Preparation and Nutritional Evaluation of Hatchery Waste Meal for Broilers

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ABSTRACT : Hatchery waste including infertile eggs, dead embryos in shell, dead or low grade chicks was cooked at 100℃ for 15 minutes and then oven dried and ground. Hatchery waste meal (HWM) thus prepared contained 44.25% protein, 4,573 kcal/kg gross energy, 3,600 kcal/kg metabolizable energy, 30% ether extract, 1.9% fibre, 14% ash, 9.8% nitrogen free extract, 7.26% Ca, 0.84%P, 1.86% lysine and 0.66% methionine with no *Salmonella* and *E. coli*. In biological evaluation trial, significantly higher weight gain was observed in ration containing 12% HWM compared with that containing similar amount of fish meal. Protein efficiency ratio on the two rations was 3.96 vs 2.85; protein digestibility, 86.02 vs 71.9; net protein utilization, 64.9 vs 42.37 and biological value, 75.37 vs 58.84, respectively, indicating better balance of amino acids in HWM compared with fish meal. Growth performance trial on broiler chicks also revealed better weight gain and feed efficiency on ration containing 12% HWM than that containing similar level of fish meal. *(Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 4 : 554-557)*

Key Words : Hatchery Waste Meal, Broilers, Nutritional Value

INTRODUCTION

One of the important waste of poultry industry which at the moment is being wasted and polluting the environment is hatchery waste originating from chick hatcheries. An average amount of hatchery waste production is estimated as 16.2 g/egg set for incubation (Ristic and Kormanjos, 1988). It normally includes shells from hatched chicks, infertile eggs, dead embryos in the shell and dead or low grade chicks. These can be changed into useful feed by cooking, drying and grinding (Gohl, 1975). Processed hatchery waste may be a good source of energy, protein and has considerable amount of fat (Reddy, 1988) and calcium with low phosphorous (Dufloth et al., 1987).

Different processing techniques for making meal from hatchery waste include dehydration, cooking with water, toasting, autoclaving, rendering, fermentation, irradiation and extrusion. Hatchery waste processed through a triple pass dehydrator has been shown to be of high quality ingredient for laying hen's feed (Vandepopuliere et al., 1977). Tadiyanant et al. (1993) reported that high temperature-short time extrusion was alternative method of converting it into useful feed stuff which is free of aerobic micro-organisms. Ilian and Salman (1986) however, reported that cooking the waste in water at a ratio of 2 and 1 was an efficient and economical method.

This study was conducted to prepare a dry and stable product from hatchery waste by cooking without water and then evaluating its nutritive value through chemical, biological and broiler performance trial.

MATERIALS AND METHODS

Raw hatchery waste, which comprised of candled infertile eggs, dead chicks in shell and shells of the hatched eggs, was collected from a hatchery immediately after the removal of hatch. It was then toasted, at 100℃ for 15 minutes with regular stirring in an open container without the addition of water. After toasting the material was sun-dried for 24 hours and ground. A representative sample of the hatchery waste meal (HWM) was subjected to proximate analysis, calcium and phosphorus content (AOAC, 1990), gross energy (Herris, 1970), total viable bacterial counts and identification of pathogens (Collee et al, 1989).

Biological evaluation of the HWM was done with broiler chicks to determine its protein quality. In this trial 0, 25, 50, 75 or 100% of the fish meal component of the broiler ration was replaced with HWM on protein equivalent basis. Six iso-nitrogenous (at 23% protein) and a nitrogen free ration were formulated with similar (3,000 kcal/kg) energy content (table 1). Ration A supplying total protein from boiled and dried egg albumen served as control, while ration B, without protein, was fed to the birds to determine endogenous nitrogen loss. Rations C, D, E, F and G had 0, 25, 50, 75 or 100 % of the fish meal replaced with HWM on protein equivalent basis.

Thirty five, 7 days old broiler chicks of mixed sexes with uniform weights were kept individually in separate cages. The above mentioned seven rations were randomly assigned to these birds in such a way that 5 birds were kept on each ration. The birds were fed allotted rations *ad libitum* along with fresh and clean water round the clock. Droppings of individual bird were collected every 24 hr and weighed. A representative sample was deep frozen for nitrogen analysis at the end of the 10 days metabolism trial. Record of weight gain, feed intake and faeces voided were maintained. After the 10 day experimental period, all the chicks were killed in a glass desiccator saturated with chloroform vapours. After opening their abdominal cavities, the carcass were oven dried, weighed and finally ground for nitrogen determination. With the help of the above chemical analysis, feed:gain ratio, protein

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Table 1. Ingredient and nutrient composition of rations used in metabolism trial

Ingredients	RATIONS						
	A	B	C	D	E	F	G
Fish meal	-	-	-	11.40	22.80	34.21	45.62
Hatchery waste meal	-	-	51.50	39.00	26.00	13.02	-
Egg albumen	29.07	-	-	-	-	-	-
Corn starch	49.35	83.13	28.81	29.93	35.70	39.34	42.76
Corn oil	-	0.17	0.77	1.30	2.20	2.80	3.00
Molasses	3.00	-	2.23	0.80	0.80	-	-
L-Lysine · HCl	-	-	0.14	-	-	-	-
DL-Methionine	-	-	0.14	0.01	-	-	-
Wheat straw (ground)	14.58	12.50	11.71	14.47	9.70	10.13	5.62
Lime stone	1.20	1.20	-	-	-	-	-
Dicalcium Phosphate	2.30	2.50	-	-	-	-	-
NaH_2PO_4	-	-	4.20	2.50	2.30	-	-
Vit. Min Premix*	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100	100	100
Nutrients							
Crude protein (%)	23	-	23	23	23	23	23
M.E. (kcal/kg)	3,030	3,030	3,029	3,031	3,031	3,028	3,027
Crude fibre (%)	6.00	5.19	5.83	5.72	4.95	5.13	4.20
Calcium (%)	1.00	1.03	3.74	3.07	2.36	1.65	1.89
Phosphorus (%)	0.45	0.45	1.27	1.06	1.14	0.799	0.92
Lysine (%)	1.50	-	1.10	1.10	1.30	1.40	1.60
Methionine (%)	0.9	-	0.50	0.50	0.50	0.50	0.50

* Vit. Min. Premix Per 100 g ration contained: Vit.A 880 IU, D_3 220 IU, E 5 mg, K 0.2 mg, Thiamine 300 mg, Riboflavin 1 mg, Biotin 22 mg, Folic acid 100 ug, Pyridoxin 1 mg, Niacin 5 mg, Calcium pantothenate 3 mg, Cynocobalamine 2 ug, Choline chloride 0.15 g and Minerals; $K_2H_2PO_4$ 1.61 g, $MgSO_4 \cdot 7H_2O$ 0.51 g, $MnSO_4 \cdot 4H_2O$ 0.25 g, NaCl 0.837 g, Fe-citrate-$5H_2O$ 0.137g, KI 0.004 g, $ZnCl_2$ 1.5 mg, $CuSO_4 \cdot 5H_2O$ 1.5 mg, $Ca(H_2PO_4)$ 2 2.5 g and $CaCO_3$ 2.00 g.

Table 2. Ingredient and nutrient composition of broiler rations used in feeding trial

Ingredient	RATIONS				
	A	B	C	D	E
Corn	47.70	33.78	26.49	18.97	12.26
Wheat	11.10	20.00	28.00	37.60	43.65
Wheat bran	4.00	4.00	4.10	4.25	4.00
Corn gluten 60%	5.00	5.00	4.25	3.00	3.25
Sunflower meal	4.00	4.00	4.00	4.00	4.00
Cotton seed meal	8.00	8.00	8.00	8.00	8.00
Rape seed meal	4.00	4.00	4.00	4.00	4.00
Hatchery waste meal	-	3.00	6.00	9.00	12.00
Fish meal	12.00	9.00	6.00	3.00	-
Blood meal	3.50	3.50	3.50	3.50	3.50
CaCO3	0.85	0.85	0.85	-	-
Dicalcium phosphate	-	-	0.40	0.55	1.22
Soy oil	2.65	2.65	2.10	1.75	1.65
Molasses	1.85	1.85	1.85	1.85	1.85
L-Lysine.HCl	-	-	0.10	0.11	0.16
DL-Methionine	0.045	0.07	0.095	0.12	0.15
Vit. Min. Mixture*	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100
Nutrients:					
Crude protein %	22.99	23.14	23.05	22.92	23.11
M.E. (Kcal/kg)	2,995	3,018	3,001	3,015	3,018
Crude fibre (%)	4.98	5.05	5.15	5.20	5.10
Calcium (%)	1.01	1.08	1.14	1.00	1.10
Phosphorus (%)	0.60	0.53	0.50	0.50	0.50
Lysine (%)	1.16	1.11	1.06	1.11	1.10
Methionine (%)	0.50	0.50	0.50	0.50	0.50

* Vit. Min. Premix Per 100 g ration contained: Vit.A 880 IU, D_3 220 IU, E 5 mg, K 0.2 mg, Thiamine 300 mg, Riboflavin 1 mg, Biotin 22 mg, Folic acid 100 ug, Pyridoxin 1 mg, Niacin 5 mg, Calcium pantothenate 3 mg, Cynocobalamine 2 ug, Choline chloride 0.15 g and Minerals; $K_2H_2PO_4$ 1.61 g, $MgSO_4 \cdot 7H_2O$ 0.51 g, $MnSO_4 \cdot 4H_2O$ 0.25 g, NaCl 0.837 g, Fe-citrate-$5H_2O$ 0.137 g, KI 0.004 g, $ZnCl_2$ 1.5 mg, $CuSO_4 \cdot 5H_2O$ 1.5 mg, $Ca(H_2PO_4)$ 2 2.5 g and $CaCO_3$ 2.00 g.

digestibility (PD), net protein utilization (NPU), biological value (BV) and protein efficiency ratio (PER) were worked out (Pellet and Young, 1980).

A feeding trial was also conducted to determine the optimum level of HWM inclusion, to replace fish meal, in the rations of the broilers. In five experimental broiler rations (A, B, C, D, and E), the level of fish meal was decreased successively from 12 to 9, 6, 3 or 0% of the ration, with simultaneous respective inclusion of 0, 3, 6, 9 or 12 per cent HWM (table 2). One hundred and fifty day-old Hubbard broiler chicks of mixed sexes were randomly divided into 15 experimental units of 10 chicks each. Each of the experimental ration was allotted randomly to three experimental units and fed for a period of four weeks. During this period the data on feed intake and weight gain were maintained and feed:gain ratio worked out.

The data collected were subjected to statistical analysis by using analysis of variance technique in completely randomised design (Mead et al., 1993) for interpretation of results.

RESULTS AND DISCUSSION

Chemical composition:

Chemical composition of the HWM is shown in table 3. Crude protein content of the HWM primarily depends upon the composition of the waste. The protein content of the meal prepared in this study was 44.25 % which was very close to that reported (42.26) by Kundu et al. (1986). However, the meals prepared by Ilian and Salman (1986) and Ristic and Kormanjos (1988) contained much lower contents of protein (about 22.5%) due to the presence of high shell proportions in the waste. The same was depicted in the ash content of their products which were 60.4 and 53.4% in respective studies, compared to 14% in the HWM prepared in this study.

Table 3. Chemical composition of the hatchery waste meal on DM basis

Description	HWM
Dry matter (%)	92.00
Crude protein (%)	44.25
Ether extract (%)	30.01
Crude fibre (%)	1.90
Ash (%)	14.04
Nitrogen free extract (%)	9.80
Gross energy (kcal/kg)	4,572
Metabolizable En.(kcal/kg)	3,600
Calcium (%)	7.26
Phosphorus (%)	0.84
Lysine (%)	1.86
Methionine (%)	0.657
Total viable Bacteria (# / gm)	950
E. Coli	Nil
Salmonella (# /gm)	Nil

The gross energy content of the HWM was 4,573 kcal/kg. Calculation of ME by prediction equation (NRC, 1994) indicated that it contained 3,600 kcal/kg ME. This value was far less than that reported by Verma and Rao (1974), which was 5,254 kcal/kg, but they used only infertile eggs and dead in shells which contain more proportion of yolk contents, rich in fat/energy. Ilian and Salman (1986) reported ME content of their product as 2,706 kcal/kg, which was lower than that of our HWM, but their product contained high proportion of ash.

Biological evaluation

The results of the metabolism trial have been summarised in table 4. Compared to the control and all other rations, average weight gain of the chicks was higher ($p<0.01$) on ration C containing 100 per replacement of fish meal with HWM. On the other hand, the feed consumption by the birds was highest on ration G containing maximum fish meal with no HWM, but the differences among all the rations were non-significant statistically. Feed:gain ratio followed a similar pattern.

Protein efficiency ratio (PER), calculated as gain in body weight per unit of protein intake and protein digestibility, calculated as nitrogen absorbed per unit of nitrogen intake were also highest on C and lowest on ration G. Both net protein utilization (NPU), nitrogen retained per unit of nitrogen intake, and biological value (BV), nitrogen retained per unit of absorbed, were highest on ration A, containing 100 per cent protein from egg albumen, and lowest on ration G. However, the differences between A and C rations in respect of PER, PD and NPU were non-significant statistically. The BV of the C ration was only next to A.

Overall results of the biological evaluation trial indicated that as the content of HWM decreased in the experimental rations with the corresponding increase in fish meal, BV, NPU and PD of the rations decreased. This indicated a better amino acid profile of the HWM compared to fish meal. Unknown growth factors in HWM (Wisman, 1964) might also be higher in HWM than fish meal. Presence of lower fibre and ash along with better processing of HWM might also be the reasons for the better quality of HWM compared with fish meal.

Feeding trial

The results of the 4 weeks feeding trial in terms of weight gain, feed consumption and feed gain:ratio have been summarised in table 5. The birds fed on ration containing complete replacement of fish meal with HWM gained the maximum weight with the best feed:gain ratio. However, the differences among different rations were statistically non-significant. Maximum feed consumption was, however, on ration A containing 12% fish meal with no HWM, but the differences among rations were again non-significant. Similar improvement in feed efficiency with progressive replacement of fish meal with HWM have been reported by Kundu et al.

Table 4. Results of the trial for biological evaluation of HWM

Description	Rations					
	A	C	D	E	F	G
Weight gain/chick (g)	160.23^{b}± 7.93	183.59^{a}±13.50	161.33^{b}± 7.91	151.14^{b}±11.25	149.19^{b}±13.75	151.18^{b}± 5.78
Feed consumption (g)	181.3±19.69	202.62±26.84	192.99±18.73	200.34±29.68	209.58±30.98	231.57±18.31
FCR (feed/gain)	1.13^{d}± 0.09	1.10^{d}± 0.07	1.20^{cd}± 0.14	1.32^{bc}± 0.01	1.40^{b}± 0.09	1.53^{a}± 0.07
PER (gain/protein)	3.87^{a}± 0.32	3.96^{a}± 0.24	3.66^{ab}± 0.45	3.31^{bc}± 0.26	3.12^{cd}± 0.21	2.85^{d}± 0.12
PD (%)	84.51^{a}± 5.32	86.02^{a}± 4.26	83.05^{ab}± 4.97	77.35^{bc}± 4.12	74.01^{c}± 5.22	71.90^{c}± 6.66
NPU (%)	68.35^{a}± 4.18	64.90^{ab}± 4.78	60.50^{b}± 3.19	52.50^{c}± 2.67	45.10^{d}± 4.36	42.37^{d}± 4.98
BV (%)	80.89^{a}± 1.02	75.37^{b}± 1.88	72.90^{b}± 1.98	67.88^{c}± 0.39	60.88^{d}± 2.89	8.84^{d}± 2.35

Different superscripts on mean values in a row represent significant ($p<0.01$) differences.

Table 5. Average weight gain, feed consumption and feed efficiency of broiler chicks during 4 weeks feeding trial on feeds containing different levels of HWM

Description	Rations				
	A	B	C	D	E
Weight gain/ chick (gm)	842.66±12.70	765.00±43.30	788.33±67.51	811.66±46.45	855.00±39.05
Feed consumption (gm)	1523.33±48.21	1440.33±57.71	1405.00±42.72	1474.66±63.79	1471.33±45.62
FCR (Feed/ gain)	1.803± 0.05	1.880± 0.06	1.787± 0.19	1.813± 0.06	1.720± 0.05

(1986). Reddy (1988) and Dhaliwal et al. (1996) have also indicated that HWM might be used in poultry feeding as a part or complete replacement of fish meal.

It may be inferred, from the results of the present study that a high quality and pathogen (*Salmonella* and *E. Coli*) free animal protein feed can be prepared by cooking hatchery waste at 100℃ for 15 minutes and then oven drying. HWM thus prepared not only contain fairly good amounts of protein, energy and calcium but its protein quality, measured in terms of PER, PD, NPU, BV, was also superior to fish meal. HWM prepared by dry cooking method can be used in poultry rations up to 12 per cent of the ration and can completely replace fish meal.

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