Chemical Composition and *In Sacco* Degradation of Fish Waste Meal as Alternative Protein Feed Source

Maurinda Safitri[1], Cuk Tri Noviandi[1*], Ristianto Utomo[1]
[1]Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3 Kampus UGM Bulaksumur Yogyakarta, Indonesia
*Corresponding author: c.t.noviandi@ugm.ac.id

ABSTRACT

This study was done to evaluate chemical composition and *in sacco* degradability of fish waste meal. Fresh fish (*Congresox talabon*) waste meal used in this study was collected from fish crackers industries of Indramayu, West Java. Fresh fish waste samples were dried and ground prior to be analyzed. The sample was analyzed for chemicals composition (dry matter, ash, crude protein, crude fiber, and crude fat) and incubated using nylon bag technique in 2 rumen fistulated Bali cattle to determine its dry matter, organic matter, and crude protein degradability. The results showed that fish waste meal contains a high level of crude protein (56.4%), fat (13.1%), and ash (27.3%), which showed its potency as protein and mineral source. The *in sacco* data showed that DM, OM, and CP degradations were similar or slightly higher than a+b fraction (49.6, 55.5, and 54.7% vs. 49.6, 55.7, and 57.5%, respectively), which imply that fish waste meal was optimally degraded in the rumen.

Keywords: Fish waste meal, Protein feed, Chemical composition, *In sacco*.

INTRODUCTION

Feed protein source is important component in animal feed and should be available in sufficient quantities. Protein has important role in growth process, repair body tissue, as a component of hormone and enzyme, and perform antibody function (Poedjiadi, 2005). Protein deficiency is unexpected because it can lead to slow rate of livestock growth. Therefore, the supply of feed ingredients protein sources are expected to be always available from various sources. One of possible source may come from fish protein.

Fish protein is readily available in form of solid fish waste meal. This protein souce is highly available as the result from an increase development of fish processing industries. The ruminally undegraded protein in fish meal has high value because of its high lysine content. Fish meal is also high in methionine. Fish meal has an amino acid profile close to that believed to be required for milk production (Shaver, 2015). However there is lack infomation on the chemical compostion and ruminal degradability of the local Indonesian fish waste meal.

Information obtained in vivo is the most reliable and should be the reference to evaluate other methods, because it represents the actual animal response to a dietary treatment. However, in vivo digestion trials are expensive, laborious, time-consuming and not readily applicable to large numbers of feeds or when only small quantities of each feedstuff are available (Lopez, 2005). Estimation of rumen degradability of different nutrients is usually done by in sacco methods (NRC, 2001). This method is the most prommising approach to estimate the wide variety of feedstuffs.

The aim of this experiment was to determine the chemical compositon, *in sacco* ruminal degradability, and effective degradability of DM, OM and CP of fish waste meal.

MATERIALS AND METHODS

Sample preparation and chemical analysis

Fresh fish sample was collected from fish chips industries of Indramayu, West Java. Fresh fish waste was oven dried (55°C) for 6 days and ground over 2 mm sieve. The sample was analyzed for chemicals composition (dry matter, ash, crude protein, crude fiber, and crude fat) by AOAC (2005) method.

Animals and diet

Two cannulated male Bali cattles (approximately 223 to 316 kg live weight) were individualy housed in stalls with free access to water. The cattles were fed maintanance diet of forage:concentrates (80:20). The diet was fed two times in a day at 07.00 and 14.00 h.

In sacco degradation

Fed sample approximately 5 g were placed in nylon bag (internal dimension: 6 x 11 cm; pore size 46 μm) and introduced into the rumen at 06:00 h, just before the morning meal. The bags were withdrawn after 2, 4, 8, 16, 24, and 48 h incubation, rinsend under cold tap water, and stored at -15° C. After thawing, the bags were machine washed for 6 minutes and dried at 55° C for 48 h. Zero hour bags were not incubated in the rumen but were treated the same rinsed procedures as rumen incubated bags. Residues were analyzed for DM, OM and CP content to calculate the dissapearance of this component.

Statistical analysis

The chemical composition and degradation kinetics were analyzed by descriptive analysis. *In sacco* degradability of DM, OM and CP were fitted to exponential model described by Ørskov and McDonald (1979):

$P = a+b (1-e^{-ct})$.

where: P = degradability, a = rapidly soluble fraction, b = potentially degradable fraction, c = rate of degradation of b fraction, t = incubation time

The effective degradability (DT) was calculated acording the following equation:

$DT = a+ [(b*c) / (c*k)]$

where: k = fractional passage rate (0,05/h)

RESULTS AND DISCUSSION

Chemical composition of fish waste meal is shown in Table 1. The chemical composition characteristics of fish waste meal provides high level of CP, EE, and minerals content. This result is consistent with Esteban *et al*. (2007) who reported that CP and EE from fish waste respectively 57.9 and 19.1%. However, the fish waste meal had lower crude protein compared comercial fish meal (60.4 to 70.2%) (Barlow and Windsor, 1984) but it is higher than soybean meal (44.7%) (Hartadi *et al*., 2005).

Table 1. Chemical composition of fish waste meal

Chemical composition	Fish waste meal
Dry matter	93.6
Crude protein	56.4
Ether extract	13.1
Crude fiber	0.40
Ash	27.3
Calcium	11.3
Phosphorus	8.76
Total digestible nutrients	57.2

Furthermore it can be seen that the fish waste meal contained high ash content. The high level of ash indicates that the fish waste meal is rich minerals sources. The calsium and phosphorus in this experiment are higher than observed by Barlow and Windsor (1984) who obtained range mineral contains of different fish sources are from 2.0 to 8.0% calcium and 1.5 to 4.8% phosphorus. This high level of calcium was due to the presence of fish bone in the fish waste meal.

Dry matter and organic matter dissapearance were fast from 2 to 16 hours incubation and slower until 48 hours incubation (Table 2). However, the crude protein degradation was low for the first two hours of rumen incubation and increased during the rest of the incubation times. The result of 24 hours DM and CP degradation were higher than reported by Ha and Kennelly (1984) which only reached 25.1 and 34.8%. Chiou *et al*., (1995) reported the 48 hours CP degradation of commercial fish meal was 44.0% and 59.3% for 72 hours incubation. This result were lower than CP degradation data from fish waste meal after 48 hours incubation time.

Table 2. *In sacco* degradation kinetics of fish waste meal

Incubation time	DM degradation (%)	OM degradation (%)	CP degradation (%)
2	31.0	23.8	20.1
4	35.4	30.0	24.1
8	41.4	39.0	30.9
16	46.9	48.7	40.6
24	48.7	52.7	46.7
48	49.6	55.5	54.7

DM = dry matter, OM = organic matter, CP = crude protein

The 48 hours degradation of DM, OM, and CP respectively 49.6, 55.5, and 54.7%. Degradation values obtained were close to the poteintial degradation value (a+b) which respectively 49.6, 55.7, and 57.5%. This result indicates that almost all fraction of the fish waste meal can be degraded in the rumen.

The degradation characteristics and effective degradability is shown in Table 3. The value a, b, c, a+b, and DT fraction of fish waste meal DM degradation respectively 25.1, 24.5, 0.10, 49.6, and 41.7%. The previous study by Chumpawadee *et al*. (2005) reported that comercial fish meal had lower a fraction (23.87%), but the b faction was higher (32.95%). This higher a fraction might represents the rich of soluble faction and lower b fraction demonstrate the lack of potentially degradable fraction of dry matter in the fish waste meal. Potential degradation fraction (a+b) in fish waste meal lower than the result by Chumpawadee *et al*. (2005) (49.5 vs. 56.82%), this might be due to the high of fish bone component in the fish waste meal that was not easily degraded in the rumen. The DT fraction of fish waste meal from Chumpawadee *et al*. (2005) relatively the same with DT value from the fish waste meal.

Table 3. *In sacco* degradation characteristic and effective degradability of fish waste meal

Degradation parameters	Fish waste meal
Dry matter degradability	
a (%)	25.1
b (%)	24.5
c (/h)	0.10
a+b (%)	49.6
DT 5% (%)	41.7
Organic matter degradability	
a (%)	16.1
b (%)	39.6
c (/h)	0.10
a+b (%)	55.7
DT 5% (%)	40.1
Crude protein degradability	
a (%)	15.6
b (%)	41.9
c (/h)	0.06
a+b (%)	57.5
DT 5% (%)	35.9

a = rapidly soluble fraction, b = potentially degradable fraction, c = rate of degradation of b fraction, a+b = potential degradation, DT = effective degradability

The value a, b, c, a+b, and DT fraction of fish waste meal OM degradation respectively 16.1, 39.6, 0.10, 55.7, and 40.1%. The fish waste meal soluble fraction (a) was low but the potentially degradable fraction (b) was higher than the data obtained by Chumpawadee *et al*. (2005). Simillar data values were obtained for c fraction of DM and OM degradation, which were higher than c value from the experiment by Chumpawadee *et al*. (2005). This two experiment resulted the same DT value.

The fraction values of a, b, c, a+b, and DT *in sacco* CP degradation respectively 15.6, 41.9, 0.06, 57.5, and 35.9%. This value indicates that the soluble protein fraction of fish waste meal was lower than the insoluble fraction because it contains unsoluble fish bone which hard to degraded in the rumen. Chiou *et al*. (1995) suggest different result that the soluble protein fraction was higher than the insoluble fraction (32.8 vs. 15.3%) which may lead to a slow and stable rumen degradation.

CONCLUSIONS

Fish waste meal can be used as protein and mineral feed sources. Fish waste meal slow degraded but it can be fully degraded in the rumen.

REFERENCES

AOAC. 2005. Official Methods of Analysis of the Association of Official Analytical Chemists. Maryland, USA.

Barlow, S.M and M.L. Windsor. 1983. Fishery by-products. In: M. Rechcigi, Jr. (Ed.) CRC Handbook of Nutritional Supplement. Volume II. Agricultural Use. pp 253–272. CRC Press, Inc., Boca Raton, FL.

Chiou, P.W.S., K.S. Chen, K.S. Kuo, J.C. Hsu, and B. Yu. 1995. Studies on the protein degradabilities of feedstuffs in Taiwan. Anim. Feed Sci. Technol. 55: 215–226.

Chumpawadee, S., K. Sommart, T. Vongpralub, and V. Pattarajinda. 2005. In sacco degradation characteristic of protein feed source in Brahman-Thai native crossbred streers. Walailak J. Sci. Tech. 2: 21 –229.

Esteban, M.B., A.J. Garcia, P. Ramos, and M.C. Marquez. 2007. Evaluation of fruit-vegetable and fish wastes as alternative feedstuffs in pig diets. Waste Management. 27: 193–200.

Ha, J.K. and J.J. Kennelly. 1984. In situ dry matter and protein degradation of various protein sources in dairy cattle. Can. J. Anim. Sci. 64: 443–452.

Hartadi, H., L.C. Kearl, S. Reksohadiprojo, L.E. Harris, S. Lebdosukojo, dan A.D. Tillman. 2005. Tabel-tabel Dari Komposisi Bahan Makanan Ternak Untuk Indonesia. Gadjah Mada University Press. Yogyakarta.

NRC, 2001. Nutrient Requirements of Dairy Cattle, 7th revised ed.,National Research Council, National Academy Press, Washing- ton, DC.

Lopez, S. 2005. *In vitro* and *in situ* techniques for estimating digestibility. In: Djikstra, J., J.M. Forbes, and J. France eds. Quantitative Aspects of Ruminant Digestion and Metabolism pp. 157 - 206. 2nd ed. CABI Publishing, Wallingford.

Orskov, E.R., McDonald, I., 1979. The estimation of protein degradability in the rumen from incubation measurements weighed according to rate of passage. J. Agricult. Sci. 92, 499– 503.

Poedjiadi, A. 2005. Dasar-dasar Biokimia. Revision edition. UI Press. Jakarta.

Shaver, R.D. 2015. By-product feedstuffs in dairy cattle diets in the upper midwest. Forage Resource and Information. University of Wisconsin-Madison.