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A NUTRITIONAL EVALUATION OF HATCHERY BY-PRODUCT IN THE DIETS FOR LAYING HENS

By

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Abstract: *laying hens during 25-41 wk of age was investigated. HBP was collected, Proximate chemical composition of Hatchery by-product (HBP) and feeding trial in which three levels of HBP was included in cooked for 30 min and dried at 55C° and included at 0, 5 and 10% in laying hen diets in straight run experimental design. This resulted in 3 experimental treatments. Each treatment was replicated 3 times of eight hens each, thus a total number of 72 hens of Hy-line strain was used.*

Hatchery by product contains 36.5% CP, 28.5% EE, 1.2% CF, 27% ash, 18% Ca and 0.75% available P and 2850 kcal ME. Results revealed that HBP could be fed to laying hens up to 10% without adverse effects on egg production traits, quality of fresh and stored eggs, inner body organs and lipid metabolism.

It could be concluded that HBP at 10% in the laying hens diets form 25-41 wk of age did not negatively affect productive performance and egg quality, inner organs and lipid metabolism while contributed to decrease environmental pollution.

INTRODUCTION

It is well recognized that laying hens required a relatively high amount of protein, which is considered as the most expensive item of the diet. HBP is a rich protein source and showed steadily production increase in the last decade due to the increase in hatchery houses for production of day old chickens in Saudai Arabia. Therefore, encouraging production of local non-conventional animal protein sources such as HBP should be given considerable attention as an alternative feed resource and to eliminate its negative environmental impact (Aggoor, 2003; Shahriar *et al*., 2008).

Hatchability of poultry eggs ranges from 50 to 80 percent depending on the hatchery practices adopted, birds species and age, method of collection and storage of eggs and collection frequency and time etc. Hatchery waste included eggshells, nonfertile eggs, dead embryos and dead or culled chicks. Different methods can be used for the disposal of HBP include landfill, land application, rendering, egg wringing, fermentation, and composting. Each has its own advantages and disadvantages are discarded adding to the burning problem of environmental. As the industry grows and concentrates, chick production per hatchery also increases and hatchery waste management and disposal are serious concerns for the poultry industry. Vandepopuliere (1977) reported that the options hatchery waste are: incineration, burial, composting, and rendering meanwhile only burial and land spreading have been commonly utilized for hatchery waste. However, recycling large quantities of hatchery waste to agricultural lands raises some serious nutrient management and biosecurity issues.

Wisman and Beane (1965) and Vandepopuliere *et al.* (1977) reported that raw HBP when cooked and dehydrated can be successfully used to replace meat and bone meal and soybean meal protein in broiler and laying hen diets. When HBP meal was incorporated into diets at the 8 and 16% level replacing soybean meal and meat and bone meal and fed to layers performance was not found to be different (Vanderpopuliere, 1977). Including HBP meal in pullet's diets at 3.6, 7.25, 10.5, or 14.1 % and reported that 7.25 % and 10.5 % impaired feed conversion ratio (FCR) and decreased egg production (Zohari, 1975). Another experiment showed no difference in performance when HBP was fed to layers (Dufloth, 1987). Broiler growth, feed conversion and feed intake were decreased when HBP meal fed, but this might have been related to the elevated levels of dietary calcium (Zohari, 1975). Feed conversion ratio improved when HBP meal was compared to bone meal in turkey feeding trial (Lilburn, 1997). However, variability in animal by products was reported (Deshmukh and Patterson, 1997; Shahriar *et al*., 2008; Sathishkumar and Prabakara, 2008) due to differences in pre-harvest treatment, conditions and techniques of processing, as well as the nature of primary ingredients.

Chemical composition of HBP were determined and the effect of different levels of HBP at 0, 5 and 10% in pullet's diets from 25 to 41 wk of age on productive performance, quality of fresh and stored eggs, inner organs and lipids metabolism in laying hens were investigated.

Hatchery by-product, laying hens, egg production, egg quality, lipid.

MATERIALS AND METHODS

The experiment was carried out at King Abdulaziz University, Faculty of Meteorology Environmental and Arid land Agriculture utilizing 72 Hy-line layers during 25-41 wk of age. The purpose of this work was to chemically evaluate the nutrient contents and the effect of inclusion of different levels of 0, 5 and 10% of HBP in the laying hen diets. The HBP were collected from hatchery house in Jeddah area it included shells, from hatched eggs, infertile eggs, dead embryos and dead and culled chicks. It was boiled for 30 min, dried in hot air oven at 55° C for 36 hrs and were finally grinded and passes through 2 mm filter and packed in plastic bags and stored at 20 ° C until analyses and use in the diet formulation. Proximate chemical composition, Ca and P were done according to (AOAC, 1990). Cooking for 30 min was effective techniques for possible destroyed all pathogens in the HBP (Sathishkumar and Prabakaran, 2008).

A straight run experimental design was used with 3 levels of HBP at 0, 5 and 10%. Each treatment was replicated three times of 8 hens each resulting in a total of 72 of hens from Hy-line layers. Diets (Table 1) were formulated based on NRC (1994) to cover requirements recommendation for laying hens. Pullets were randomly distributed into experimental groups. The experimental period started at the age of 25 weeks (50% production) and ended at 41 wk of age. Hens were housed in individual cages in environmental control house. Feed in a mash form and water were offered *ad libitum* and chickens were illuminated with 16:8 light dark-cycle.

Measurements:

Individual body weight and feed intake were recorded during the experimental period from 25 to 41 wk of age. Laying rate (number/hen/d), egg weight (g), egg mass (g/hen) and feed intake (g/hen/d) were measured daily. For each replicate egg mass was calculated as the mean of egg weight produced by mean of laying rate during the production days divided by 100. Feed conversion ratio was calculated as the amount of feed required to produce 1 kg of egg.

At 41 wks of age, five hens per treatment were slaughtered after being fasted overnight to obtain reproductive organs, liver and intestinal. They were weighted and their absolute and relative weight was recorded. At 41 wks of age, five blood samples per treatment were collected from wing vein in heparinzed tubes. Plasma was separated by centrifugation at 3000 rpm for 10 minutes and stored at -18°C until analysis. Plasma total lipids (Chabrol and Charonnat, 1973) and total cholesterol (Watson, 1960) were determined.

At 30, 35 and 40 wks of age, 24 eggs per treatment per time were collected for determination of egg quality traits. Eggs were divided into two portions of 12 eggs each. The 1st protein was used for determination of egg quality of fresh eggs (at the same day of laying), while the other portion (12 eggs) was kept in the refrigerator at 5 °C for one month (30 days) after which it was broken out for egg quality evaluation (Attia *et al*., 1995). Also, five yolks per treatment were separated and frozen for further analyses. Yolk samples were chemically analyzed (AOAC, 1990) for total lipid according to Folch *et al*. (1957), and the cholesterol content of the yolk was determined in 5 samples per treatment using commercial diagnostic kit (Zlatkis *et al*., 1953).

Statistical analysis:

Data were analyzed using the GLM procedure of SAS® (SAS, 1996) using one way ANOVA. 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 $P \leq 0.05$.

RESULTS AND DTSCUSSION

Proximate chemical composition:

Hatchery by product contains 36.5% CP, 28.5% EE, 1.2% CF, 27% ash, 18% Ca and 0.75% available P. The chemical analyses of HBP reported herein are in line with those reported by (Deshmukh and Patterson; 1997; Sathishkumar and Prabakara, 2008; Shahriar *et al*., 2008). Also, Rasool *et al*. (1999) found similar value to ether extract found herein.

Kundu *et al*. (1986) showed lower total ash content in poultry hatchery waste, whereas Khan and Bhatti (2002) obtained higher values than that reported herein. Ash content of HBP varied according to hatchability and higher values contributed to the high ash content due to increasing shell output. Earlier reports available on calcium content of poultry hatchery waste (Lilburn *et al*., 1997; Khan and Bhatti, 2002) were higher than the calcium obtained in this research, but our value is higher than those reported by Sathishkumar and Prabakara (2008). However, our results are comparable to those reported by Deshmukh and Patterson (1997) for calcium, but higher for phosphorus. Also, the present value for inorganic P are similar to those reported by Khan and Bhatti (2002), but lower that those reported by Shahriar *et al*. (2008). Differences in nutrient profiles of HBP meal could be elucidated based on pre-harvest treatment, conditions and techniques of processing, as well as the nature of primary ingredients

It is worth noticing the Amino acid profiles of HBP reported in the literature e.g. methionine, cystine and lysine were 1.03, 0.82 and 2.20%, respectively (Sathishkumar and Prabakara, 2008), while these values were 0.67, 0.68 and 1.43%, respectively (Deshmukh and Patterson, 1997)

Metabolizable energy content of HBP was calculated to be 2850 kcal/kg according to Pesti *et al.* (1986) and is comparable to the ME value of 2795 kcal ME/kg diet reported by Sathishkumar and Prabakara (2008) using the same equation. As ether extract content of HBP increased ME content increased due to higher ME of fats compared to the other nutrient profiles in feed composition. On the other hand, Shahriar *et al.* (2008) reported values of 3520 based on equation by Rose (1997). Differences in ME among values reported in the literature could be attributed to differences in primary materials, ether extract, ash, Ca content of HBP (Pesti *et al.*, 1986; Sathishkumar and Prabakara; 2008; Shahriar *et al.*, 2008).

Productive performance and body weight change:

Table (2) shows the effect of different dietary levels of HBP on productive performance of laying hens from 25 to 41 wk of age. Egg weight was not significantly affected by level of HBP. This finding agreed with those of Tadtiyanant *et al.* (1993) and Sathishkumar and Prabakara (2008) who reported that egg weight of laying hens and Japanese quail was not significantly affected by hatchery waste.

Laying rate was not significantly affected by HBP up to 10% in laying hen diets from 25 to 41 wk of age. These observations are similar to those reported in chicken layers (Dufloth *et al.* 1987 and Tadtiyanant *et al.,* 1993) and laying Japanese quail (Sathishkumar and Prabakara, 2008). However, including HBP meal in pullet's diets at 3.6, 7.25, 10.5, or 14.1 % and reported that 7.25 % and 10.5 % decreased egg production (Zohari, 1975).

Egg mass was found to be higher (11.4%) of hens fed 10% HBP than that of those fed 5%, but differences between these groups and the control was not significant. The present results could be elucidated based on the fact that HBP had good and balance nutrient profiles including amino acids, unsaturated fatty acids, high availability of Ca and inorganic P (Sathishkumar and Prabakara; 2008; Shahriar *et al.;* 2008). Also, feeding different protein sources induced complementary nature and improved bird's performance (Irish and Balnave, 1993).

Feed intake was not significantly affected by different dietary HBP levels. The results showed that HBP up to 10% did not significantly affect palatability. The results are in agreement with those reported by (Ilian and

Salman, 1986; Sathishkumar and Prabakara; 2008) but different from those reported by Vandepopuliere *et al.* (1977) and Shahriar *et al.* (2008) who reported that incorporation of broiler hatchery waste resulted in lower feed intake.

A level of 0 and 10% HBP improved FCR compared to 5% HBP, and this coincided with increasing egg mass of the former levels. The improved performance at 10% of HBP may be due to increasing fat content in the experimental diets and its effect on feed utilization (Acikgoz *et al.*, 2003; Aggoor *et al.*, 2003). In accordance with the present results Wisman and Beane (1965), Ilian and Salman (1986) and Sathishkumar and Prabakara 2008) reported that poultry hatchery waste in laying hens rations up to 9% did not negatively affect FCR of laying hens and Japanese quail hens. However, including HBP meal in pullet's diets at 3.6, 7.25, 10.5, or 14.1 % and reported that 7.25 % and 10.5 % impaired FCR of laying hens (Zohari, 1975).

Livability (%) was not influenced by incorporation of HBP and in fact the lowest livability was shown at 5% level during the experiment course. The results indicated that cooking served as an effective technique for processing of HBP waste and might destroyed almost pathogenic microbes. Chrappa *et al.* (1986) Shahriar *et al.* (2008) and Sathishkumar and Prabakara (2008) also observed that mortality was not affected by feeding hatchery waste up to 4 percent level.

Body weight change was not significantly affected by different dietary levels of HBP. This indicates that HBP up to 10% in laying hen diets supported egg production traits while maintain body weight gain during early part of laying period (25-41 wk of age).

Quality of fresh eggs:

Table (3) shows the effect of different dietary levels of HBP on the quality of fresh eggs of laying hens from 25 to 41 wk of age. Level of 10% HBP significantly decreased shell thickness, Haugh unit score and yolk index of fresh eggs compared to the control level and 5 and 5% respectively. Meanwhile, yolk color was not significantly affected by different dietary HBP Levels. Yolk Height and yolk width were significantly decreased of group fed 5% HBP compared to 10 and 0% HBP, respectively.

The decreases in egg quality especially shell thickness and Haugh unit score at 10% may be due to high fats and unsaturated fatty acid in HBP diets. High unsaturated fatty acids interfere with calcium availability and are subjected to lipid pre oxidation and oxidative rancidity (Atteh and Leeson, 1985; Attia *et al.*, 2009).

Quality of stored eggs:

Table (3) shows the effect of different dietary levels of HBP on stored egg quality traits of laying hens from 25 to 41 wk of age. A level of 5% HBP significantly maintained better shell thickness during the storage period compared to the other levels and yolk color than only the control level. Meanwhile, a level of 10% HBP significantly increased yolk height and yolk width compared to 5% level, while significantly decreased yolk index and Haugh unit score compared to only the control group. The decreases in egg quality of sorted especially shell thickness and Haugh unit score at 10% coincided with the decrease observed in fresh eggs. As mentioned above this may be due to high fats and unsaturated fatty acid in eggs and the subject of unsaturated to lipid pre oxidation and oxidative rancidity (Grashorn, 1994; Danicke *et al.*, 2000; Attia *et al.*, 2009). The results indicated that HBP had no negative effect on quality of fresh and stored eggs since values for egg quality are in acceptable range of commercial values.

Body organs and leg color:

Table (4) shows the effect of different dietary levels of HBP on inner body organs and leg color of 41 wk old laying hens. There were no significant effect of HBP on percent liver and leg color. The latter agreed with the results of yolk color (Table 3). Percent blood significantly decreased due to included 5 and 10% HBP. However, percent intestinal, intestinal length, percent oviduct and percent ovary were significantly increased due to inclusion of 5% HBP compared to 10% HBP. Meanwhile, 10% HBP did not affect percent intestinal and oviduct compared to the control group and while yielded the highest productive performance (Table 2). In addition, intestinal length and percent oviduct was higher of the control than those fed 10% HBP. Similarly, Shahriar *et al.* (2008) reported that hatchery waste induced significant changes in body composition and abdominal fat of broiler chickens.

Total lipids and cholesterol in plasma and yolk:

Table (5) shows the effect of different dietary levels of HBP on blood and yolk total lipids and cholesterol of 41 wk old hens.

Plasma and yolk total lipids and cholesterol was significantly higher of laying hens fed 0 and 5% HBP compared to 10% HBP. The decrease in plasma lipids and cholesterol of hens fed 10% HBP could be attributed to increasing the intake of unsaturated fatty acids. Similar results were reported by Grashorn (1994) and Attia *et al.* (2009). On the other hand, Shahriar *et* al. (2008) reported that hatchery waste at 6 and 8% significantly decreased serum triglyceride while increased serum cholesterol.

Conclusion and application:

The results obtained in the present study indicated that 10% HBP in laying hens diets had no adverse effect on productive performance and egg quality traits and lipid metabolism while contributes to decrease environmental pollution.

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Table 1. Composition of the experimental diets containing different levels of hatchery by-product

Ingredients	Hatchery by-product, %		
	0.0	5.0	10.0
Yellow corn	63.50	62.35	58.90
Soybean meal, 44%	28.00	24.12	20.50
Di – Cal phosphate	1.00	1.00	1.00
Limestone	6.50	5.0	3.6
Dl – Methionine	0.20	0.19	0.19
Salt	0.30	0.30	0.30
Lysine	0.00	0.04	0.09
Premix	0.30	0.30	0.30
Anti – oxidant	0.10	0.10	0.10
Anti – aflatoxine	0.10	0.10	0.10
Hatchery by- product	0.00	5.00	10.00
Filler	0.00	1.70	5.12
Total	100.0	100.0	100.0
Calculated analysis			
CP, %	17.8	17.8	17.8
ME, k.cal/ kg	2760	2776	2722
Ca, %	2.90	2.90	2.90
Avail. P., %	0.31	0.33	0.36
Methionine,%	0.49	0.48	0.49
TSAA	0.79	0.79	0.80
Lysine, %	0.92	0.92	0.92

[1]Premix provide per kg of diet: 1800 µg retinol acetate, 10 mg of DL-alpha-tocopherol acetate, 2.5 mg menadione sodium bisulphate, 50 µg cholecalciferol, 2.5 mg riboflavin, 10 mg Ca-D- pantothenate, 12 mg nicotinic acid, 300 mg choline chloride, 4 µg cyanocobalamin, 5 mg pyridoxine hydrochloride, 3 mg thiamine mononitrate, 0.5 mg folic acid, 0.2 mg D-biotin, Trace mineral (milligrams per kilogram of diet): 40 Mn, 40 Zn, 40 Fe, 4 Cu, 0.02 Se, 0.5 iodine.

Table 2. Production performance ± SE pullets fed different levels of hatchery by-product from 25-41 wk of age

Hatchery by –product, %	EW, g	Laying rate,%	EM, g/d	FCR, g/g	Feed intake, g/hen	Livability, %	Body weight change, g
0	56.7± 1.26	79.3± 3.13	45.0^{ab}±1.30	2.34^{ab}± 0.07	105.2± 1.9	92.6± 3.70	99.3± 63.8
5	55.70± 1.57	76.1± 2.73	42.4^{b}± 1.61	2.50^{a}± 0.08	105.9± 2.3	85.2± 7.40	87.3± 45.6
10	57.60± 1.64	82.0± 2.73	47.2^{a}± 2.12	2.25^{b}± 0.09	106.5± 3.5	96.3± 3.70	90.5± 42.8
Probability	NS	NS	**	**	NS	NS	NS

HBP =Hatchery by-product

Table 3. Quality of fresh and stored eggs ± SE from laying hens fed different levels of hatchery by-product from 25 to 41 wk of age

Hatchery by -product, %	Shell thick (mm)	Haugh units	Yolk color	Yolk height	Yolk width	Yolk index
Quality of fresh eggs						
0	0.342^{a}± 0.009	94.3^{a}± 1.91	4.45±018	4.91^{ab}± 0.12	3.20^{a}± 0.062	65.2^{a}± 3.23
5	0.338^{ab}± 0.008	95.1^{a}± 1.93	4.50± 0.21	4.71^{b}± 0.10	3.06^{b}± 0.021	65.0^{a}± 2.53
10	0.332^{b}± 0.010	91.0^{b}± 1.76	4.20± 0.15	5.26^{a}± 0.21	3.18^{ab}±0.026	60.3^{b}± 3.12
Probability	*	*	NS	**	**	**
Quality of stored eggs						
0	0.316^{b}± 0.008	81.0^{a}± 1.6	3.05^{b}± 0.22	3.59^{ab}± 0.99	3.59^{ab}± 0.27	124^{a}± 4.75
5	0.342^{a}± 0.001	78.8^{ab}± 1.3	3.40^{a}± 0.23	3.44^{b}± 0.85	3.44^{b}±0.95	121^{ab}± 3.81
10	0.316^{b}± 0.75	75.3^{b}± 1.2	3.20^{ab}± 0.35	3.73^{a}± 0.63	3.73^{a}± 1.06	118^{b}± 5.31
Probability	NS	*	**	*	**	**

HBP =Hatchery by-product

Table 4. Body organs (%) ± SE of laying hens fed different levels of different levels of hatchery by-product from 25 to 41 wk of age

HBP, %	Blood, %	Intestinal, %	Intestinal Length, cm	Oviduct, %	Ovary, %	Liver, %	Leg color
0	$6.82^{a} \pm 0.72$	$4.46^{b} \pm 0.28$	$143.0^{a} \pm 1.53$	$3.37^{a} \pm 0.28$	$2.88^{b} \pm 0.43$	2.00 ± 0.27	1.65 ± 0.29
5	$4.50^{b} \pm 0.54$	$5.21^{a} \pm 0.34$	$142.7^{a} \pm 0.92$	$3.42^{a} \pm 0.39$	$3.24^{a} \pm 0.32$	2.14 ± 0.16	2.00 ± 0.00
10	$4.13^{b} \pm 0.12$	$4.21^{b} \pm 0.12$	$138.0^{b} \pm 0.97$	$3.05^{b} \pm 0.28$	$2.81^{b} \pm 0.28$	1.79 ± 0.01	1.33 ± 0.21
Probability	**	**	**	*	**	NS	NS

HBP =Hatchery by-product

Table 5. Plasma and yolk total lipids and cholesterol ± SE of laying hens fed different levels of hatchery by-product different from 25 to 41 wk of age

HBP,%	Plasma		Yolk	
	Total lipids g/100ml	Cholesterol g/100ml	Total lipids mg/g	Cholesterol mg/g
0	$2.12^{a} \pm 0.01$	$148.9^{a} \pm 1.4$	$348.5^{a} \pm 11.0$	$14.15^{a} \pm 0.44$
5	$2.09^{a} \pm 0.02$	$147.7^{a} \pm 3.54$	$328.9^{a} \pm 10.8$	$13.66^{a} \pm 1.08$
10	$1.12^{b} \pm 0.02$	$111.8^{b} \pm 1.05$	$240.6^{b} \pm 10.4$	$7.76^{b} \pm 1.12$
Probability	**	**	**	**

HBP =Hatchery by-product

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الملخص العربي

التقييم الغذائي لمخلفات التفريخ في علائق الدجاج البياض

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اجري التحليل الكيماوي و تم اجراء تجربة تغذية للمخلفات التفريخ باستخدام ثلاث مستويات من المخلف المطبخ و المجفف علي درجة ٥٥ درجة منوية هي صفر و ٥ و ١٠% في علائق الدجاج البياض في الفترة من ٢٥-٤١ اسبوع من العمر و ذلك باستخدام ثلاث مكرارت بكل منها ثمانية دجاجات بياضة باجمالي ٧٢ دجاجة بياضة في تصميم الخط المستقيم و ذلك لتقييم مخلفات التفريخ كمصدر للبروتين في علائق الداجاج البياض.

أظهرت النتائج إن مخلف التفريخ المجفف يحتوي علي ٣٦,٥% بروتين و ٢٨,٥% دهن خام و ١,٢% الياف خام و ٢٧% رماد و ١٨% كالسيوم و ٠,٧٥% فسفور متاح و ٢٨٥٠ كليو كالوري طاقة ممثلة/كجم مخلف و اوضح النتائج ان استخدام المخلف حتي نسبة ١٠% في علائق الدجاج البياض التجاري لم يؤثر سالبيا علي انتاج البيض و وزن البيض و كتلة البيض و الاستهلاك الغذائي و الكفاءة التحويلية للغذاء و معدلات النفوق و كذلك جودة البيض الطازج و المخزن لمدة لشهر في التلاجة و لم يتاثر ايضا النسبة المئوية لوزن الاعضاء الداخلية و الاعضاء التناسيلة بينما انخفضت نسبة الدهن الكلي و الكلسترول في بلازما الدم و صفار البيض معنويا عند استخدام ١٠% من مخلفات التفريخ في علائق الداج البياض.

وخلاصة القول انه يمكن استخدام مخلفات التفريخ حتي ١٠% في علائق الدجاج البياض دون تأثير سالبي علي الصفات الانتاجية و جودة البيض الطازج و المخزن لمدة لشهر في التلاجة و الاعضاء الداخلية و الاعضاء التناسيلة بينما انخفضت نسبة الدهن الكلي و الكلسترول في بلازما الدم و صفار البيض معنويا عند استخدام ١٠% من مخلفات التفريخ في علائق الداج البياض مما يقلل التلوث البيئي.