FOOD SCIENCE AND TECHNOLOGY: INTEGRATION FOR ASEAN ECONOMIC COMMUNITY SUSTAINABLE DEVELOPMENT

Proceedings of the 15th ASEAN Conference on Food Science and Technology

November 14-17, 2017 Ho Chi Minh City, Vietnam

The Effect of Dietary Substitution of Hydrolyzed Feather Meal to Anchovy Fish Meal on Nutrients Retention, Performance and Economic Potential of Broiler Chickens

Jet Saartje Mandey*, Cathrien A. Rahasia, Bonie F.J. Sondakh, Cherly J. Pontoh, Jein Rinny Leke

Animal Husbandry Faculty, Sam Ratulangi University, Manado, Indonesia

Corresponding author e-mail address: jetsm_fapet@yahoo.co.id

Abstract

This study was conducted to determine the effects of dietary substitution ofhydrolyzed feather meal (HFM) to anchovy fish meal (AFM) on broilers performance, nutrients retention and economic potential. Feathers were pressure and hydrolyzed by nyra palm vinegar to obtain the feather meal utilized in these experiments. Two hundred broiler chickens were randomly allocated to five treatment diets in a completely randomized design; each treatment had four replicate with ten birds each. The diets were: group A (100% AFM); group B (75% AFM and 25% HFM); group C (50% AFM and 50% HFM); group D (25% AFM and 75% HFM); and group E (100% HFM). Results indicated that inclusion level of 5 to 10 percent of HFM replaced to AFM in the diets gave significant reduction of feed intake and body weight. However, the diets had no significantly influenced FCR of broilers compared to the control group. The IOFC for treatment 5 obtained the highest income and the lowest was treatment 1. The percent of nutrients retention were highest in AFM, intermediate to lowest in HFM diet. It can be concluded that keeping in view the results of FCR, the author suggest that feather meal can replace fish meal in feed by 100 % without any negative influence on the performance of broilers.

Keywords: Anchovy fish meal, broiler, feather meal, nutrient retention, performance

1. Introduction

Feed ingredients should have optimum level of protein and energy for the better growth of broilers. There are two sources of feed proteins, i.e. proteins of animal origin and proteins of plant origin. Plant proteins are usually low in lysine and methionine and their biological value is lower (Ahmad et al., 2009). In broiler diet, fish meal, poultry by-product meal, meat and bone meal are the principal sources of animal protein. Among these, fish meal is widely used since long.

Cheap and locally available alternative sources of protein feed stuff should be identified to meet the growing demand. Feathers represent 5 to 7% of the total weight of mature chickens and are generated in huge amounts as a waste by-product at commercial poultry. Feather meal is good source of protein that can be used to replace of other protein sources and can be effectively used as a cheap protein source in poultry diet (Onifade et al., 1998). Feather meal presents variable nutrient composition and nutrient bioavailability (Wang & Parsons, 1997). The amino acid profile of feather meal is similar to fish meal (Sarmwatanakul & Bamrongtum, 2000). Proteins found in feather is not easily digested and contain high concentrations of keratin and collagen. Inclusion of feather meal in broiler chickens diet usually did not exceed 3% due to the low digestibility of its protein. However, inclusion of 5-8% feather meal was reported by Madubuike et al. (2009) and Holanda et al. (2009). The digestibility of feather meal could be improved through treatment.

The major component of feather meal is keratin, which necessitates pre-hydrolyzing to make it digestible by poultry. Feathers can be hydrolyzed by the help of steam and heat. Heating feather meal results in cleavage of disulfide bonds of cystine, which allow better digestion of this product in growing chicks (Moran et al., 1966). Due to differences in processing conditions, feather meals vary widely in their protein digestibilities (Han & Parsons, 1991). Binkley & Vasak (1951) reported that a good product could be made easily when feathers were heated at 40 PSI for one hour or 60 PSI for one-half hour with constant agitation. The feathers were then dried and ground to produce a free-flowing meal. That above 60 PSI the feathers tended to "gum" and were difficult to remove from the cooker. Currently, feathers are converted to feather meal, produced by steam pressure cooking and a great quantity of feather meal is available for use in animal feeds (Onifade et al., 1998).

The successful use of cheaper protein source as substitute of costly fish meal may reduce the production cost of balanced poultry feed and at the same time it will reduce dependence on fish meal. For this reason, it is very important to find out the possibilities of using alternate sources of low cost proteins to substitute expensive fish meal. Clayton (1968) concluded that incomeover feed cost is a good measure of economic efficiency. The present study has therefore been designed to examine the effects of the replacement of fish meal by graded levels ofhydrolized feather meal in diets on nutrients retention, performance and economic potential of broilers.

2. Materials and methods

2.1. Preparation of feather meal

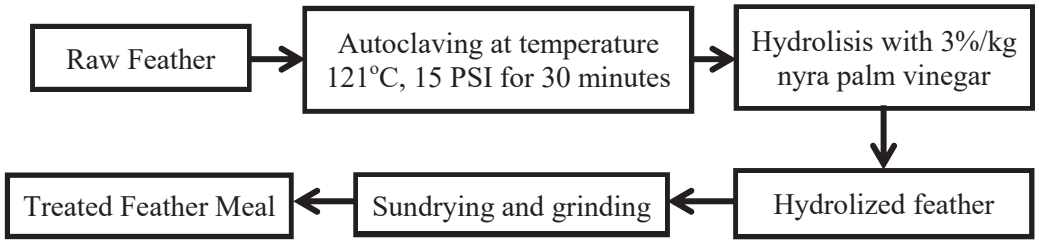
Chicken feathers were collected from a poultry farm when broilers were processed at five weeks. They were separated from other wastes, washed and sterilized with autoclaved at temperature 121°C, pressure 15 PSI for 30 minutes. The feathers then were cutted and mixed with nyra palm vinegar 3%/kg feathers and kept in plastic bag for 1 week for hydrolizing. The hydrolyzed feathers were sundried, milled and designated hydrolyzed feather meal (HFM) for the purpose of these studies. The entire procedure is presented in Figure 1.

2.2. Housing and design of the experiment

Two hundred broiler chickens were randomly allocated to five treatment diets in a completely randomized design; each treatment had four replicate with ten birds each. The treatment diets were: group A (broiler fed with 100% AFM); group B (broiler fed 75% AFM and 25% HFM); group C (broiler fed 50% AFM and 50% HFM); group D (broiler fed 25% AFM and 75% HFM); and group E (broiler fed 100% HFM) and birds were fed for 35 days. Composition and calculated analysis of experimental diets are shown in Table 1, chemicals composition of feather meal and anchovy fish meal are shown in Table 2, and amino acids of feather meal and anchovy fish meal are shown in Table 3. At the end of the experimental periods, body weight gain and feed intake were assessed while the feed conversion ratio and economic potential were calculated. The daily feed intake was recorded per animal to calculate feed consumption according to this equation:

Feed intake (grams/bird/day) = total feed offered - total feed refused / No. of chicks.

Feed conversion ratio (FCR) of each group was calculated by following formula: live weight (g)/weight gained.



Fiqure 1. Schematic diagram the feather meal treatment

Table 1. Composition and calculated analysis of experimental diets (%) on dry matter basis

Ingredients (%)	Treatments				
	Group A	Group B	Group C	Group D	Group E
Yellow Corn	56.5	56.5	56.5	56.5	56.5
Rice Bran	7	7	7	7	7
Coconut Cake	10	10	10	10	10
Soybean Cake	15	15	15	15	15
Anchovy Fish Meal	10	7.5	5	2.5	0
Hydrolized Feather Meal	0	2.5	5	7.5	10
Bone Meal	1	1	1	1	1
Top Mix	0.5	0.5	0.5	0.5	0.5
Chemical Compositions:					
Dry Matter (%)	85.46	86.05	86.25	86.55	86.85
Protein (%)	21.71	21.66	21.59	21.51	21.49
Crude Fiber (%)	4.09	3.98	3.73	3.55	3.34
Fat (%)	4.48	4.46	4.44	4.21	3.92
Ash (%)	9.92	9.61	9.48	9.37	8.21
Ca (%)	1.94	1.87	1.73	1.61	1.42
P (%)	1.42	1.37	1.31	1.28	1.21
Energy Kcal/kg)	3404	3550	3607	3689	3704

2.3. Nutrients retention

The in vivo digestibility trial was conducted by using 5 weeks old broilers. Twenty broilers having similar body weight (1700 - 1725 g) were reared in individual cages. The experiment was conducted using total collection method, period lasted 10 days: a 7-day pre collection period and a 3-day collection period, and during experiment birds were fed same amount of feed. The collected excreta were sprayed by 2% boric acid solution to prevent any loss in ammonia. The excreta of all experimental units were collected daily on trays covered with plastic and then dried in an oven at 60^{o}C for 24 hours. At the end of the experimental period, the twenty samples of excreta were weighed and ground prior to analysis for dry matter and crude protein. Nutrients intake and excretion were assessed, while nutrients retention was calculation. Retention was calculated as follows: % retention = (consumed - excreted)/consumed x 100 (Pintar et al., 2005).

2.4. Income over feed cost

The income over feed cost and broiler chicken cost analysis were estimated to determine economic profitability. Cost of feeds and chicks, livability and the return from sales of the live weight of broilers were recorded to determine the income over feed and chick cost using the formula below:

IOFCC = [average live weight x % livability x Rp/kg] – [(feed consumed x cost of feeds) + cost of chick] (Britanico et al., 2012).

Table 2. Chemicals composition of feather meal and anchovy fish meal

Chicken Feather Meal Hydrolized	Chicken Feather Meal Unhydrolized	Anchovy Fish Meal*
94.41	91.05	93.0
60.97	59.71	65.8
0.56	0.59	0.9
3.49	3.07	9.0
0.97	0.83	14.3
0.07	0.07	3.9
0.09	0.07	2.6
3897	3897	2900**

*GE, gross energy; *Hartadi et al. (2005); **Parakkasi(1980)*

Table 3. Amino acids of feather meal and anchovy fish meal

Amino Acids	Chicken Feather Meal	Anchovy Fish Meal*
	(% Protein)	
Arginine	7.09	4.42
Hystidine	0.63	1.80
Isoleucyne	5.55	3.45
Leucyne	8.27	6.47
Lysine	2.23	4.60
Methionine	0.67	2.26
Phenylalanine	4.85	2.80
Threonine	0.62	3.30
Valine	7.73	3.77

Hartadi et al. (2005)

2.5. Statistical analysis

The collected data were analyzed by analysis of variance and the comparison of means was conducted by Duncan's multiple range test (Steel & Torrie, 1994) at a probably level of 5% when the treatment indicated significant effect. The IBM SPSS Statistics 22 software was used for the statistical processing of data.

3. Results and discussion

The results onparameters feed intake, final body weight, FCR and economics are presented in Table 4, and the retention of dry matter, crude protein and nitrogenare shown in Table 5. Results indicated that feed intake broilers were significantly (P<0.01) influenced by the level of feather mealinclusion in the diet. The findings revealed that inclusion level of 5 to 10 percent of feather meal replaced to fish meal in the broiler diets gave significant reduction of feed intake and body weight. However, statistical analysis revealed that treated diets no significantly influenced FCR(P>0.05) of broilers compared to the control group. Broilers at treated groups had obtained a FCR ranging from 1.48 - 1.51. Inclusion HFM replaced to AFM significantly reduced DM retention, protein retention and nitrogen retention, but still in superior value (> 60%).

Tabel 4. Effect of hydrolized feather meal on the performance and economic potential of chickens

Variables	Hydrolized Feather Meal					SEM*	*P Value*
	0%	2.5%	5%	7.5%	10%		
Feed Intake, g/b	2345.95^{a}	2310.33^{a}	2259.33^{b}	2140.65^{c}	2066.73^{d}	25.01	.000
Final Body Weight, g/b	1591.88^{a}	1555.75^{a}	1498.75^{b}	1421.75^{c}	1372.08^{c}	19.98	.000
Body Weight Gain, g/b	1545.38^{a}	1509.25^{a}	1452.25^{b}	1375.25^{c}	1325.58^{c}	20.03	.000
FCR	1.48	1.49	1.51	1.51	1.51	.007	.432
IOFC (Rp)	14,300^{a}	14,901^{ab}	15,170^{ab}	15,385^{b}	15,757^{b}	159.01	.027
IOFCC (Rp)	7,800^{a}	8,401^{ab}	8,670^{ab}	8,964^{b}	9,257^{b}	160.00	.022

**SEM = standard error of mean.*

The income over feed cost and broiler cost analysis for chicken groups for treatment 1 obtained the highest income with an average of Rp 7,799 per head followed by treatment 2, 3, and 4 and the lowest was treatment 5 with an average of Rp 5,537. The percent of nutrients retention were highest in AFM, intermediate to lowest in HFM diet. Inclusion of HFM in broiler diets may be suggested at 10% level by replacing similar amount of AFM.

These results are similar to Madubuike et al. (2009) that reported the highest feed intake was in control group followed by 2.5, 5, 7.5 and 10% fish meal in feed. While Ochitum (1993) reported non significant difference in total feed intake of broilers up to 3% feather meal in diet. Effect of feather meal on feed intake

of current study is not in line with Nakhash (2008) who suggested 5% feather meal in broiler diet. Broilers can adjust their feed intake over a considerable range of energy and protein level in order to meet their daily energy needs. Broiler fed with feather meal increases their feed intake for their body maintenance.

Table 5. Effect of feather meal on dry matter, protein and nitrogen retention and excretion

Variables	Hydrolized Feather Meal					SEM*	*P Value*
	0%	2.5%	5%	7.5%	10%		
DM Intake, g	96.54[a]	95.29[b]	94.89[b]	89.02[c]	85.63[d]	.97	.000
DM excretion, g	22.45[a]	25.19[b]	25.68[b]	30.98[c]	33.25[d]	.92	.000
DM Retention	74.09[a]	70.10[b]	69.19[c]	58.04[d]	52.38[e]	1.87	.000
DM Retention (%)	76.75[a]	73.57[b]	72.92[b]	65.20[c]	61.17[d]	1.24	.000
Protein Intake, g	28.66[a]	27.77[b]	27.66[b]	22.02[c]	18.12[d]	.95	.000
Protein Excretion, g	7.59[ab]	7.82[bc]	8.30[c]	7.61a[b]	7.14[a]	.11	.003
Protein Retention, g	21.07[e]	19.95[d]	19.36[c]	14.41[b]	10.98[a]	.88	.000
Protein Retention (%)	73.52[a]	71.84[b]	69.98[c]	65.43[d]	60.59[e]	1.09	.000
N Intake, g	4.43a	4.52a	69.98[c]	3.52b	2.90c	.16	.000
N Excretion, g	1.19[ab]	1.25[ab]	1.33[b]	1.22[ab]	1.14[a]	.03	.228
N Retention, g	3.37[a]	3.19[a]	3.10[a]	2.31[b]	1.76[c]	.15	.000
N Retention (%)	73.63[a]	71.78[b]	69.98[c]	65.34[d]	60.69[e]	1.08	.000

**SEM = standard error of mean.*

As Wang et al. (1990) reported that 20, 40 and 60% of fish meal substituted by feather meal showed non-significant difference in final live body weight. Jackson & Fulton (1971) recommended 10% level inclusion of feather meal in broiler feed with optimum utilization of feed. Eissler & Firman (1996) stated that inclusion of feather meal in broiler diet usually did not exceed 3% due to the low digestibility of its protein. However, inclusion of 5-8% feather meal have been reported by (Madubuike et al., 2009; Holanda et al., 2009; Xavier et al., 2011) without any negative effect on live body weight. Our results indicated that the feed intake, live weight and feed conversion were still good value with 100% HFM inclusion level in broiler diet.

The body weight decreased with the increasing level of HFM could be due to the lower digestibility of protein of HFM. This difference might be due to amino acids imbalance of feather meal and resulted in relatively low performance of broilers. The deficiencies of methionine and lysine might be additional responsible factors for low biological value of feather meal. Tsang et al. (1963) reported that incorporated hydrolyzed poultry feather (feathermeal) with soybean meal at different levels and their dataregarding final weight showed no difference in weightgain when 8% feather meal were incorporated.

Previous findings and recent experiment result about theuse of feather meal a replacement of fish meal on the finallive body weight showed similar pattern. The energy content of feather meal is more than fish meal and in rapidly growing broiler energy becomes one of the limiting nutrients. Ayayi and Iyayi (2014) and Ayayi and Iyayi (2015) reported that birds fed 2% HFM diet had similar FCR to birds on the control diet (0% HFM) at 14 - 28 days. When birds were fed with and without HFM, the average BWG and FCR were similar for all treatments but there was significant difference in the FI. Feeding HFM at 2% in broiler starter diets did not negatively affect performance but the feed intake could be improved to improve performance (Ayayi and Iyayi, 2015).

The dates in this result showe.d that treatment of chicken feathers by autoclaved at temperature 121^{o}C, pressure 15 PSI for 30 minutes and mixed with nyra palm vinegar 3%/kg feathers for hydrolyzing produces good HFM of digestibility: dry matter retention, protein retention and nitrogen retention.

Economical aspect of feather meal feeding was discussed by various scientists. In recent study group broiler fed 100% feather meal in diet proved to be cheapest compared to control group. Similar results were reported by Ahaotu and Ekenyem (2009) and Madubuike et al. (2009). They reported significant difference in cost of feed production with or without feather meal inclusion. The recent study result regarding economic impact was similar to Nakhash (2008) and Caires et al. (2010) whichconcluded that inclusion feather meal

reduce the relative cost per unit weight gain. Moreover, Hasni et al. (2014) reported that broiler fed with 100% feather meal as replacement of fish meal proved to be most economically raised, without any negative effect on their performance.

4. Conclusion

Keeping inview the results of the present study, it can be concluded that feather meal can replace fish meal in feed by 100 % without any negative influence on the performance of broilers.

References

Ahaotu, O. E., & Ekenyem, B. U. (2009). Replacement value of feather meal for fish meal on performance of finisher broiler chicks. *International Journal Tropical Agriculture and Food System*., *3(3)*, 117-126.

Ahmad, M. H., Miah, M. Y., Ali, M. A., & Hossain, M. A. (2009). Effect of different protein concentrates replacement of fish meal on the performance of broilers. *International Journalof Poultry Science*, *5 (10)*, 959-963.

Ajayi, H. I., & Iyayi, E. A. (2014). Ileal nutrient digestibility and performance in broiler chickens fed graded levels of feather meal. *Ibadan Journal of Agriculture Research*, *10 (1)*, 78-87.

Ajayi, H. I., and E. A. Iyayi, E. A. (2015). Performance of broiler chickens fed hydrolized feather meal. Conference Paper. https://www.researchgate.net/publication/279267385.

Blnkley, C. H., & Vasak, O. R. (1951). Friable meal produced from feathers. *American Egg and Poultry Rev.,* 68, 12.

Britanico, Ellen B., Merca, Florinia E., Angeles, Amado A., Sonia P. Acda, Sonia P., & Luis, Edwin S. (2012). Effects of supplementing diets with amino acid chelates ofcopper, zinc, manganese and iron on the performance of broilers. *Philippine Journal Veterinary Animal Science, 38 (1),* 1-10.

Caires, C. M. I., Fernandes, E. A.,Fagundes, N. S., Carvalho, A. P., M. P. Maciel, M. P., and B. R. Oliveira, B. R. (2010). The use of animal byproducts in broiler feeds. Use of animal co-products in broilers diets. *Revista Brasileira de Ciencia Aviccola*, *12* (1).

Clayton, G. A. (1968). Some implications of selection results in poultry. *World's Poultry Science Journal*, *24*.

Han, Y., & Parsons, C. M. (1991). Protein and amino acid quality of feather meals. *Poultry Science*, *70*, 812-822.

Hartadi, H., S. Reksohadiprojo, S., & Tillman, A. D. (2005). *Tabel Komposisi Bahan Pakan Untuk Indonesia*. Cetakan ke-5. GadjahMada Univ. Press. Yoygakarta.

Hasni, M. S.,Sahito, H. A.,Memon, M. A.,Sanjrani, M. I., Gopang, M. A., and N. A. Soomro, N. A. (2014). Effect of Feeding Various Levels of Feather Meal as a Replacement of Fish Meal on the Growth of Broiler. *International Journal of Agriculture Innovations and Research*, *3 (2)*, 505-511.

Holanda, M. A. C.,Ludke, M.,Ludka, C. M. M., Holanda, J. V.,Rabello, M. C. R., Dutra, C. B. V., Junior, W. M., Vigoderis, R. B., and A. A. G. Costa, A. A. G. (2009). Effect of feather meal in broiler chickens feed. *Revista Brasileirade. Animalia*, *10(3)*, 696-707.

Jackson, N., & Fulton, R. B. (1971). Composition of feather meal and offal meal and its values as a protein supplement in the diet of broilers. *Journal Science Food Agriculture*, *22*, 38-42.

Madubuike, F. N.,Ekenyem, B. U., & Ahaotu, E. O. (2009). Effect of dietary substitution of feather meal for fish meal on the performance of starter broilers. *Animal Production Research Advance*, *5 (1)*, 1-5.

Moran, E. T. Jr., Summers, J. D.,& Slinger, S. J. (1966). Keratin as a source of protein for the growing chick. *Poultry Science*, *45*, 1257-1266.

Nakhash, R. M. S. (2008). *The effects of partial replacement of soybean meal in the grower diet with sundried blood and boiled feather meal on the performance of broiler chicks*. Thesis. Faculty of Graduate Studies, An-Najah National Univ. Nablus, Palestine.

Ochitum, S. (1993). The effect of partial replacement of soyabean meal with broiled feather meal on the performance of broiler chickens. *Africa Journal Animal Science*, *6(4)*, 597-600.

Onifade, A. A., Al-Sane, N. A., Al-Musallam, S., & Al-Zarban, A. (1998). A review: potentials for biotechnological applications of keratin-degrading microorganisms and their enzymes for nutritional improvement of feathers and other keratins as livestock feed resources. *Bioresource Technology*, *66*, 1-11.

Parakkasi, A. (1980). *Ilmu Gizi dan Makanan Ternk Monogastrik*. Penerbit Angkasa Bandung.

Pintar, J., Homen, B., Gazic, K., Janjecic, Z., M. Sikiric, M., & Cerny, T. (2005). Effect of supplemental phytase on nutrient excretion and retention in broilers fed different cereal based diets. *Czech Journal Animal Science*, *50 (1)*, 40-46.

Sarmwatanakul, A., & Bamrongtum, B. (2000). *Aquarium Fish Nutrition*. Extension paper No. 1. Ornament Fish Research and Public Aquarium. Bangkok.

Steel, R. G. D., & Torrie, J. H. (1994). *Principles and Procedures of Statistics*. McGraw-Hill Book Co. Inc. Pub. Ltd. London.

Tsang, S. T. L., McKee, E. L., Andrews, G. P.,Winslade, Constance E., Steinhauser, R. L., & Windsor, H. A. (1963). The utilization of hydrolyzed poultry feathers in iso-nitrogenous and iso-caloric broiler rations. *Poultry Science*, *42(6)*, 1369-1672.

Wang, X., & Parsons, C. M. (1997). Effect of processing systems on protein quality of feather meals and hog hair meals. *Poultry Science*, *76*, 491-496.

Wang, P., Yueying, Z., Wang, K., Guoshu, Z., Chengrong, M., & Wushun, H. (1990). Evaluation of acid hydrolyzed feather meal with chicken. *Journal Huazhong Agriculture*, *03*.

Xavier, S. A. G., Stringini, J. H., de Brito, A. B., Andrade, M. A., Café, M. B., & Leandro, N. S. M. (2011). Feather and blood meal in pre-starter and starter diets for broilers. *Revista Brasileira Zootec*, *40 (8)*, 1745-1752.