EFFECT OF AUTOCLAVING, TOASTING, AND COOKING ON CHEMICAL COMPOSITION OF HATCHERY WASTE MEAL

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ABSTRACT

The study was conducted to compare the effect of autoclaving, toasting and cooking processes on raw hatchery waste with shell and without shell. Average crude protein contents of hatchery waste meal (with shell) were 18.17% due to cooking and 16.83% due to toasting. Crude fibre contents were the lowest under cooking process. Crude fat contents were reduced to 11.44% by autoclaving. Total ash contents were increased substantially during all treatments. Calcium contents were reduced to 20% due to autoclaving. Nitrogen Free Extract (NFE) contents and metabalizable energy contents were significantly modified. Average crude protein contents of hatchery waste meal (without shell) and crude fat contents were significantly increased ($P<0.01$) under respective processes. Total ash contents were reduced due to removal of egg shell. Calcium and phosphorus contents were also reduced significantly due to removal of eggshell. NFE contents were markedly reduced when there were no eggshell. Energy contents were significantly increased when there were no eggshell. Overall, results of hatchery waste without shell were better than with shell. However, hatchery waste meal with shell is rich source of calcium. Within processing, there were non-significant differences for all nutrients with no Salmonella and *E. coli*. Average acid values of cooked hatchery waste meal were increased significantly ($P<0.01$) from 3.04 to 7.88 after 9 months of storage. Amino acid profile of unprocessed hatchery waste (with shell), cooked processed waste with and without shell revealed sufficient quantity of all essential amino acids, particularly cooked processed hatchery waste (without shell) contained the higher levels of lysine and methionine.

Key Words: Hatchery waste, autoclaving, toasting, cooking, meal, chemical composition.

INTRODUCTION

Hatchery waste, one of the important wastes of Pouyltry industry which at the moment is being wasted and polluting the environment. It includes infertile eggs, dead embryos in shell, shell of hatched eggs and low grade unsalable chicks. An average amount of egg incubation wastes is estimated to be 16.2 gm per egg set for incubation (Ristic and Kormanjos, 1988). In Pakistan, total numbers of hatcheries in 1999-2000 were 150, out of which 106 are belonged to Punjab, 40 Sind and 4 NWFP, while there is no hatchery unit in Balochistan (Ministry of Food, Agriculture and Livestock, 1999-2000). Directorate of Poultry Research Institutte, Rawalapindi (1999-2000) also compiled information at Punab level. During this period, the number of eggs set were 250.978 million, so there was availability of 4.482 thousand tons of hatchery waste. Maximum number of hatcheries were reported in District Rawalpindi, i.e., 32, so there was about 1.547 thousand tons hatchery waste produced. The main source of hatchery waste was broiler chick hatcheries which provided 3.687 thousand tons raw hatchery material.

Raw hatchery waste can be converted into useful feed by different processing techniques such as cooking with water, dehydration, toasting, autoclaving, rendering, fermentation, irradiation and extrusion. Hatchery waste cooked with water has been shown to be of high quality ingredient for broiler and layer diets and process was found to be an efficient and economical (Ilian and Salman, 1986). Verma and Rao (1974) reported that hatchery waste when was autoclaved then dried at 100 °C for 10 hr, the resulting hatchery waste meal served as good source of protein and other nutrients and this could be used in Poultry feeding as a part or complete replacement of fishmeal. Tadtiyanant *et al.* (1993) reported that high temperature short time extrusion was alternative method of converting it into useful feedstuff, which is free of aerobic micro-organisms. Rasool *et al.* (1999) applied toasting process to hatchery waste and prepared ideal waste meal with considerable amount of nutrients besides being free of aerobic organisms.

Hatchery by-product meal has a crude protein content of 13.09% (Froning and Bergguist, (1990) which may be increased to 42.26% by excluding shell (Kundu *et al.*, 1986) and was also reported that the hatchery waste meal was a good protein source with

high calcium and fat contents, i.e., 23.96 and 42.15%, respectively.

A comparative study was thus planned to prepare a dry and stable product from raw hatchery waste by cooking, toasting and autoclaving process and then determine its nutritive value by chemical method.

MATERIALS AND METHODS

Raw hatchery waste consisting of infertile eggs, dead chicks in shell and shells of the hatched eggs, were collected from hatchery of Breeding and Incubation section at Poultry Research Institute, Rawalpindi. All residues from the three hatching trays after removal of normal chicks was utilized. Physical characteristics of waste were recorded like, whole eggs (un hatched), dead and culled chicks, broken eggs including pips, hatch percent, weight of waste and also moisture percantage. Raw hatchery waste was divided into two groups, i.e., with shell and without shell and processed the material by following methods.

Autoclaving Process

Raw hatchery waste was cooked under 15 PSI pressure at 135 °C for 15 minutes and then heated to dryness in oven at 65 °C. for 24 hr.

Toasting Process

Raw hatchery waste was cooked to dryness in hot air oven at 150 °C temp for 15 minutes then dried at 65 °C for 24 hr.

Cooking Process

The waste was cooked with water at 2:1 ratio for 15 minutes and then oven dried at 65 °C for 24 hr. All pre-and-post processed hatchery waste samples were analyzed in laboratory chemically for proximate constituents, including minerals (AOAC, 1990) gross energy (Herris, 1970) and amino acid profile (Moore and Stein, 1954). Chemical score of hatchery waste meal was also calculated (FAO/WHO, 1957). After determining the gross energy contents of hatchery waste meal, metabolizeable energy (ME) was calculated by following the prediction equation (NRC, 1994). For determining the amino acid profile of representative samples of un-processed hatchery waste with shell, cooked hatchery waste with shell and cooked hatchery waste without shell were only analyzed. Pre-and-post processed hatchery waste samples were also analyzed for identification of pathogens (Collee *et al.*, 1989). For this purpose, raw and processed hatchery waste samples were sent to disease section of Poultry Institute, Rawalpindi. Hatchery waste meal (containing rich source of fat) was also analyzed for free fatty acid values to determine rancidity at different storage periods (AOAC, 1990). For this purpose, cooked hatchery waste meal was stored for 9 months and acid values analyzed at one month interval. The data thus collected were subjrected to statistical analysis using analysis of variance technique and the significance of means were compared using Duncan's Multiple Range Test (Steel and Torrie, 1982).

RESULTS AND DISCUSSION

The physical characteristics of hatchery waste were 25-30 whole eggs (unhatched) per tray, 10-15 dead & culled chicks per tray, 13-19 broken eggs, includes pips per tray, 65-70% hatchibility, 8.748 Kg/3 trays of hatchery waste, and 45% moisture. There were 180 eggs set in each hatch tray.

Microbiological Test

Bacterial examination revealed the presence of *E. coli* and Salmonella (Arizona) in un-processed hatchery waste. However, no microorganisms were observed in any of the processed (autoclaved, toasted and cooked) hatchery waste meal. Results obtained in this study agreed with those of Rasool *et al.* (1999). Similarly Miller (1984), Tadtiyanant *et al.* (1990) and Dhaliwal *et al.* (1998) also reported that microbial screening of the extruded processed meal did not reveal any bacterial count.

Chemical Composition of Hatchery Waste

Chemical composition of raw and processed hatchery waste (with egg shell) is shown in Table 1. The result indicates that crude protein contents of un-processed hatchery waste was significantly ($P<0.01$) high, i.e., 20.1% than any other processed meal prepared, such as 17, 16.83 and 18.17% in autoclaved, toasted, and cooked hatchery waste, respectively. It may be due to some protein having been denatured at high temperature with time during processing. Ristic and Kormanjos (1988) reported 22.4% CP in autoclaved hatchery waste meal and Ilain and Salman (1986) also reported 22.8% CP in cooked hatchery waste meal. Above reported CP contents are somewhat higher than our study, while Froning and Bergguist (1990) and Millar (1984) reported 13.09% CP, respectively in extruded egg shell hatchery waste, which is lower than our study. It indicates that there are some factors that affect the crude protein contents, i.e., proportion of egg shells, processing technique particularly temperature and treatment period, etc.

Crude fat contents in un-processed hatchery waste meal (16.30%) were significantly ($P>0.01$) higher than

any other processed hatchery meal (14.50, 12.13 and 11.44% in cooked, toasted and autoclaved meal, respectively). The reason may be the loss of volatile fatty acids as well as some other fat lost by melting during process. Fat contents of the cooked meal in this study (14.50%) was close to the reported 14.4% in cooked meal by Ilian and Salman (1986). However, the autoclaved egg shell hatchery waste meal by Ristic and Kormanjos (1988) and extruded eggs shell waste meal by Froning and Bergguist (1990) contained much lower contents of fat (3.7 and 0.7%, respectively) due to presence of high shell content as well as some loss of fat during process.

Table 1: Effects of Autoclaving, Toasting and Cooking Processing on Composition of Hatchery Raw Material (With Egg Shell).

Section	Mean Values in %age			
	Un-processed	Autoclaved Meal	Toasted Meal	Cooked Meal
Crude Protein	20.1^{a}	17^{b}	16.83^{b}	18.17^{b}
Crude Protein	0.96a	0.95ab	0.92^{bcd}	0.89^{c}
Crude Fat	16.30^{a}	11.44^{b}	12.13^{bc}	14.50^{d}
Total ash	49.17^{a}	54.67^{b}	54.50^{bc}	53.00^{bcd}
N.F.E.	13.41	15.94	16.15	13.44
Calcium	24^{a}	20^{b}	22.03^{abc}	23.10^{acd}
Phosphorus	3.02^{a}	2.55^{bc}	2.85^{b}	2.23^{cd}
Sodium	1.01^{a}	0.920^{b}	0.917^{b}	0.99^{a}
Potassium	0.65^{a}	0.49^{b}	0.51^{b}	0.52^{b}
Netabdize-able Eneagy (Kcal).	1994a	1670b	1714bc	1823^{cd}

a,b,c,d: Different superscripts on mean in rows show significant (P<0.01) difference.

Total ash contents of un-processed hatchery waste (49.17%) were significantly (P<0.01) lower than any processed meal (54.67, 54.50 and 53.0% in autoclaved, toasting and cooked meal, respectively). The reason may be the loss of other nutrients like protein, fat etc, during processing, ultimately percentage wise ash contents might have increased on dry matter basis. The result of this study are close to ash contents of 53.4% of autoclaved meal obtained by Ristic and Kormanjos (1988). However, Tacon (1982) and El-Alaily and Attia (1978) reported high ash contents (86.8 and 59.43%, respectively) due to high shell contents in cooked meal.

Overall results of Table 1 showed that due to presence of high shell contents, such type of meal can be used in the layer rations to fulfil the mineral requirements with reasonable amount of crude protein and other nutrients.

Chemical composition of raw and processed hatchery waste (without egg shell) is shown in Table 2.

The trend of effect of processing on crude protein and crude fat contents is similar as discussed regarding processing with shell. However, due to absence of egg shell, total ash contents in all hatchery meals showed non significant difference. The average vlaue of protein content of processed hatchery meal (without shell) was 45.47%. The protein content in this study is closely related to protein values (42.26% and 44.25%) of cooked hatchery waste meals prepared by Kundu *et al.* 91986) and Rasool *et al.* (1999), respectively. While, Dhaliwal *et al.* (1998) reported 54.59% crude protein of extruded hatchery waste meals. The reason is that they mixed hatchery waste with soybean flakes (40:60) then it was extruded, so due to which extruded product had high protein contents.

Table 2: Effects of Autoclaving, Toasting and Cooking Processings on Composition of Hatchery Raw Material (Without Shell).

Section	Mean Values in %age			
	Un-processed	Autoclav-ed Meal	Toasted Meal	Cooked Meal
Crude Protein	47.17^{a}	45.40^{b}	45.25b	45.77^{b}
Crude Protein	1.0^{a}	0.98^{ab}	0.93^{bc}	0.90^{cd}
Crude Fat	18^{a}	15.10^{b}	15.03^{b}	15.50^{b}
Total ash	32.25	33.33	33.77	33.17
N.F.E.	1.58^{a}	5.19^{b}	5.02^{b}	4.66^{b}
Calcium	9.0	8.50	8.83	9.07
Phosphorus	2.25	2.20	2.21	2.22
Sodium	1.07	1.17	0.99	1.03
Potassium	0.90	0.85	0.91	0.82
Netabdize-able Eneagy (Kcal).	2888a	2737b	2721b	2750b

a,b,c,d: Different superscripts on mean in rows show significant (P<0.01) difference.

Crude fat and energy contents in processed hatchery waste meal (without shell) were comparatively better than hatchery waste (with shell). Average values of crude fat and energy contents of processed hatchery waste meal (without shell) were 15.21% and 2736 Kcal/Kg, respectively. Similar results were shown in the study of Ilian & Salman (1986) and they reported that cooked hatchery waste contained 2706 Kcal/Kg M.E and 14.4% crude fat.

Acid values of hatchery waste meal as effected by storage period is shown in Table 3. Acid value of cooked hatchery waste increased significantly (P<0.01) after each month at ambient temperature. Similar results were reported by Ponomareva (1983), who stored fish feeds at ambient temperature of 20 - 22 °C or 4 - 6 °C. Feed stored at high temperature deteriorated rapidly. In another study, Trebusiewiez *et al.* (1980) reported high acid value of broiler starter and finisher feed (containing 4% fat) when stored at 16 °C for 3 months. The acid value increased from 8.66 to 21.99 in starter and to 26.38 in finisher feed. These high values are due to fat with poly-unsaturated faty acids which are highly

sensitive towards oxidation during storage as compared to hatchery waste contained saturated fatty acids.

Table 3: Mean Acid Values of Hatchery Waste Meals Effected by Storage Period.

Months of Forage	Temperature (C^0)	Mean Acid Values
October, 1998	27	3.04
November, 1998	19	3.62
December, 1998	16	4.21
January, 1999	14	4.38
February, 1999	20	4.95
March, 1999	22	5.19
April, 1999	30	5.96
May, 1999	35	6.12
June, 1999	38	7.88

Amino acid profile (Table 4) revealed that sufficient quantity of almost all amino acids (essential amino acids) were present in all hatchery waste meal. Profile shows that cooked processed hatchery waste (without shell) also contains valine, while it was not present in hatchery waste meal (with shell). Similar results were obtained by Vandepapulier *et al.* (1977). They analyzed the two types of hatchery waste, i.e., broiler and egg type chick hatchery waste. Chemical score of the hatchery waste meal (Table 5) was 4.66, 3.02 and 12.04 of un-processed hatchery waste (withshell), cooked processed hatchery waste (with shell) and cooked processed hatchery waste (without shell), respectively. Lysine was the Ist limiting amino acid. There may be two reasons that digestion of protein in the method is not always complete so certain amino acids such as lysine may not be fully available. Second is that toasting can also degrade protein quality unless carefully controlled so lysine may be tied-up by Maillard (browning) reactions, in which free amino groups react with sugars to produce undigestible brown polymers (Cheeks, 1991).

Table 4: Amino Acid Profile (G/100 Gm) of Hatchery Waste Meal (Hwm).

Amino Acids.	Unproces-sed HWM with shells	Processed HWM with shells	Processed HWM without shells
Aspartic acid	3.96	2.81	12.09
Serine	1.63	1.089	5.056
Glutamic acid	4.84	3.429	15.58
Glycine	4.15	3.190	1.36
Alanine	0.139	0.067	0.3905
Cysteine	0.1215	0.994	4.22
Methionine	1.43	0.994	4.22
Isoleucine	2.668	1.90	8.00
Phenylalnine	0.457	0.299	1.127
Tyrasine	0.4856	0.358	1.9169
Lysine	0.1968	0.127	0.5068
Arginine	0.1899	0.129	0.2042
Valine	–	–	0.8657
C. P (%)	20.5	18.6	46

In may be inferred from the results of the present study that:

i Cooking process is simple, economical and more feasible at farm level by which high quality and pathogen free animal protein feed can be prepared.

ii Processed hatchery waste meal (without shell) is rich in protein and essential amino acids pattern as compared to processed hatchery waste meal with shell.

iii Processed hatchery waste (with shell) is rich in minerals particularly calcium and

iv Processed hatchery waste meal is a good source of energy.

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Table 5: Chemical Score of Hatchery Waste Meal Using Fao (1957) Amino Acid Pattern.

Amino Acids	FAO Amino Acid Pattern (mg/gm)	Un-processed HWM (mg/gm)	Available amino acid (%)	Processed HWM with shel (mg/gm)	Available amino acid (%)	Processed HWM without shell (mg/gm)	Available amino acid (%)
Phenylalanine	28	4.37	15.60	2.99	10.68	11.27	40.25
Leucine	48	-	-	-	-	-	-
Valine	42	-	-	-	-	8.65	20.59
Lysine	42	1.96	4.66	1.27	3.02	5.06	12.04
Methionine	22	4.30	19.54	9.93	45.0	42.0	19.0
Isoleucine	42	26.6	63.33	19.0	45.0	80.0	19.0

The chemical score of Hatchery waste Meal protein is 4.66, 3.02 & 12.04, respectively & it is limiting in lysine.

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