0.27 | 0.71±0.20 | 146.0±20.2 | 156.0±6.35 |
| | Frozen with boiled | - | 2.62±0.12 | 1.66±0.32 | 0.96±0.44 | 393.5±70.2 | 181.5±3.18 |
| | | + | 3.00±0.12 | 1.60±0.25 | 1.41±0.36 | 319.5±56.4 | 173.5±5.49 |
| | Autoclaved | - | 3.39±0.11 | 2.89±0.07 | 0.50±0.17 | 257±9.2 | 137.5±16.45 |
| | | + | 2.34±0.13 | 1.66±0.17 | 0.68±0.04 | 511.0±116.1 | 164.5±6.06 |
| 7 | Frozen | - | 2.62±0.08 | 2.03±0.26 | 0.60±0.19 | 351.0±109.1 | 151.5±3.75 |
| | | + | 2.83±0.32 | 2.06±0.36 | 0.78±0.043 | 370.5±71.3 | 155.5±15.30 |
| | Frozen with boiled | - | 2.56±0.03 | 1.87±0.14 | 0.70±0.11 | 243.5±7.2 | 218.0±1.15 |
| | | + | 2.56±0.19 | 2.05±0.03 | 0.51±0.23 | 108.0±27.7 | 150.5±15.87 |
| | Autoclaved | - | 2.85±0.03 | 2.38±0.20 | 0.47±0.17 | 282.5±66.7 | 166.0±2.89 |
| | | + | 2.46±0.08 | 1.57±0.02 | 0.88±0.05 | 837±95.8 | 171.5±10.68 |
| Control (-) | | | 2.88±0.07 | 2.42±0.12 | 0.46±0.05 | 468.6±32.5 | 142.5±11.51 |
| Control (+) | | | 2.27±0.08 | 2.06±0.14 | 0.21±0.06 | 242.5±25.8 | 120.5±12.31 |
| Interactions | | | | | | | |
| GPM* PM | | | NS | NS | NS | NS | |
| GMP* DWE level | | | NS | NS | NS | NS | |
| Processing method* DWE level | | | NS | NS | NS | NS | |
| GPM* process methods* DWE level | | | ** | ** | * | ** | |

¹Dried whole eggs. ²Processing method. ³Growth promoters supplementation. ^{a-c}Means within a column under the same treatment bearing different superscripts are significantly different. * = p<0.05. ** = p<0.01. NS, Not Significant

K and antioxidant carotenoids, lutein and zeaxanthin that could boost the immune response of chickens (Burley and Vadehra, 1989; Davis and Reeves, 2002). In the present study, both bursa and thymus weights and index as well as spleen percentage were not significantly affected by DWE processing ways and/or DWE level in contrast to our expectations. The bioactive components included ovotransferrin as iron-fortified products and had bactericidal properties against acute enteritis in infants. Also, lysozyme, a bactericidal enzyme, has as an antiviral and anti-inflammatory, ovomucin inhibit haemagglutination by viruses and have a cytotoxic effect on cultured cells, ovoinhibitor a trypsin inhibitor that inhabits bacterial and fungal serine proteinases and chymotrypsin and cystatin and antimicrobial, antiviral and insecticidal (Schaafsma *et al.*, 2000; Sparks, 2006). The lack of significant effect of DWE on lymphoid organs studied herein (Table 4) may indicate better experimental hygienic condition and/or maternal antibody during early stage of growth period due to lack

of determined antibody against specific diseases, although a significant increase in plasma globulin was shown (Table 6). The hypertrophy in heart and pancreas at 7% DWE may indicate less nutrient availability due to increased intake of trypsin inhibitor and or amino acid imbalance. The increase in plasma cholesterol with increasing DWE level indicates increasing cholesterol intake and similar to the findings of Griminger and Fisher (1986). There was no mortality during the experimental course thus, data was eliminated.

Growth promoter mixture: The recent trend in poultry nutrition is to use a mixture of different growth promoters to benefit from different mode of action of various active substances (Al-Harathi, 2002). The significant positive effect (3.5%) of GPM on growth of broilers during the later growth period (24-41 d of age) and for the whole experimental period (3-41 d of age) resulted in significant improvement of 2.8% in FCR from 3-41 d of age (Table 3). The improved FCR of different

experimental groups due to GPM could be attributed to the increase in growth of DWE groups and the decrease in feed intake of the control group (Table 3). This improvement could not be identified to specific components of GPM since several agents contributed such as probiotics (Cavazzoni *et al.*, 1998; Pelicia *et al.*, 2004) Vit. C (Sahin *et al.*, 2003; Attia *et al.*, 2009b) and black and red peppers (Al-Harathi, 2002; Abdo *et al.*, 2003; Awad *et al.*, 2006; Chichlowski *et al.*, 2007) which showed improved performance of broilers.

The effect of GPM on spleen percentage depends on level of DWE and processing method. GPM significantly affect the lymphoid organs of broiler chickens, showing increased general immunity. This was further confirmed by the increase in plasma globulin. The decrease in plasma total lipid and the increase in plasma total protein, and albumin due to GPM are in agreement with the results of Al-Harathi (2002) and Abdo *et al.* (2003). In this regard, a decrease in plasma total lipid due to GPM supplementation was reported due to probiotics (Chichlowski *et al.*, 2007) and capsaicin (El-Husseiny *et al.*, 2002; Abdo *et al.*, 2003).

Interaction effects: There was a combined positive effect of DWE and growth promoters in growth performance (Table 3). The results showed that growth promoters mixture added to diet contained 3.5 and 7.0% frozen DWE increased growth by 8.7 and 8.4% respectively and this coincided with increasing feed intake and improved FCR of only group fed 3.5% frozen DWE (4.2%). The combined effect increased also growth by 15.5% and improved FCR by 8.1% of group fed 7.0% autoclaved DWE, meanwhile the increased growth rate could be attributed partial by the 6.6% increase in feed intake.

A significant interaction between DWE level, processing method and growth promoter supplementations in percentage spleen (Table 4), pancreas (Table 5), plasma total protein, albumin, globulin and total lipids was observed (Table 6). The results indicated that the effect of growth promoting mixture depends on method of processing and level of DWE. For example, growth promoters decreased percentage pancreas of group fed 3.5% frozen DWE and 7% autoclaved and the control group. Meanwhile it induced pancreatic hypertrophy in the other groups (Table 5). Changes in the other parameters showed different trends depend on DWE, processing method and GPM and draw conclusive trend could not be achieved.

Conclusion: DWE up to 7% could be included in broiler diets without adverse effects on productive performance, carcass characteristics and lymphoid organs. Meanwhile, GPM supplementation to 3.5 and 7.0% frozen DWE resulted in the best productive performance, thus frozen way may be a safer way for processing DWE utilized as feedstuff in broiler diets.

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