ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 8 (11): 1086-1092, 2009
ISSN 1682-8356

Effect of Dried Whole Eggs Processed by Various Ways on Pullet's Performance and Egg Production and Quality Traits

A.A. El-Deek and M.A. Al-Harthi
Meteorology, Environment and Arid Land Agriculture College,
King Adularia University, P.O. Box 80208, Jeddah 21589, Saudi Arabia

Abstract: The effect of feeding different dietary levels of Dried Whole Eggs (DWE) processed by various ways during 14-20 wk of age on the performance of pullets up to 25 wk of age was investigated. Eggs that are not approved for human consumption were collected and then were dried at 55°C. DWE were processed by freezing at -18°C, freezing with boiling and autoclaving at 121°C. It was included in the pullet diets at 2.5 and 5%. There was also, a control diet that was fed without DWE. Thus, the experimental design was factorial (2 x 3) with added a control group (0% DWE). Each diet was fed to three replicates of 8 pullets each. Pullet's performance, egg production and quality traits and absolute and relative weight of reproductive organs was studied. Growth of pullets up to 25 wk of age was not significantly affected by various processing techniques, however, age at 50% production significantly decreased due to autoclaving compared with freezing with boiling technique. Level of 5% DWE increased growth of pullets up to 20 wk of age and this effect diminished at 25 wk of age. Laying rate, egg weight, egg mass and Feed Conversion Ratio (FCR) were significantly improved due to feeding DWE processed by freezing with boiling compared to the other methods and this was obvious within each DWE level. Age at 50% production significantly decreased and egg production traits significantly improved due to inclusion of 5% DWE. Egg quality traits of fresh eggs were not significantly affected by DWE level and/or technique of processing. However, freezing technique maintained better Haugh unit score and freezing with boiling maintained better yolk index after stored for one month in the refrigeration. On the other hand, 2.5% DWE maintained shell thickness and Haugh unit score of eggs stored for one month in the refrigeration. Absolute and relative weight of organs were significantly affected by processing methods and/or DWE levels and 5% DWE significantly increased absolute and relative weight of blood, intestinal length and leg color while significantly decreased absolute and relative weight of liver and absolute weight of intestinal. In conclusion, up to 5% frozen with boiled DWE can be included in the pullet's diets during 14-20 wk of age without adverse effect on pullet's performance and egg production and quality traits up to 25 wk of age.

Key words: Dried whole eggs, processing method, pullets performance, egg production, egg quality

INTRODUCTION

European countries have banned the routine usage of antibiotics in chicken feeds (Pingel, 2003). However, banning of antibiotics would leave animal and poultry producers with a dramatic increase in feed costs and disease and pathogens occurrence (Cook, 2004). Eggs are rich source of antibodies and high quality nutrients. Avian eggs are a vehicle for reproduction and a staple food within the human diet and have a natural balance of essential nutrients (Anton *et al*., 2006). Egg by-products such as outcomes from breaking facilities and unsellable eggs are known to be rich in fat, maternal antibodies, protein, bioactive nutrients and lyzosyme (Schmdit *et al*., 1992; Sparks, 2006).

Egg components such as lysozyme, avidin, phosvitin and other biochemical substances (Sparks, 2006), scialic acid and scialoligosaccharides (Stadelman, 1999; Juneja, 1998) are beneficial for human well-being. 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 (Nakai, 1998). 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; Anton *et al*., 2006; Sparks, 2006). The application of IgY medication to humans may be by injection of purified IgY or by encapsulation of an egg yolk concentrate so the IgY is not destroyed by the acidity in the stomach. However, results obtained with animals fed either liquid or dried egg yolk, oral administration may be possible. Dried egg powder can be fed to large flocks and eggs antibodies improve FCR and growth rates. However, it should not lead to drug resistant bacteria (Cook, 2004).

Processing methods could improve the keeping quality of egg by-products through affecting the pathogen and nutrient availability. In this regard, autoclaving, boiling in water, water soaking, steaming, radiation and treatment with acid or alkaline improve the quality of several agriculture-by products (González-Alvarado *et al*., 2007; García *et al*., 2008; El-Deek and Al-Harthi, 2005; Jiménez-Moreno *et al*., 2009).

This work aims to investigate the effect of different dietary levels of DWE processed by various methods during 14-20 wk of age on pullet's performance, egg production and quality traits and reproductive organs of pullets up to 25 wk of age.

MATERIALS AND METHODS

Birds, experimental design and housing: A trial was implemented at King Abdulaziz University, Faculty of Meteorology Environmental and Arid land Agriculture utilizing 168 Lohman pullets at the age of 14 wks in order to investigate the effect of inclusion 2.5 and 5% DWE in laying hens diets. DWE were processed by different methods: freezing at -18°C, freezing with boiling and autoclaving at 121°C. The experimental design was a factorial arrangement of 2 x 3 settings plus a control (0% DWE), resulting in seven experimental treatments. Each treatment was replicated 3 times, of 8 pullets each. Diets (Table 1) were formulated based on NRC (1994) to cover nutrient requirements for Leghorn pullets. The experimental period lasted from 14-20 weeks of age and then hens were fed a commercial laying hen diet (18% CP, 2900 kcal ME/kg diet, 3.2% Ca and 0.35% nPP) until 25 wk of age to determine subsequent laying performance and egg quality traits during the early part of laying period.

Pullets were housed in environmental control house. Feed and water were offered *ad libtium*. Pullets were kept on 12 h light:12 h dark cycle during 14-18 wks and from 19 wk of age, light schedule was gradually increased to reach maximum of 15 h light: 9 h dark cycle and kept constant thereafter.

Criteria of response: Pullets were weighed at 14, 16, 20 and 25 weeks of age, age at 50% egg production, livability and egg production traits during 20-25 weeks of age were measured according to Attia *et al*. (2009). The methods of the same authors were used for determination of egg quality traits of fresh eggs and eggs stored in refrigeration at -5°C for one month. Eggs quality measurements were performed on 15 eggs /treatment/time taken at the beginning, middle and at the end of laying period. Five pullets per treatment were slaughtered at 25 wk of age to determine absolute and relative weight of blood, intestinal, oviduct, ovary and liver.

Also, relative length of intestinal and egg color was determined, the latter was done using yolk color fan (Hoffman La Roche yolk color fan; Vuilleumier, 1969).

Statistical analysis: Data were analyzed using the GLM procedure of SAS® (SAS, 1996) using two way factorial analyses (3 x 2 + control group) with the main effects being processing method and/or DWE level. Duncan's New Multiple Range Test (Duncan, 1955) was utilized to test mean differences at $p \leq 0.05$.

Table 1: Composition of the experimental diets containing different levels of dried whole eggs (DWE) processed by different methods

		2.5% DWE			5.0% DWE		
Ingredients	Control	Freeze	Freeze and boiled	Autoclaved	Freeze	Freeze and boiled	Autoclaved
Yellow corn	69.60	67.20	66.80	67.50	65.00	64.20	65.20
Soybean meal, 44%	22.60	20.90	21.50	20.60	19.00	20.10	18.60
Di-Cal phosphate	1.247	1.081	1.101	1.098	0.918	0.959	0.949
Limestone	3.805	2.645	3.156	2.579	1.486	2.507	1.352
Dl-Methionine	0.225	0.165	0.165	0.197	0.110	0.120	0.170
Salt	0.300	0.300	0.300	0.300	0.300	0.300	0.300
Lysine	0.060	0.00	0.00	0.00	0.00	0.00	0.00
Premix[1]	0.300	0.300	0.300	0.300	0.300	0.300	0.300
Anti-oxidant	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Anti-aflatoxine	0.100	0.100	0.100	0.100	0.100	0.100	0.100
DWE	0.00	2.50	2.50	2.50	5.00	5.00	5.00
Filler	1.663	4.709	3.978	4.726	7.686	6.314	7.929
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis							
CP %	15.99	16.06	16.05	15.99	16.07	15.99	15.97
ME, k.cal/kg	2852	2849	2850	2855	2848	2849	2852
Ca %	1.80	1.80	1.80	1.80	1.80	1.80	1.80
Avail. P %	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Lysine %	0.849	1.012	0.955	0.901	1.23	1.11	1.013
Methionine %	0.490	0.489	0.485	0.490	0.492	0.494	0.491

DWE: Dried whole processed eggs,

[1]Vit+Min mixture provides per kilogram of diet: vitamin A, 6000 IU; vitamin E, 10 IU; menadione, 2.5 mg; Vit. D_3, 2000 ICU; riboflavin, 2.5 mg; Ca pantothenate, 10 mg; nicotinic acid, 12 mg; choline chloride, 300 mg; vitamin B_{12}, 4 μg; vitamin B_6, 5 mg; thiamine, 3 mg; folic acid, 0.50 mg; biotin, 0.2 mg. Trace mineral (milligrams per kilogram of diet): Zn, 40; Fe, 40; Cu, 4; Se, 0.10.

[2]Calculated values (NRC, 1994)

Table 2: Body weight, age at 50% egg production of pullets fed different levels of DWE processed by various methods

Treatment		BW 14 wks (g)	BW 16 wks (g)	BW 20 wks (g)	Age at 50% egg production	BW 25 wks (g)
Processing method						
Freeze		1089±10.0	1398±16.0	1680±25.3	157.3^{ab}±0.54	1803±41.2
Freeze and boiled		1090±11.2	1400±13.6	1663±21.3	158.2^{a}±0.52	1650±63.3
Autoclaved		1086±10.0	1404±15.8	1644±25.3	156.5^{b}±0.47	1797±45.5
DWE level (%)						
Control		1089^{ab}±11.3	1373^{b}±16.5	1616^{b}±17.5	159.0^{a}±0.56	1718±73.1
2.5		1047^{b}±5.3	1357^{b}±7.5	1628^{b}±13.0	158.3^{a}±0.26	1767±26.3
5.0		1121^{a}±4.2	1436^{a}±6.7	1707^{a}±8.5	155.5^{b}±0.15	1767±25.5
Interaction between DWE level and processing method						
DWE	**Pro. method**					
2.5%	Freeze	1051±13.8	1371±23.0	1638±35.8	159.0^{a}±0.96	1803±51.1
	Freeze and boiled	1044±14.8	1371±15.3	1613±35.7	161.7^{a}±0.37	1657±98.0
	Autoclaved	1049±12.5	1357±23.2	1589±42.8	159.0^{a}±0.64	1837±54.9
5.0%	Freeze	1127±10.74	1424±21.5	1721±34.4	155.7^{b}±0.24	1803±70.0
	Freeze and boiled	1136±11.2	1428±21.4	1712±19.5	154.7^{c}±0.18	1643±89.8
	Autoclaved	1122±12.2	1451±17.6	1699±23.2	154.0^{c}±0.00	1757±74.0
Probabilities						
Processing (P)		NS	NS	NS	**	NS
Additives Levels (A)		**	**	**	**	NS
Interaction		NS	NS	NS	**	NS

NS = Non-significant ** = p<0.01

Table 3: Laying performance, body weight and viability of pullets fed different dietary levels of DWE processed by various methods

Treatment		Laying rate (%)	Egg weight (g)	Egg mass (g/d)	FCR (g/g)	Viability (%)
Processing method						
Freezing		74.0^{b}±4.1	58.8^{b}±1.4	43.6^{c}±2.6	2.32^{a}±0.19	87.0±3.41
Freeze and boiled		80.2^{a}±2.6	60.3^{a}±1.3	48.4^{a}±2.1	2.01^{c}±0.10	88.9±4.06
Autoclaved		79.5^{a}±3.9	57.7^{b}±1.3	45.9^{b}±2.3	2.14^{b}±0.13	92.6±2.34
DWE levels (%)						
Control		75.4^{b}±3.9	57.9^{b}±1.3	43.7^{b}±2.5	2.28^{a}±0.19	92.6±2.34
2.5		73.8^{b}±4.1	58.5^{a}±1.9	43.2^{b}±2.5	2.32^{a}±0.19	89.2±1.70
5.0		82.0^{a}±3.0	59.3^{a}±1.4	48.7^{a}±2.1	1.99^{b}±0.09	95.9±1.30
Interaction between DWE level and processing method						
DWE Level	**Pro. Method**					
2.5	Freezing	70.9±4.9	58.5^{ab}±1.7	41.5±3.0	2.51±0.29	85.2±3.70
	Freezing and boiling	74.7±3.3	59.4^{a}±0.9	44.4±2.1	2.19±0.13	81.5±3.70
	Autoclaving	75.7±4.2	57.7^{b}±1.2	43.8±2.3	2.25±0.14	88.9±0.00
5.0	Freezing	77.0±3.4	59.1^{a}±1.1	45.6±2.1	2.13±0.10	88.9±6.41
	Freezing and boiling	85.7±2.0	61.1^{a}±1.7	52.5±2.0	1.83±0.07	96.3±3.70
	Autoclaving	83.3±3.6	57.7^{b}±1.3	48.1±2.2	2.03±0.11	96.3±3.70
Probabilities						
Processing		**	**	*	*	NS
DWE Level		**	**	**	**	NS
Interaction		NS	**	NS	NS	NS

DWE: Dried whole processed eggs

RESULTS

Results of BW at 14, 16 and 20 weeks of age are presented in (Table 4). Processing method did not show any significant effect on pullet's growth up to 25 wk of age. However, all parameters were significantly ($p \leq 0.01$) affected by dietary DWE levels. DWE at 5% showed heavier BW at 14, 16 and 20 weeks as compared to the control and 2.5% fed group. No significant interaction was achieved at 14, 16, or 20 weeks of age, nor there were significant effects on BW at 25 wk of age.

Pullets fed frozen with boiled DWE reached age at 50% production earlier than those fed autoclaved DWE. Pullets fed DWE 5% reached age at 50% egg production earlier than those fed 0% and 2.5% DWE levels. A significant interaction was obtained showing that pullets on frozen with boiled or autoclaved DWE at 5% level reached age at 50% earlier than their corresponding groups fed 2.5% DWE. In addition, pullets fed 5.0% frozen DWE reached age at 50% laying rate earlier than their corresponding groups fed DWE at 2.5%.

Results for laying traits are illustrated in (Table 3). Processing methods did significantly affect egg production traits, group fed frozen with boiled DWE had significantly higher laying rate, egg weight, egg mass and better FCR than those on the other processing methods.

Pullets fed DWE at 5% had significantly higher laying rate, egg weight, egg mass and better FCR than those on 0 and 2.5% DWE levels. A significant interaction was shown for only egg weight in which group fed 2.5 and 5% autoclaved DWE level laid smaller eggs than its corresponding group fed 5% DWE and frozen with boiled

Table 4: Fresh and stored egg quality of pullets fed different dietary levels of DWE processed by various methods

		Fresh Eggs			
Treatment		Yolk color	Shell thick (mm)	Haugh unit	Yolk index
Processing method					
Freeze		5.0±0.17	0.369±0.009	93.6±1.79	0.65±0.03
Freeze and boiled		4.9±0.18	0.303±0.010	96.1±1.84	0.63±0.04
Autoclaved		5.1±0.15	0.333±0.012	92.7±1.74	0.61±0.03
DWE level (%)					
Control		5.3±0.19	0.331±0.014	93.0±1.88	0.67±0.03
2.5		4.9±0.15	0.310±0.008	93.0±1.33	0.65±0.03
5.0		5.0±0.19	0.359±0.012	95.3±2.24	0.60±0.03
Interaction between DWE level and processing method					
DWE Level	**Pro. Method**				
2.5	Freezing	4.6±0.13	0.335±0.006	89.7±1.36	0.71±0.03
	Freezing and boiling	5.0±0.16	0.280±0.009	97.8±1.28	0.66±0.04
	Autoclaving	5.0±0.15	0.316±0.012	91.6±1.37	0.60±0.03
5.0	Freezing	5.3±0.21	0.402±0.011	97.8±2.22	0.60±0.04
	Freezing and boiling	4.7±0.19	0.325±0.011	94.4±2.40	0.59±0.04
	Autoclaving	5.1±0.16	0.349±0.013	93.7±2.11	0.63±0.03
Probabilities					
Processing		NS	NS	NS	NS
DWE Level		NS	NS	NS	NS
Interaction		NS	NS	NS	NS
		Stored Eggs			
Treatment		Yolk color	Shell thick (mm)	Haugh unit	Yolk index
Processing method					
Freeze		3.40±0.17	0.355±0.009	79.0^{a}±1.69	1.03^{a}±0.03
Freeze and boiled		3.60±0.18	0.368±0.008	77.3^{b}±1.42	0.87^{b}±0.04
Autoclaved		3.40±0.15	0.368±0.010	77.1^{b}±1.39	1.01^{a}±0.04
DWE level (%)					
Control		3.65^{a}±0.19	0.360^{b}±0.009	80.4^{a}±1.58	0.80^{c}±0.03
2.5		3.30^{b}±0.15	0.367^{a}±0.009	78.0^{ab}±1.53	0.88^{b}±0.03
5.0		3.63^{a}±0.19	0.359^{b}±0.009	77.6^{b}±1.47	1.06^{a}±0.04
Interaction between DWE level and processing method					
DWE Level	**Pro. Method**				
2.5	Freezing	3.20±0.13	0.362^{b}±0.010	78.0^{a}±1.89	0.94^{b}±0.03
	Freezing and boiling	3.40±0.16	0.367^{b}±0.007	76.3^{b}±1.32	0.71^{c}±0.04
	Autoclaving	3.30±0.15	0.373^{a}±0.011	79.7^{c}±1.37	0.99^{b}±0.03
5.0	Freezing	3.60±0.21	0.347^{c}±0.009	80.0^{a}±1.50	1.11^{a}±0.04
	Freezing and boiling	3.80±0.19	0.369^{b}±0.009	78.2^{d}±1.52	1.03^{a}±0.05
	Autoclaving	3.50±0.16	0.362^{b}±0.009	74.5^{d}±1.41	1.04^{a}±0.05
Probabilities					
Processing		NS	NS	**	**
DWE Level		**	**	**	**
Interaction		NS	**	**	**

DWE: Dried whole processed eggs

treatment at 2.5% DWE. Livability was not significantly affected by processing method and/or level of DWE, however, livability was higher of groups fed 5% DWE processed by freezing with boiling or autoclaving.

Egg quality measurements of fresh and sorted eggs are presented in Table 4. Results obtained demonstrated that processing methods and/or DWE levels had no significant effects on quality measurements of fresh eggs including yolk color score, shell thickness, Haugh unit score and yolk index.

Data of the storage eggs indicated that, freezing technique maintained better Haugh unit score, while freezing with boiling maintained better yolk index compared to the other methods. DWE at 5% significantly increased yolk color score compared to 2.5% only while, shell thickness was significantly increased of 2.5% DWE compared to the other levels. Haugh unit score significantly increased of the control group compared to only 5% DWE. The control group maintained also better yolk index during the storage period.

Significant interactions were achieved for shell thickness, Haugh unit score and yolk index of storage eggs. Results indicated that autoclaved DWE at 2.5% significantly increased shell thickness compared to the other experimental groups. In addition, frozen 2.5% DWE yield higher shell thickness than their corresponding group fed 5% DWE.

Haugh unit score of eggs laid by pullets fed 2.5 and 5% DWE processed by freezing was significantly higher than the other experimental group. Also, eggs from 2.5% DWE fed groups had higher Haugh unit score than those of groups fed 5% DWE. Pullets fed 2.5% DWE processed by all methods had significantly better yolk index than those fed 5% DWE processed by the same method.

Table 5: Absolute and relative weight of body organs, intestinal length and leg color of pullets fed different dietary levels of DWE processed by various methods

Treatment		Blood (g)	Blood (%)	Intestine (g)	Intestine (%)	Intestine Length (cm)	Leg color
Processing method							
Freeze		70.0^{b}±3.48	3.94^{b}±0.27	75.0^{b}±2.06	4.17^{b}±0.09	147.8±56.00	2.16^{a}±0.21
Freeze and boiled		73.3^{b}±8.65	4.46^{ab}±0.47	85.8^{a}±3.36	5.26^{a}±0.24	143.2±4.28	1.50^{b}±0.15
Autoclaved		86.2^{a}±11.5	4.91^{a}±0.73	76.0^{b}±4.83	4.22^{b}±0.21	140.3±3.13	2.50^{a}±0.15
DWE level (%)							
Control		55.3^{c}±6.93	3.28^{c}±0.42	83.2^{a}±3.95	5.00±0.40	142.2^{a}±4.19	2.16^{a}±0.21
2.5		59.6^{b}±4.00	3.41^{b}±0.23	83.6^{a}±1.97	4.79±0.14	141.5^{b}±1.80	1.88^{b}±0.09
5.0		77.1^{a}±2.46	4.40^{a}±0.15	79.9^{b}±1.23	4.57±0.11	142.5^{a}±1.42	2.21^{a}±0.10
Interaction between DWE level and processing method							
DWE Level	**Processing**						
2.5	Freezing	66.7^{d}±4.21	3.92^{c}±0.09	70.70^{c}±2.10	3.03^{c}±0.14	151.0^{ab}±1.32	2.33±0.22
	Freezing and boiling	53.3^{e}±5.58	4.28^{b}±0.27	96.0^{a}±1.76	3.39^{a}±0.26	156.3^{a}±2.84	1.33±0.22
	Autoclaving	90.7^{a}±23.15	4.43^{b}±0.36	82.0^{b}±8.85	3.31^{ab}±0.15	149.7^{b}±1.65	2.33±0.21
5.0	Freezing	73.3^{c}±5.58	4.40^{b}±0.04	79.3^{c}±2.60	3.21^{b}±0.06	140.7^{c}±3.28	2.00±0.36
	Freezing and boiling	93.3^{b}±11.74	4.64^{b}±0.15	75.7^{d}±2.38	3.47^{a}±0.13	130.0^{d}±1.83	1.67±0.21
	Autoclaving	81.7^{b}±4.59	4.02^{c}±0.24	70.0^{e}±3.11	2.93^{c}±0.17	131.0^{d}±2.39	2.67±0.21
Probabilities							
Processing		**	**	*	**	NS	**
DWE Level		*	**	**	NS	**	**
Interaction		**	*	**	**	**	NS

DWE: Dried whole processed eggs

Table 6: Absolute and relative weight body organs of pullets fed different dietary levels of DWE processed by various methods

Treatment		Oviduct Wt (g)	Oviduct (%)	Ovary Wt (g)	Ovary (%)	Liver Wt (g)	Liver (%)
Processing method							
Freeze		56.0±0.95	3.12±0.08	39.3^{a}±2.60	2.21^{a}±0.17	26.7^{c}±0.55	1.69^{c}±0.05
Freeze and boiled		55.8±1.43	3.43±0.14	36.7^{b}±1.51	2.28^{a}±0.17	31.8^{a}±1.17	1.71^{b}±0.08
Autoclaved		56.2±2.63	3.12±0.12	35.7^{b}±1.71	1.99^{b}±0.09	29.8^{b}±1.04	1.77^{a}±0.08
DWE level (%)							
Control		57.0±1.85	3.35±0.09	31.5±1.03	1.84±0.05	32.3^{a}±1.08	1.92^{a}±0.10
2.5		57.7±1.01	3.28±0.07	33.9±0.89	1.94±0.06	31.5^{a}±0.49	1.80^{ab}±0.04
5.0		55.8±0.90	3.17±0.05	34.6±0.97	1.97±0.06	29.8^{b}±0.51	1.70^{b}±.04
Interaction between DWE level and processing method							
DWE Level	**Pro. Method**						
2.5	Freezing	54.3±1.12	3.03^{b}±0.14	35.3^{b}±3.27	1.96^{c}±0.18	28.7^{c}±1.38	1.58^{cd}±0.03
	Freezing and boiling	55.0±0.96	3.39^{a}±0.26	38.7^{b}±2.77	2.41^{a}±0.30	31.0^{b}±1.10	1.90^{a}±0.10
	Autoclaving	60.7±2.14	3.31^{ab}±0.15	35.0^{bc}±2.28	1.92^{c}±0.14	34.7^{a}±1.28	1.91^{a}±0.12
5.0	Freezing	57.7±1.28	3.21^{ab}±0.06	43.3^{a}±3.55	2.45^{a}±0.28	32.3^{b}±1.38	1.80^{b}±0.08
	Freezing and boiling	56.7±2.80	3.47^{a}±0.13	34.7^{c}±0.92	2.16^{b}±0.18	24.7^{d}±0.76	1.52^{d}±0.06
	Autoclaving	51.7±4.20	2.93^{c}±0.17	36.3^{b}±2.74	2.03^{bc}±0.11	28.7^{c}±0.56	1.64^{c}±0.05
Probability							
Processing		NS	NS	**	**	**	**
DWE Level		NS	NS	NS	NS	**	*
Interaction		NS	**	**	**	**	**

DWE: Dried whole processed eggs

Absolute and relative of organs are presented in (Table 5 and 6). Results indicated that autoclaving significantly increased absolute and relative weight of blood and leg color (Table 5) and liver percentage (Table 6). However, freezing and boiling significantly increased absolute and relative weight of intestinal (Table 5), relative weight of ovary and absolute weight of liver (Table 6). There was no significant difference between freezing with or without boiling in absolute and relative weight of blood and relative weight of ovary.

Results showed that DWE at 5% yield significantly higher absolute and relative weight of blood compared to the other levels, intestinal length and leg color compared to only 2.5% DWE although intestinal weight was significantly decreased compared to the other levels. In addition, group fed 2.5% DWE had significantly higher absolute and relative weight of blood, but had significantly lower intestinal length and leg color than the control. Absolute and relative weight of liver significantly decreased due to feeding 5% DWE diet compared to the control group and 2.5% DWE except for percentage liver of 2.5% DWE level.

There was a significant interaction between DWE level and processing method on most of organs parameters. Results indicated that 2.5% DWE processed by freezing with boiling significantly increased absolute and relative weight of intestinal and intestinal length, relative weight of oviduct and ovary and liver percentage, this showed that the effect of DWE level depends on processing method.

DISCUSSION

The improvement in pullet's performance such as growth and the decrease in age at 50% production and the increase in laying performance and FCR during early part of laying period of pullets fed 5% DWE indicate that

increasing DWE level increased nutrients availability. Eggs are rich source of different nutrients and thus can boost health status and productive performance such as laying rate and decreased fatty liver (Attia *et al*., 2009). Lecithin, the major phospholipids of eggs, can improve digestion and assimilation of fat (An *et al*., 1997; Dersjant and Peisker, 2005), control fatty liver syndrome (Hansen and Waizem, 1993; Aydin and Cook, 2004), improve health condition (Dumitru *et al*., 2002), enhance synthesis of hepatic lipoprotein (Nimpf and Schneider, 1991) and act as a natural antioxidant (Dersjant and Peisker, 2005).

Eggs are not only rich in lecithin, but also in many other valuable nutrients and bioactive components (Burley and Vadehra, 1989; Nimpf and Schneider, 1991). Such nutrients e.g. high quality protein/amino acids, fatty acid, vitamins and minerals can enhance pullet's performance when fed diets marginally deficient in one or more of the nutrient demands for egg formation which most likely to occurs under field condition. Bioactive components could enhance health and overcome stress condition in the laying house (Schmdit *et al*., 1992; Attia *et al*., 2009). In this regard, dried egg powder can be fed to large flocks and eggs antibodies improve FCR and growth rates (El-Deek and Al-Harthi, 2005)and can replace antibiotics-feed additives in animal nutrition (Bedford and Fothergill, 2002; Cook, 2004). Egg components such as lysozyme, avidin, phosvitin, scialic acid, scialoligosaccharides and other biochemical substances are beneficial components (Stadelman, 1999; Juneja, 1998; Sparks, 2006). 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. Furthermore, the egg yolk is a reservoir of antibodies and immunoglobulin, IgY (Li-Chan, 1998; Anton *et al*., 2006; Sparks, 2006).

Processing method showed some beneficial effects depend on criteria of response for example, age at 50% production significantly decreased due to autoclaving compared with freezing with boiling technique. However, Laying rate, egg weight, egg mass and FCR were significantly improved due to feeding DWE processed by freezing with boiling compared to the other methods. This indicates that the effect of processing method depends on criteria of response.

Interestingly, egg quality traits of fresh eggs were not significantly affected by DWE level and/or technique of processing. However, beneficial effect of freezing technique was shown due to maintaining better Haugh unit score and yolk index after stored for one month in the refrigeration, thus extend egg shelf life. This improvement in egg quality traits after shelf life for one month showing the positive effect of freezing techniques on maintaining the bioactive components of eggs such as antioxidant agents of eggs for longer period and/or control bacterial growth. In this regard, Schmdit *et al*. (1992) and Schaafsma *et al*. (2000) showed that egg by-products in animal diets significantly reduced the survival rate of the pathogenic bacteria of *Escherichia coli* and *Salmonella typhimurium* from 87.3-80.9% when incubated with lysozyme. They suggested this resulted in an expected higher growth rate of farm animals as they are fed on these eggs by-products. In this regard, livability was not significantly different among different experimental groups (Table 3), although it was higher of groups fed 5% DWE than those fed 2.5% DWE.

The bioactive components of eggs included ovotransferrin as iron-fortified products and had bactericidal properties against acute enteritis in infants. In addition, lysozyme 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 effects. In addition, antibodies, high quality protein, UFA, folic acid, choline, iron, selenium and vitamins A, B, D, E and K and antioxidant carotenoids, lutein and zeaxanthin could boost the immune response and thus health status of chickens (Burley and Vadehra, 1989; Schaafsma *et al*., 2000; Sparks, 2006).

Absolute and relative weight of organs were significantly affected by processing methods and/or level of DWE and 5% DWE significantly increased absolute and relative weight of blood, intestinal length and leg color while significantly decreased absolute and relative weight of liver and absolute weight of intestinal. The increase in leg color at higher DWE level indicating higher availability of pigmentations such as carotenoids, lutein and zeaxanthin, however, the increase was not significantly different from the control.

Conclusion: In conclusion, up to 5% frozen with boiled DWE can be included in the pullet's diets during 14-20 wk of age without adverse effect on pullet's performance and egg production and quality traits up to 25 wk of age.

ACKNOWLEDGEMENT

The authors of this work would like to thank King Abdulaziz City for Science and Technology, Riyadh 11442, P. O. Box 6086, Saudi Arabia for funding this project which made this work possible.

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