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Utilization of Hatchery by-products as Feed ingredients in Broiler Chicken Feed

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Abstract: *A study was carried out to investigate the effect of utilization of hatchery by products (unhatched egg, infertile egg and empty eggshell) as feed ingredients in broiler chicken diet. Infertile egg and unhatched egg were pretreated at 60^0C for 7 mins to eliminate salmonella and separated into egg liquid and eggshell. Egg liquid was recovered and dried at 60^0C to obtain the final moisture content 6 %. Dried egg flakes were grounded prior to addition as feed ingredients. The separated eggshell were mixed with empty eggshell, treated in boiling water for 30 min, and dried at 60^0C for 2 hrs. Eggshells were also grounded prior to adding in the diet. Based on the nutritional recommendation given by HUBBARD farm, three diets were formulated with the same level of metabolize energy and crude protein content. The control diet (feed A) consisted of 6% fishmeal in starter diets and 5% fishmeal in grower diet with supplementation of lysine and methionine. The second diet (feed B) consisted of dried egg replacing the half of the fishmeal and eggshell replacing half of limestone supplied with lysine and methionine. The third diets (feed C) consisted of dried egg replacing whole of fishmeal, eggshell in place of limestone without lysine and methionine supplement. The feeding experiments were conducted in three different groups of broiler chicks fed up to sixth weeks. Feed B was found to be significantly different ($P < 0.05$) in comparison to feed A and C after fourth week of feeding. The birds fed with feed B showed best result in terms of body weight gain and lowest feed conversion ratio and mortality rate.*

Keywords: hatchery by products, Infertile egg, unhatched egg , feed ingredients, Broiler feed

Introduction

Poultry feeding, in essence, comprises of meeting requirements with appropriate combination of feed ingredients and pure sources of limiting nutrients to yield an

economically and nutritionally balanced ratio (Combs, 1961). Feed represents approximately 70 percent of the total cost of producing poultry and egg. It is imperative that economical as well as nutritionally balanced diets should be provid during all phases of productive life in egger, chicks, grower and layer stages and in broiler starter and finisher stages. For this reason, in developing countries, providing economically and nutritionally balanced rations to poultry has continued to be a thorny problem. Careful evaluation and utilization of quality feed stuff would certainly enhance the performance of poultry in terms of products and health (Lal and Krishnan, 1993).

The major sources of protein used in animal feed are mainly cereal components and oilseed cake which provides energy as well as protein, but these are generally deficit in certain amino acids namely lysine, methionine and cysteine. Soybean meal, a major plant protein supplements is deficit in methionine but more than necessary quantities of lysine. Due to the lack of certain feedstuff, the calorie and protein requirements of livestock cannot be fulfilled, as a result, supplementation of the amino acid in feed mixture is a well established practice worldwide (Waddel, 1958).

Ever, increment in human population, urbanization and industrialization made deficient land for their cultivations and could not meet the demand of poultry feed ingredients for fastly growing poultry farming and poultry industries. Moreover, there is stiff competition for cereal grains, which has been predominant food resources for human consumption, and hence the shortage of cereal grain poses a serious threat to feed industry to prepare concentrate feed (Natanam, 1998). Following rapid growth of poultry industries, wastes have also multiplied. Hatchery wastes (infertile egg, unhatched egg, damaged and unsound egg, poultry manure) can be alternatively used as feed ingredients (Shrestha, 1998).

In recent years, poultry industries are rapidly growing than other livestock market. In other hand, shortage of feed ingredient and its increasing price could not meet the demand of poultry feed. Even increasing of poultry industries wastes has also increased. Disposal of these wastes is another problem to growing industries, as concerning with environmental pollution. Thus, the key objective of this work is to utilize the hatchery by products (infertile egg, unhatched egg and empty eggshell) as poultry feedstuff and to prepare high calorie protein rich supplement for broiler feed and finally to solve the problem of disposal of such by products.

Materials and methodology

Yellow maize, polished broken rice, de-oiled rice bran (DORB), mustard cake, fish meal, bone meal, common salt, wheat bran and soy meal were collected from Sagar Feed Industries ,sunsari, Nepal and used for the feed formulation. Some of these ingredients are imported from India and some from local market of sunsari. Besides, lysine monohydrate (99.8% purity, Degusa, Germany) and DL-methionine(99.8%,Degussa,Germany) were also used as amino acid supplement. (MERIVITE AB_2D_3K), ROVIMIXB (vitamin A, liquid feed supplement) and DELVIT D_3 as

vitamin supplements and Mineral mix as minerals supplement were also used and supplied from Sagar Feed Industries, sunsari, Nepal.

Broken, empty eggshell, unhatched egg and infertile egg were used as by-product utilization from the hatchery of Sagar feed industries, sunsari, Nepal.

Preparation of dried egg powder

Unhatched and infertile eggs were collected and washed with tape water to remove surface impurities and pretreated immersing in hot water having temperature 60°C for 7 mins to eliminate *salmonella* spp. due to possibility of the chances of presence and decrease the chances of pollurum disease in chicks. These pretreated eggs were separated from their shell. The separated egg liquid was stirred and dried at 60°C in a cabinet drier till the moisture content reached 6 percent. The dried egg flakes were grounded to obtain dried egg powder.

Preparation of eggshell grits

The empty eggshells were washed with tape water to remove surface impurities. These shells were boiled in water for 30 min. After boiling, it was dried at 60°C for 2 hrs and milled to grittiness.

Feed Formulation

The nutritional requirements prescribed by HUBBARD farm, New Hemisphere,03608 USA for broiler chickens was taken as a reference feed formulae (Table 1). Considering the nutritional requirement for starter and grower chicken, three different diets were formulated namely: *As* (as control), *Bs* and *Cs*, supplemented with dried egg replacing fish meal 3 percent and 6 percent respectively, in the later two for starter chicks. Likewise, another three different feed were formulated for grower chicks namely: *Ag* (as control), *Bg* and *Cg*, supplemented with dried egg replacing fish meal 2.5 percent and 5 percent, accordingly, in the later two formulations.

Table1: Nutritional requirement standards for broiler chicken

Particulars	**Starter chicks (0 to 3 weeks old)**	**Grower chicken (4 to 5 weeks old)**
Kcal. /kg body weight	2800	2900
Crude protein %, min	21	18
Crude fat %,	5 – 6	5 – 6
Salt %	0.25 – 0.40	0.25 – 0.40
Calcium %, min	1	0.95
Phosphorus %	0.4	0.4
Lysine %, min	1.03	0.96
Methionine + Cysteine %, min	0.823	0.762

Based on the Protein and Metabolize energy requirement prescribed by HUBBARD farm for broiler chicken, and with the aid of feed composition table prescribed by "division of poultry research institute" Izatnagar UP, India; the quantity of ingredients used in the starter feed ration and grower feed rations were as follows (Table 2 and Table 3)

Table 2: Amount of ingredients (in kgs) for starter feed rations

Ingredients	**Diet *As***	**Diet *Bs***	**Diet *Cs***
Fish meal	6.00	3.00	-
Dried egg	-	3.00	6.00
Bone meal	1.00	1.00	2.00
Lime stone	1.00	-	-
Egg shell grits	-	1.30	1.50
De-oiled rice bran	-	6.00	12.00
Maize	44.40	40.00	37.50
Polished rice	19.00	15.10	12.00
Soybean meal	25.00	25.00	25.00
Mustard cake	3.00	5.00	3.50
Salt	0.30	0.30	0.30
Lysine	0.03	0.03	-
Methionine	0.07	0.07	-
Coccidiostats	+	+	+
Minerals / Vitamins	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**

Table 3: Amount of ingredients (in kgs) for grower feed rations

Ingredients	**Diet *Ag***	**Diet *Bg***	**Diet *Cg***
Fish meal	5.00	2.50	-
Dried egg	-	2.50	5.00
Bone meal	1.20	1.00	2.00
Lime stone	1.00	-	-
Egg shell grits	-	1.30	1.50
De-oiled rice bran	-	5.00	10.00
Maize	60.00	40.00	37.00
Rice polish	7.50	15.00	12.00
Soybean meal	18.00	25.00	25.00
Mustard cake	5.00	5.00	5.00
Wheat bran	1.80	2.20	2.20
Salt	0.20	0.20	0.20
Lysine	0.10	0.10	-
Methionine	0.10	0.10	-
Coccidiostats	+	+	+
Minerals / Vitamins	0.10	0.10	0.10
Total	**100.00**	**100.00**	**100.00**

Brooding and Feeding

One day old 102 broiler chicks were obtained from sagar feed industries, sunsari, Nepal and subdivided into three groups with 34 chicks in each. All chicks were examined to be healthy. Vaccination with RDF and RD was given against viral and bursal diseases.

Brooding room temperature was maintained at 30±1°C for the first week and at 27±1°C for subsequent weeks. Brooding was provided up to 4 weeks. The chickens were provided with starter diet till 3rd week and from 4th to 6th weeks, they were given grower diets. All three groups of chicken were given diets with same level of metabolic energy. Energy for starter and grower chicks were maintained at 2800 Kcal/ka and 2900 Kcal/kg respectively. The control diet for starter (*As*) contained 6 percent fish meal without the addition of dried egg and eggshell, but, B*s* and C*s* diets contained dried egg at the level of 3 percent and 6 percent respectively replacing fish meal in the formulation. Similarly control diet for grower chicks (*Ag*) contained 5 percent fish meal, whilst, B*g* and C*g* contained prepared dried egg at the rate of 2.5 percent and 5 percent respectively replacing fish meal. Diet *Cs* and C*g* were not supplemented with critical amino acids (lysine and methionine).

The chickens were provided with plenty of clean and fresh drinking water. The initial weights of all the chicks were recorded on day one. Feed consumption and depletion was recorded weekly. Feeding programmers were performed up to 5 weeks of completion and analyzed them in terms of feed conversion ratio, body weight gain and mortality ratio.

Quality evaluation of Feed

Feed conversion ration (FCR): It was calculated taking the weight of each group of bird after consumption of 100 kg ration.

$$FCR = \frac{Commulative\ (Total)\ feed\ intake}{Total\ weight\ of\ live\ Bird}$$

Body weight gain: Body weights of 10 randomly selected chicks from each group were recorded every week.

Percentage mortality: It was calculated after observing number of deflected birds of each group after the consumption of 100 kg feed.

$$\%\ Mortality = \frac{Total\ number\ of\ mortalities}{Total\ number\ of\ chicks\ placed} x\,100$$

Chemical analysis of feed ingredients

Moisture content, Crude fat, crude protein, Total ash, and mineral content were estimated according to AOAC method (2000).

Results and discussion

Proximate composition of dried egg and eggshell

The proximate composition of prepared dried egg and eggshell grits determine from analysis is presented in Table 4.

Table 4: Proximate composition of dried egg and eggshell grits

Parameter	Dried egg	Egg shell
Moisture content, %	6.00 ±0.05	2.00±0.02
Crude protein, %	48.00±0.15	5.80±0.06
Crude fat, %	40.25±0.10	0.30±0.01
Crude fiber, %	0.00	0.00
Total ash, %	3.45±0.05	93.45±0.20
Calcium, %	0.21±0.02	83.00±0.17
Phosphorus, %	0.76±0.04	0.98±0.01
Carbohydrates, %	2.25±0.08	Not analyzed
Metabolize energy, Kcal/kg*	59.50±0.13	Not analyzed

*(*Calorie was calculated as: gram protein x 4.63 + gram lipid x 9.02 + gram carbohydrates x 3.87)*

Nutritional value of formulated feeds

The computed values of the formulation of feed are presented in Table 5 and 6.

Table 5: Composition of Broiler feed for Starter rations

Parameter	Feed As	Feed Bs	Feed Cs
Metabolize energy, Kcal/kg	2800	2800±1.50	2801±2
Protein, %	21.40	21.45±0.40	21.60±0.30
Fat, %	5.06	5.63±0.15	6.1±0.20
Crude fiber, %	4.08	4.45±0.10	4.76±0.15
Calcium, %	1.13	1.43±0.05	1.89±0.05
Phosphorus, %	0.45	0.47±0.05	0.53±0.02
Lysine, %	1.21±0.03	1.20±0.03	1.20±0.02
Methionine + Cysteine, %	0.82±0.02	082±0.02	0.72±0.02
Tryptophan, %	034±0.02	0.35±0.01	0.30±0.01

Table 6: Composition of Broiler feed for Grower rations

Parameter	Feed Ag	Feed Bg	Feed Cg
Metabolize energy, Kcal/kg	2900±1.50	2900±1.50	2901±1.80
Protein, %	18.23±0.50	18.25±0.60	18.45±0.50
Fat, %	4.08±0.12	4.81±0.10	5.95±0.12
Crude fiber, %	3.52±0.08	4.05±0.08	3.37±0.10
Calcium, %	1.17±0.11	1.62±0.10	1.76±0.10
Phosphorus, %	0.48±0.05	0.45±0.06	0.45±0.06
Lysine, %	0.96±0.08	0.96±0.07	0.95±0.07
Methionine + Cysteine, %	0.76±0.06	0.76±0.07	0.60±0.06
Tryptophan, %	0.30±0.01	0.26±0.01	0.24±0.02

Evaluation of quality of Feed

Effect of body weight of birds fed with different diets A, B and C

The average body weight of group of birds per week up to the completion of sixth weeks is summarized in graph 1.

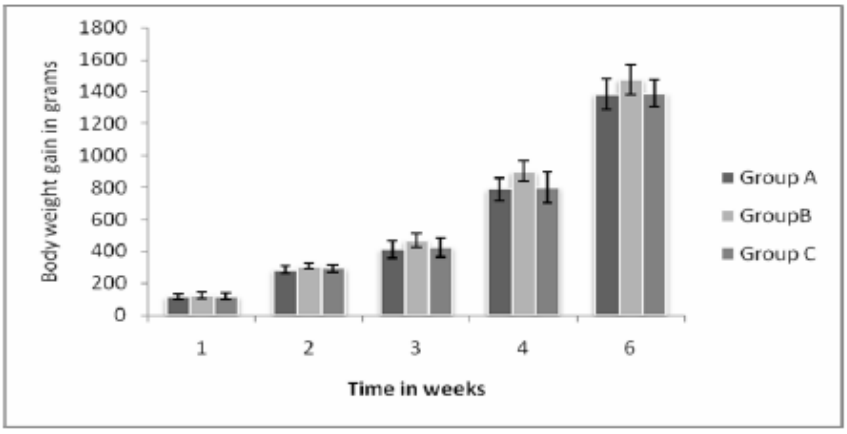

Figure 1: Comparison on average body weight gain by different groups of birds fed with different Diets A, B and C.

The growth pattern of the birds fed with diet B was found to be the best even though the growth patterns of all the three treatment were found to be acceptable. According to Mekada, *et al.* (1977), chicks grow more rapidly doubling its weight in about 2nd week and increasing it by 10 fold in 6th week.

The effect of diets in terms of body weight gain up to 3rd weeks was found to be insignificant at $p<0.05$ level but after the end of 4th week and 5th week, effect was found to be significantly different in terms of body weight at $p<0.05$. diet B fed birds had the

highest weight gain which showed significantly different with the effect of diet A and C at the completion of 6th week.

Diet A contains 6% fishmeal in starter diet *As* supplemented with critical amino acids lysine and methionine. Limestone was used as the source of calcium. It was taken as control diet. Though the diet was supplemented with amino acid, the body weight gain was found to be lowest as compared to the other diets. Many proteins contain amino acids that are linked together so that the energy cannot free them for absorption (Patrick and Schiable, 1980).

Diet B was supplemented with dried egg partially replacing fish meal in both starter and grower ration. It also replaced limestone by eggshell grits to provide extra calcium. Egg protein has high biological value and egg fat offers extra calorific value for digestion of protein thereby increasing the utilization of nutrient (Rao and Reddy, 2000). Due to good quality source of protein and fat and high inorganic calcium supplement in Diet B, better weight gain was observed in diet B chicks.

In diet C, fishmeal was fully replaced with dried egg and eggshell grits. The protein content was higher than other diets but not supplemented with critical amino acids. It showed significant result with the control diet. The protein in feed are slowly digested, hence available amino acid would be absorbed and deaminized before allowing it to release and made available for absorption (Patrick and Schiable, 1980). The above result showed that the effect of diet C was as same as that of control diet.

Effect of Feed conversion ratio (FCR) of birds fed with different diets A, B and C

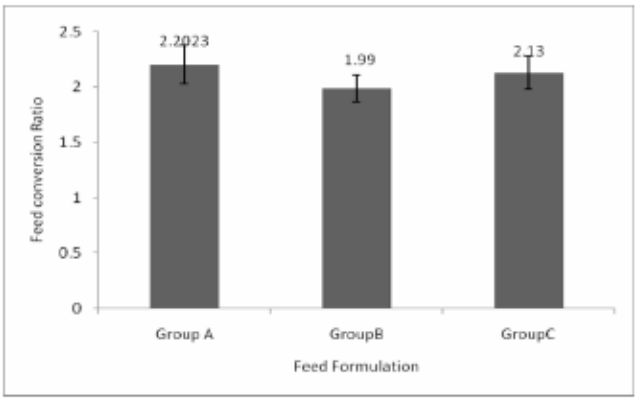

Figure 2: Comparison of Feed conversion ratio of bird fed with different diets

Considering the depletion of bird during the feeding period, and total consumption of feed, FCR of the birds with different diets A, B and C were showed as in figure 2.

Birds fed with diet B has the lowest average FCR as comparison to diets fed with A and C. The FCR less than 2.5 was found as good or acceptable level. Statistically, treatment A, B and C are significantly different in terms of FCR at $p<0.05$. The LSD at $p<0.05$

showed that treatment B was significantly different but treatment C was insignificant with treatment A.

Feeding poorly balanced rations, over-crowding, high mortality and inefficient management of the flock might increase average number of FCR (kg feed/kg body weight) and thus decrease profit (Perry and Dow, 1945).

Effect of mortality of chickens fed with different diets

Chickens fed with different diets A, B and C was observed and depletion was recorded daily. The percentage mortality of the chickens fed with different diets after the consumption of 100 kg feed and correspondingly its livability is showed in figure 3.

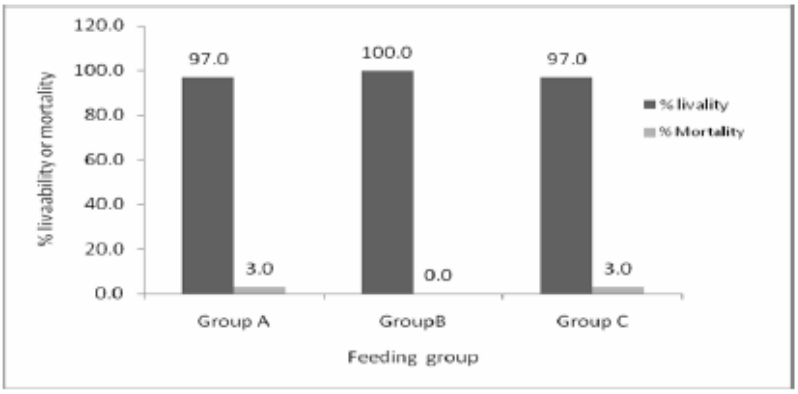

Figure 3: Comparative livability of birds fed with diets A, B and C

Mortality occurred may be due to the infected birds, contamination of feed, various diseases, physical and environmental stresses. Figure 3 showed that the bird with diet B had lowest mortality (highest livability) while birds fed with diet A and C have same mortality. Even having the same mortality rate, economic loss from group C was more costly than that of group A. The relative cost due to mortality is affected by the age of which mortality occurs (Chand, *et al*, 1994).

Conclusion

Diet that partially replaced fish meal with dried egg in starter and grower broiler chicken, showed that the highest body weight gain and livability, lowest feed conversion ratio and mortality in comparison to other two diet formulations. Therefore, it can be concluded that infertile egg and unhatched egg can be used as a high calorie/protein rich sources while empty egg shell can be used as the calcium supplement in poultry ration. The research showed that dried egg can be used up to 6 percent in broiler starter diets and up to 5 percent in grower diets without any inherent effect in term of body weight, feed

conversion ratio and mortality rate. It is, thus, recommended that hatchery by-product is an important animal protein and calcium supplement in case of scarcity of other animal protein sources and can be important way of minimizing direct disposal of such wastes in environment.

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