THE USE OF INTERNAL MARKER TO ESTIMATE DIGESTIBILITY IN BLACK-CAPPED LORY (*Lorius lory* L., 1758)

PENGGUNAAN MARKER INTERNAL DALAM MENENTUKAN KECERNAAN BURUNG NURI KEPALA HITAM (*Lorius lory* L., 1758)

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ABSTRAK

Studi ini bertujuan untuk menghitung nilai serapan nutrien menggunakan metode koleksi total dan rasio abu pada nuri kepala hitam (*Loriuslory*L.,1758) yang diberi pakan bubur jagung giling (K1), bubur pollard (K2), dan bubur bekatul (K3). Penelitian ini terdiri dari 7 hari uji pendahuluan, dan 2 periode koleksi data masing-masing 28 hari untuk tiap perlakuannya. Jadi total waktu penelitian untuk setiap perlakuan adalah 73 hari. Burung nuri kepala hitam yang digunakan sebanyak 5 ekor. Variabel yang diamati adalah konsumsi pakan, nilai energi metabolis semu (EMS) dan nilai kecernaan protein semu. Konsumsi tertinggi selama penelitian didapat dari perlakuan bubur pollard (K2). Bubur bekatul (K3) memiliki nilai EMS, efisiensi metabolik, dan nilai kecernaan protein semu (ADP) tertinggi dibandingkan yang lain. Penggunaan marker rasio abu menghasilkan nilai kecernaan nutrien yang lebih tinggi dibandingkan penggunaan metode koleksi total. Sebagai kesimpulan, metode rasio abu dapat digunakan sebagai metode alternatif untuk menentukan kecernaan nutrien. Selain itu, bubur bekatul direkomendasikan untuk diberikan kepada burung nuri kepala hitam.

Kata kunci: *Lorius lory*, rasio abu, metode koleksi total, energi metabolis semu, kecernaan protein

ABSTRACT

This study was conducted to calculate nutrient digestibility using total collection method and ash ratio as a marker in Black-capped lory (*Loriuslory*L.,1758) fed with cornmeal (K1), pollard (K2), and rice bran mash (K3). The study consisted of 7 days of preliminary study and 2 periods of 28 days of data collection (totally 73 days) applied for all treatments. Five adult Black-capped Lories were used. Variables observed include feed consumption, Apparent Metabolizable Energy (AME) value, and Apparent Digestibility of Protein (ADP). Pollard mash (K2) had a higher feed intake compared to cornmeal and rice bran mash. On the other hand, rice bran mash (K3) had higher Apparent Metabolizable Energy (AME) value, efficiency of metabolic, and Apparent Digestibility of Protein (ADP) values compared to the others. Ash ratio as indigestible marker produced a higher nutrient digestibility than that was produced by total collection method. In conclusion, rice bran mash was recommended as a daily feed for black-capped lory. It can be concluded that the ash ratio can be used as an alternative method for determining nutrient digestibility in lories. In addition,rice bran diet is recommended for the lory as daily routine feed in captivity.

Keywords: *Lorius lory*, ash ratio, total collection method, Apparent Metabolizable Energy value, protein digestibility

INTRODUCTION

The most general method for determining digestibility is using total collection method. This method involves collecting data of all feed consumed and all feces excreted in a short period (Dourado *et al*. 2010). However, this method has some limitations which relates to contamination of feed and feather excreta. It increases experimental error because both feed and excreta weights are overestimated (Hagen 1999). An alternative method is determining the ratio of indigestible substances, called marker in both feed and excreta. Sales *et al.*(2004) explained, there are two markers to calculate digestibility which are external marker (a known concentration of which is mixed into the diet) and internal marker (indigestible natural component). In comparison with total collection method, the marker method avoid bias due to failure in feed intake and excreta output

measurement, also contamination of excreta (Sales & Janssens 2006).

Chrome oxide (Cr_2O_3) has been used as an external marker in poultry for years. There are some limitation using Cr_2O_3 as marker, such as the incomplete recovery and analytical variation of colorimetric method used. In addition, this chemical is not approved for animal and human feeding by Food and Drug Administration (FDA), USA (Sibbald 1987). Ash ratio has been applied as a simple method for determining nutrient digestibility in invertebrate, fish, reptile, and mammal. Sales & Janssens (2006) reported that the method could be used as a simple alternative method to determine nutrient digestibility of seed for the granivorous birds.

There were many experiments related to apparent nutrient digestibility in large parrot such as African Grey parrot or other Cockatoo. But, the nutrient digestibility determination in either medium or small parrot was very limited, especially using exotic bird from Indonesia. Black-capped lory is a medium parrot found in Papua Island. A study has been conducted to calculate nutrient digestibility using total collection method and ash ratio as a marker in Black-capped lory.

Pollard, corn meal, and rice bran are listed as cereal by-products and used as energy sources. Mainly used in animal feeding, that cereal by-product have some nutritional benefits such as high dietary fiber and antioxidant properties. Moreover, this feedstuff are relatively inexpensive.

RESEARCH METHODS

Feed and Experimental Design

This research was conducted in the Bird Captivity, Zoology Division, Research Center for Biology-Indonesian Institute of Sciences, Cibinong, from April to November 2013. Feed and excreta nutrient analysis were carried out in the Laboratory of Nutrition Testing, Zoology Division, Research Center for Biology-Indonesian Institute of Sciences, Cibinong.

The study consisted of 7 days of preliminary study and 2 periods of 28 days of data collection (totally 73 days) applied for all treatments. Preliminary study, as known as habituation period, was performed to adapt the bird with the feed given. The data collection period was performed to record feed intake and collect the excreta during experiment. Five adult Black-capped Lories (*Loriuslory* L., 1758) were used. During the study, the birds were placed individually in a metabolic cage with the size of 70 cm x 43 cm x 52 cm**.**

Feed treatments consisted of cornmeal (K1), pollard (K2), and rice bran (K3). All the compositions were ground and mixed with water. Feed and water were given *ad libitum* during the experiment. The ingredient compositions of experimental diets are shown in Table 1.

The amounts of feed consumed and remained were weighed and recorded every day, as well as the amount of excreta produced. Excreta were collected in the sealed plastic bag and kept in the freezer at -20℃ until further analysis. Excreta collected were

Table 1. Ingredient and composition of the experimental diets.

Compositions	K1	K2	K3
Cornmeal (g)	60	-	-
Pollard (g)	-	18	-
Rice bran (g)	-	-	18
Fish Meal, 40% CP[1] (g)	28	34	34
Papaya (g)	130	145	145
Bean sprout (g)	27	38	38
Lampung banana (g)	105	115	115
Honey (tbsp)	1	1	1
Water (mL)	100	100	100

[1] *Crude Protein*

used for total collection method analysis and for ash ratio method analysis. Variables observed include feed consumption, Apparent Metabolizable Energy (AME) value, and Apparent Digestibility of Protein (ADP).

Chemical Analysis and Calculation of Nutrient Digestibility

Analysis of dry matter, crude protein, and ash contents of feed and excreta were carried out according to standard procedure of AOAC (1995). Crude protein content of feed and excreta were determined by digestion using the Kjeldahl method (AOAC 1995). Ash ratio was determined according to Sales & Janssens methodology (2006). Gross Energy of feed and excreta were determined using adiabatic bomb calorimeter (Parr Instrument 1266, Illinois, USA). Gross Energy data were used for calculating AME (Zarei 2006), while nutrient digestibility was calculated following Sales *et al*.(2004).

The following formulas were used to determine AME and nutrient digestibility based on total collection method :

$$\text{AME (kcal/kg)} = \frac{[(F_i \times GE_f) - (E \times GE_e)]}{F_i} \quad \ldots(1)$$

$$\text{Digestibility} = \frac{\text{Nutrient intake} - \text{nutrient output}}{\text{Nutrient intake}} \times 100\% \quad \ldots(2)$$

The formulas for determining AME and nutrient digestibility on the basis of marker method :

$$\text{AME (kcal/kg)} = \frac{(F_i \times GE_f) - [(E \times GE_e) \times (\frac{\text{Marker in feed}}{\text{Marker in excreta}})]}{F_i} \quad \ldots(3)$$

$$\text{Digestibility} = 1 - \left[\frac{\%\ \text{feed marker}}{\%\ \text{excreta marker}} x \frac{\%\ \text{excreta nutrient}}{\%\ \text{feed nutrient}}\right] \quad \ldots(4)$$

Where, AME = Apparent Metabolizable Energy (kcal/kg)

GE_f = Gross Energy of feed (kcal/kg)

GE_e = Gross Energy of excreta (kcal/kg)

Fi = Feed intake (g/bird/d)

E = Excreta (g/bird/d)

Feed intake and excreta production were calculated on dry matter basis. The marker was ash ratio of both feed and excreta.

RESULTS AND DISCUSSION

Nutrient analysis used in this research is shown in Table 2. Using the formulation, predicted metabolizable energy in K1 diet was 2,662 kcal/kg. Since Nitrogen Free Extract (NFE) consists of some carbohydrate, sugar,

starches and hemicellulose, it was resulted in high metabolizable energy value of the K1diet. AME values were determined according to the two methods and are shown in Table 3. Feed intake of K2 diet was higher than K1 and K3diets. Due to the lower energy intake of K2 diet, the bird required more feed to achieve their energy balance (Suprijatna 2005). Moreover, feed intake was influenced by dietary fat. Feed intake was higher in low fat diet. Prayogi (2007) stated that fat might be used as source of energy instead of carbohydrate.

The AME value of K3 was the highest compare to K1 and K2 diet. K3 diet has higher gross energy, fat, and fiber content. McDonald *et al*. (1981) explained that AME value was lower when high fiber diet was consumed. Meanwhile, Olukosi & Adeola (2009) reported that AME value had positive correlations with dietary gross energy and fat contents ($r \leqq 0{,}44$). However, AME value also had negative correlations with crude protein, ash, crude fiber, Ca, and P contents of the diet (Zarei 2006). Furthermore, AME value was affected by anti-nutritive activity in feed. Non-starch polysaccharides (NSP) are known to possess anti-nutritional properties. Corn, pollard, and rice bran had total NSP value 8.1%, 35.3%, and 21.8% respectively (Englyst 1989). High level of NSP decreased AME value (Choct 1999). High NSP value was considered could block some nutrient in gastrointestinal tract, thus the nutrient digestibility was decreased.

Table 2. Nutrient analysis of the diets (dry matter basis).

Diet	DM	Ash	Protein	EE	CF	NFE	Predicted ME
	----------%----------						kcal/kg
K1	89.84	13.81	15.22	2.49	3.53	54.79	2,662
K2	85.72	19.94	20.43	2.05	5.30	38.00	2,219
K3	85.08	20.51	16.07	2.69	6.86	38.95	2,154

Note: DM = Dry Matter, EE = Ether Extract, CF = Crude Fiber, NFE = nitrogen free extract, Predicted ME=Metabolizable Energy (ME = [(3.5 x CP) + (8.5 x EE) + (3.5 x NFE)] x 10)[13]

AME value which determined using ash ratio was higher compared to that measured by total collection method. Sales & Janssens (2006) also reported the same result in parrot and pigeon. The ash was ignited at 400°C. At this temperature, ash recovered near 100%. It was assumed that either ash is indigestible or bird is in mineral balance. Bjorndal (1985) stated the limitations of ash ratio. Ash might be dissolved and lost, either in gaseous phase or liquid phase in gastrointestinal tract. Even though there were limitations, this method was relative simply. Since there were no chemical added to the feed such as Chromic Oxide, which might accumulates in metabolically active organs such as the liver and kidneys (Svecevicius 2009). Moreover, this method of analysis was inexpensive since it was non

Table 3. Feed intake, excreta production, and AME value of black-capped lory.

Variables	K1	K2	K3
Feed intake (g/b/d)	134.32± 22.08	137.95± 27.28	135.90± 21.77
GE feed (kcal/kg)	3,779	3,665	3,854
Excreta production (g/b/d)	7.12 ± 3.36	7.88 ± 4.23	7.18± 4.31
AME[1] (kcal/kg)	3,572[b]	3,483[c]	3,687[a]
AME[2] (kcal/kg)	3,630[b]	3,567[c]	3,761[a]

Note: 1 = AME value based on total collection method, 2 = AME value based on ash ratio method; Subscripted with different letter within the same row indicate significant difference (P<0.05)

chemical-based method. Metabolic efficiency of K3 diet was higher than those of K1 and K2 diets (Figure 1).

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It might be explained that the bird utilized energy more efficiently to maintain its life. Metabolic efficiency also related with fat

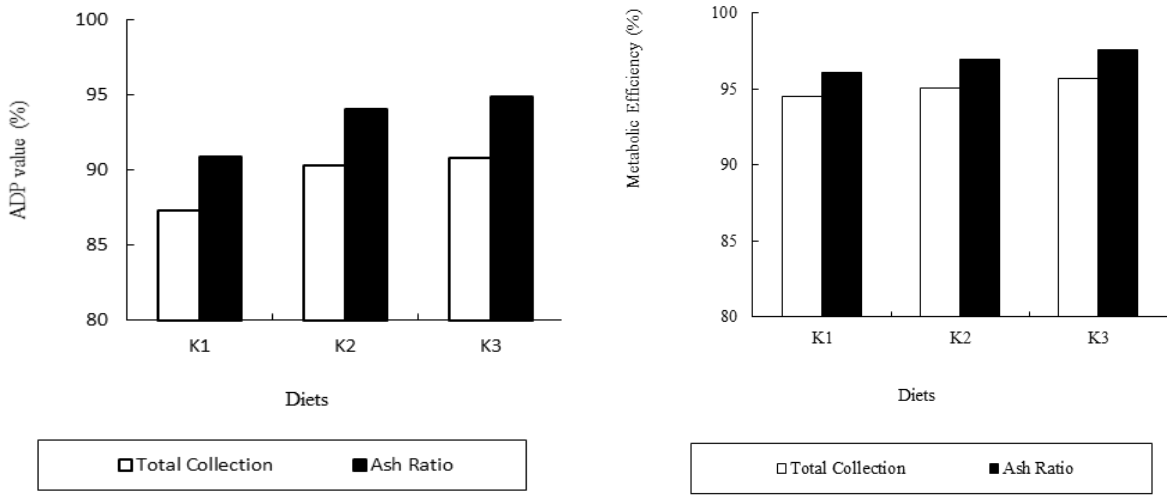

Figure 1. Comparison between metabolic efficiency (%) and ADP value (%) using both method.

content in the diet. In rice bran diet (K3), there were approximately 3% higher efficiency than that of corn meal diet. De Groote *et al*. (1970) stated that metabolic efficiency utilization was higher for the different fat.ADP in K3 diet was also higher. It indicated that the protein in K3 was easier to digest than the others. K3 diet was high in ash, fat and crude fibre contents, but had the lowest ME content. Zarei (2006) declared that ash and crude fiber are the most effective on ME content. That research also showed that there is negative correlation between ME and ash content, as well as crude fiber. The usage of rice bran in poultry feed were limited. Martin and Farrell (1998) stated only 10-20% of total feed have been used. In this experiment, there was only 4% rice bran of total diet. Fish meal addition to diets as much as 5% with rice bran improved duckling growth rate (Martin 1998), while the usage of fish meal in K3 in this experiment is about 7.5%. Therefore fishmeal contained in K3 had effect on metabolic efficiency that increasing metabolic efficiency in K3.

CONCLUSION

It can be concluded that the ash ratio can be used as an alternative method for determining nutrient digestibility in lories. In addition, rice bran diet is recommended for the lory as daily routine feed in captivity.

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REFERENCES

AOAC. (1995). *Official methods of analysis of AOAC international*. 16th ed. Association of Official Analytical Chemists, Arlington, VA.

Bjorndal, K. A. (1985). Use of Ash as An Indigestible Dietary Marker. *Bulletin of Marine Science*, *36*(1), 224-230.

Choct, M. (1999). Soluble Non-starch Polysaccharides Affect Net Utilization of Energy by Chickens. *Recent Advances in Animal Nutrition- Australia, 12*, 31-35.

De Groote, G., Reyntens, N. & Amich-Gali, J. (1970). The Metabolic Efficiency of Energy Utilization of Glucose, Soybean Oil, and Different Animal Fats by Growing Chicks. *Poultry Science,50*(3), 808-819.

Dourado, L. R. B., Siquiera, J. C., Sakomura, N. K., Pinheiro, S. R. F., Marcato,S. M., Fernandes, J. B. K. & Silva, J. H. V. (2010). Poultry Feed Metabolizable Energy Determination using Total or Partial Excreta Collection Methods. *Brazilian Journal of Poultry Science, 12*(2), 129-132.

Englyst, H. (1989). Classification and Measurement of Plant Polysaccharides. *Journal Animal Feed and Science Technology*, *23*, 27-42.

Hagen, M. (1999). The Metabolizable Energy of Sunflower Seed Kernel in Goffin's Cockatoo (*Cacatua goffini*) and The Review of The Amino Acid and Fatty Acid Composition of Oil Seed Eaten by Parrots.[Online]. Taken from http://shell.pubnix.net/~mhagen//docu/papers.html [10 September 2013].

Martin, E. A. &Farrell, D. J. (1998). Strategies to improve the nutritive value of rice bran in poultry diets. I. The addition of food enzymes to target the non-starch polysaccharide fractions in diets of chickens and ducks gave no response. *British Poultry Science 39*, 549–554.

http://dx.doi.org/10.1080/00071669888755

McDonald, P., Edwards, R. A. & Greenhalgh, J. F. D.(1981). *Animal Nutrition*. 3rd Edition. London: Longman Inc.

Olukosi, O. A. & Adeola, O. (2009). Estimation of Metabolizable Energy Content of Meat and Bone Meal for Swine. *Journal of Animal Science, 87*, 2590-2599.

Prayogi, H. S. (2007). Pengaruh Penggunaan Minyak Kelapa dalam Ransum terhadap Konsumsi Pakan, Peningkatan Bobot Badan, Konversi Pakan, dan Karkas Broiler Periode Finisher. *Jurnal Ternak Tropika, 7*(2), 18-27.

Sales, J., de Schutter, L. &Janssens, G. P. J. (2004). The Use of Internal Markers to Determine Metabolizable Energy and Digestibility of Diets in the African Grey Parrot (*Psittacus erithacus*). *Vlaams Diergeneeskundig Tijdschrift* , *73*, 176-181.

Sales, J. & Janssens, G. P. J. (2006). A Note on Ash as Indigestible Dietary Marker to Determine Digestibility of Seeds in Adult Granivorous Birds. *Journal of Animal Feed Science and Technology, 15*, 97-102.

Sibbald, I. R. (1987). Estimation of Bioavailable Amino Acids in Feedingstuffs for Poultry and Pigs: A Review with Emphasis on Balance Experiments. *Canadian Journal of Animal Science*, *67*, 221-300.

Suprijatna, E., Atmomarsono, U. & Kartasudjana, R. (2005). *Ilmu Dasar Ternak Unggas*. Jakarta: Penebar Swadaya.

Svecevicius, G. 2009. Use of behavioral responses of rainbow trout Oncorhynchus mykiss in 1 dentifying sublethal exposure to hexavalent chromium. *Bull. Environ. Contam. Toxicol*., *82*, 564-568.

Titgmeyer, E. C., Armendariz,C. K., Bindel, D. J. Greenwood, R. H. & Loest, C. A. (2001). Evaluation of Titanium Dioxide as A Digestibility Marker for Cattle. *Journal of Animal Science, 75*, 2234-2247.

Zarei, A. (2006). Apparent and True Metabolizable Energy in Artemia Meal. *International Journal of Poultry Science, 5*(7), 627-628.