Nutrient Digestibility of Palm Kernel Cake for Muscovy Ducks

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ABSTRACT : Expeller pressed and solvent extracted palm kernel cake (PKC) were force-fed to male and female Muscovy ducks at 7 weeks of age. The nutrient digestibility, apparent metabolizable energy (AME), true metabolizable energy (TME) and true available amino acid (TAAA) digestibilities were determined. There was no significant (p>0.05) effect of the type of PKC used on crude protein (CP), ether extract (EE), metabolizable energy (ME) and amino acid (AA) digestibilities. However, digestibilities of dry matter (DM) and neutral detergent fibre (NDF) was found to be higher in solvent extracted compared to expeller pressed PKC. The average digestibility of DM, CP, NDF and EE were 43, 58, 39 and 89%, respectively. It was found that the ducks utilized about 47% of the gross energy of PKC. The respective average AMEn and TMEn values of PKC for Muscovy ducks was 1,743 and 1,874 kcal/kg. The overall TAAA of PKC for Muscovy ducks was 65%. The data on the TMEn and digestible AA for PKC obtained from this study provide new information with regard to diet formulation for Muscovy ducks. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 4 : 514-517)***

Key Words : PKC, Metabolizable Energy, Digestible Amino Acid, Muscovy Ducks

INTRODUCTION

Energy values used to formulate diets for ducks are usually obtained from tables of chicken bioassay data. However, published results of comparisons between the two species in terms of nitrogen (N) and energy metabolism are variable. Mohamed et al. (1984) found that the ME values of several feedstuffs were very similar for ducks and broiler chickens. On the other hand, Sugden (1974) reported that bantams chicken metabolized more energy from the four-diets compared to teal ducks. Results of King et al. (1997) suggested that TME values obtained with chickens cannot be always extrapolated to ducks.

PKC is known to be a valuable source of protein and energy and commonly used as feed for ruminants. However, the utilization of PKC for monogastric animals was limited mainly because of its high fibre content and low palatability (Ravindran and Blair, 1992). There are few studies reported on the AME values of PKC for chickens. Bolton and Blair (1974) reported that PKC contained 1,610 kcal/kg, whereas lower values of 1,480 and 1,491 kcal/kg were reported by Yeong et al. (1981) and Chong et al. (1998), respectively. The lower ME value of PKC may be related to the high NDF content, which was reported to be between 66.8-70.1% as reported by Onifade and Babatunde (1998) and Chong et al. (1998).

Published values on the digestibility of energy, chemical components and amino acid profile of PKC for ducks is lacking. Thus, the objectives of this study is to determine the nutrient digestibility and the ME value of two types of PKC using male and female Muscovy ducks at 7 weeks of age.

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MATERIALS AND METHODS

Analysis of PKC samples

Two types of PKC were used in this study. Both types of PKC were obtained from two different palm kernel crushers in Malaysia. The expeller-pressed PKC was obtained from Penang State, while the solvent-extracted PKC obtained from Johore State. Proximate analysis of the DM, CP, EE and ash were carried out following the procedures outlined by Association of Official Analytical Chemists (AOAC, 1984). Mineral analysis was performed using atomic absorption spectrophotometer (AAS). Phosphorus (P) was measured using spectrophotometric method (Thomas et al., 1967). Gross energy (GE) was measured with an adiabatic oxygen bomb calorimeter (Parr, USA). Neutral detergent fibre (NDF) was analysed according to Van Soest and Wine (1967) and acid detergent fibre (ADF) were determined according to Van Soest (1963). Acid hydrolyses by 6 N HCl for 24 h was used for amino acid analysis according to the method described by Bidlingmeyer et al. (1984).

Birds

Twenty-eight male and female day old Muscovy ducks (fourteen from each sex) were purchased from Department of Veterinary Services hatchery. The birds were divided into two equal groups, each consisted of fourteen birds. There was four treatments comprised of two types of PKC (expeller-pressed and solvent-extracted PKC) and both sexes.

Table 1. Nutrient composition of PKC tested in the metabolic study

Nutrients	Expeller-PKC	Solvent PKC	SE
Dry matter, %	90.87	91.43	0.26
Crude protein, %	16.23	16.65	0.24
Ether extract, %	4.12[a]	1.03[b]	0.18
Gross energy, kcal/kg	4,153[a]	3,956[b]	19.73
Ash, %	5.10[a]	4.20[b]	0.03
Neutral detergent fibre, %	61.54	61.09	0.34
Acid detergent fibre, %	36.14[a]	34.31[b]	0.29
Hemicellulose, %	25.40	26.78	0.31
Calcium, %	0.27	0.27	0.01
Phosphorus, %	0.46	0.48	0.01
Magnesium, %	0.11	0.12	0.01
Copper, ppm	25.52	26.88	0.84
Zinc, ppm	53.91	52.06	0.56
Manganese, ppm	259	227	10.24
Iron, ppm	2,024[a]	993[b]	36.79

[a, b] means within row with no common superscript differ significantly ($p<0.05$).

Table 2. Amino acid content (%) of PKC used in metabolic study (air-dried basis)

Amino acids	Expeller PKC	Solvent PKC	SE
Aspartic acid	1.32	1.27	0.06
Glutamic acid	3.34	3.33	0.02
Serine	0.99	0.75	0.06
Glycine	0.71	0.67	0.03
Histidine	0.16	0.17	0.01
Arginine	2.01	1.99	0.02
Threonine	0.51	0.46	0.04
Alanine	0.98	0.94	0.02
Proline	0.60	0.58	0.02
Tyrosine	0.35	0.38	0.04
Valine	0.65	0.65	0.01
Methionine	0.30	0.31	0.03
Cystine	0.12	0.11	0.01
Isoleucine	0.46	0.47	0.02
Leucine	0.88	0.95	0.02
Phenylalanine	0.61	0.65	0.02
Lysine	0.38	0.42	0.04

Means are not significantly different ($p>0.05$).

Housing and Feeding Procedure

The ducks were housed in battery cages and fed commercial pelleted diets during the pre-experimental period. At the age of 7 weeks, the birds were moved to individual metabolic cages measured at 30×50×45 cm (length×width×height). Once in the cages, they were provided commercial pellets for *ad libitum* consumption during 3 days adaptation period under continuous light.

All the birds were deprived of feed for 24 h to ensure that their alimentary canals were empty of feed residues. They were then force-fed the specific amount of PKC. Stainless steel funnel with 40 cm stem was used in force feeding technique. The amount of PKC used was 40 and 30 g for male and female, respectively. This amount was based on preliminary assays with male and female Muscovy ducks using PKC. Once fed, the birds were kept over excreta collection trays and their housing time was recorded. Excreta voided from 0 to 24 h and from 24 to 48 h (which represent metabolic plus endogenous excretion) after housing were collected quantitatively. Each bird served as its own negative control to estimate metabolic and endogenous excretion (Sibbald, 1980). Water was available *ad libitum* during the experimental period.

The total excreta were collected in plastic trays. The excreta samples were frozen, allowed to come to equilibrium with the atmospheric moisture, weighed, and ground through a 1 mm sieve. Samples of excreta and PKC were subjected to appropriate analysis to determine DM, CP, fibre, EE and energy as well as AA digestibilities.

Calculations

The data were used to calculate AME, AMEn, TME and TMEn values according to the following formulae:

$$AME=IE-FE$$
$$TME=AME+FEL$$

Where IE=ingested energy; FE=fecal energy voided by the fed birds; while FEL=fasting energy loss by the unfed birds.

The values corrected to zero N balance, AMEn and TMEn, are calculated as follows:

$$AMEn=AME-(8.22\times ANR/FI)$$
$$TMEn=TME-(8.22\times FNL/FI)-(8.22\times ANR/FI)$$

Where ANR=apparent N retention; FI=feed intake; and FNL=fasting N loss by the unfed bird; The factor 8.22 kcal/g for N retained in the body has been used according to Hill and Anderson (1958).

The TAAA were calculated according to the following formula:

$$\text{TAAA (\%)}=\frac{\text{AA input-(AA output-AA correction)}}{\text{AA input}}\times 100$$

Statistical analysis

Data were subjected to analysis of variance (ANOVA) based on a 2×2 factorial arrangement with interaction using SPSS (1999). Duncan's multiple range test was used to compare treatment means.

RESULTS AND DISCUSSION

The proximate analysis of both types of PKC is shown in Table 1. There was no significant difference in DM and CP between the extracted and the expeller-pressed PKC.

Table 3. Average amino acid composition of PKC compared to NRC (1994) requirements for ducks at growing period

Amino acid	NRC (1994)	PKC (average of four samples)
Arginine	1.0	2.0
Isoleucine	0.46	0.47
Leucine	0.91	0.92
Valine	0.56	0.65
Lysine	0.65	0.40
Methionine	0.30	0.31
Methionine+cystine	0.55	0.43

Table 4. Dry matter, CP, EE and NDF digestibilities of PKC for male and female Muscovy ducks

Ingredient	Sex	Percent digestibility			
		DM	CP	EE	NDF
PKC expeller	Male	41.20^{b}	53.37^{b}	89.24	36.52^{b}
PKC solvent	Male	44.09^{a}	55.39^{b}	87.89	41.00^{a}
PKC expeller	Female	41.30^{b}	63.29^{a}	90.05	36.10^{b}
PKC solvent	Female	44.34^{a}	61.32^{a}	89.76	40.51^{a}
SE		1.22	2.09	3.87	1.24

^{a,b} means within column with no common superscript differ significantly ($p<0.05$).

The latter was significantly ($p<0.05$) higher in GE, EE, ash and ADF compared to the former. Both expeller and solvent-extracted PKC contained a comparable and high amount of NDF. There was no difference in the amount of Ca, P, Mg, Cu, Zn and Mn. However, the content of Fe in solvent-extracted PKC was significantly lower ($p<0.05$) than that of the expeller-pressed PKC (993 vs. 2,024 ppm). It is interesting to note that high Fe supplementation of 800 ppm to broiler starter diet resulted in depressing feed intake and body weight gain as compared to chicks fed corn-soyabean meal diet containing 188 ppm iron (Cao et al., 1996).

Amino acid content of expeller-pressed and solvent-extracted PKC are presented in Table 2. No significant difference in the amino acid content which could be attributed to the source or type of PKC.

It was found that PKC was adequate in arginine, isoleucine, leucine, valine and methionine when compared to the AA requirements given by the National Research Council (NRC) (1994) for growing ducks (Table 3). However, PKC is deficient in lysine and cyctine. The amino acid content of PKC was generally in line to those reported by Yeong (1983) and Bolton and Blair (1974).

The apparent digestibilities of DM, CP, EE and NDF of PKC are presented in Table 4. No effect was observed in EE and CP digestibility between the two types of PKC. However, NDF digestibility was significantly ($p<0.05$) higher in solvent- extracted PKC as compared to expeller-pressed PKC, probably may be due to a higher ADF content in the latter.

The digestibility of fat ranged between 88-90%, which is considered highly digestible. CP digestibility was 53-63%

Table 5. AME, AMEn, TME and TMEn values of PKC for male and female Muscovy ducks

Ingredient	Sex	AME	AMEn	TME	TMEn
		kcal/kg			
PKC expeller	Male	1,866	1,752	2,074	1,893
PKC solvent	Male	1,825	1,704	2,033	1,844
PKC expeller	Female	1,920	1,785	2,063	1,906
PKC solvent	Female	1,868	1,731	2,042	1,852
SE		62.24	61.88	51.72	61.87

Means are not significantly different ($p>0.05$).

Table 6. True amino acid availability (%) of PKC of male and female Muscovy ducks

Amino acids	Expeller PKC		Solvent PKC		SE
	Male	Female	Male	Female	
Aspartic acid	62.43	66.94	67.57	68.11	2.37
Glutamic acid	64.96^{b}	83.39^{a}	67.20^{b}	83.57^{a}	0.77
Serine	68.37	69.38	61.72	66.81	2.52
Glycine	74.23	75.71	69.99	69.15	2.17
Histidine	51.52	58.73	57.72	58.85	2.87
Arginine	87.59	89.49	88.77	87.04	1.23
Threonine	61.30^{b}	77.13^{a}	64.34^{b}	71.30^{a}	2.60
Alanine	59.99	44.12	58.47	44.12	3.96
Proline	67.18	67.02	68.63	64.83	0.98
Tyrosine	67.75	71.84	72.89	67.61	1.04
Valine	65.41^{b}	70.43^{a}	66.87^{a}	68.30^{ab}	0.84
Methionine	62.21^{b}	69.48^{a}	68.94^{a}	69.12^{a}	1.45
Cystine	44.98	45.97	44.11	47.36	1.09
Isoleucine	60.33^{b}	66.72^{a}	61.71^{ab}	64.75^{ab}	1.28
Leucine	65.34	69.75	67.88	70.65	1.43
Phenylalanine	68.88	72.39	71.97	71.89	0.90
Lysine	45.49^{b}	49.25^{ab}	47.19^{ab}	55.16^{a}	2.04

^{a,b} means within row with no common superscript differ significantly ($p<0.05$).

and significantly ($p<0.05$) higher in female than in male. Total protein content and feather protein was reported to be higher in female Muscovy ducks compared to males during the growing period (Leclercq and de Carville, 1986). This could explain the higher digestibility of CP in females than in males. The digestibility of NDF ranged between 36-41% for male and female ducks. The digestibilities of NDF reflect the hemicellulose content of feed ingredient (Farhat et al., 1998). The percentage of hemicellulose relative to NDF content was 41.27 and 43.84% for expeller-pressed and solvent-extracted PKC, respectively. This might be the reason for the higher digestibility of NDF in the former as compared to the latter.

Data on AME and TME values for PKC are shown in Table 5. No significant difference was found which could be attributed to sexes or PKC. The average AME value of PKC was 1,870 kcal/kg and AMEn, TME and TMEn values were 1,743, 2,053 and 1,874 kcal/kg, respectively. The AME value obtained in this study was higher than those reported in broiler chickens (Yeong et al., 1981; Chong et al., 1998) and from those of adult cockerels (Daud, 1992) with values of 1,491, 1,480 and 1,295 kcal/kg, respectively.

This could suggest that the ME value of PKC determined for Muscovy ducks might be higher from those of chickens.

Percent true available amino acid of PKC ranged from 45.6% for cystine to 88.2% for arginine with an average of 65.17% (Table 6). Total true amino acid digestibility for male and female Muscovy ducks fed expeller-pressed PKC was 63.41 and 66.86%, and values of 65.06 and 67.52% for male and female ducks fed solvent-extracted PKC, respectively. There was no significant ($p>0.05$) difference in amino acid digestibility between the two types of PKC. However, females fed expeller-pressed PKC significantly ($p<0.05$) digested more glutamic acid, threonine, valine, methionine and isoleucine than males. Digestibility of glutamic acid and threonine of solvent-extracted PKC were significantly ($p<0.05$) higher for females fed than for males. As such, the protein requirements for male and female Muscovy ducks could be different during the growing period. However, additional work is required to confirm this issue.

IMPLICATIONS

The data from this study provide new information on ME content and digestible amino acid of PKC for Muscovy ducks. These results are important to formulate practical diet for ducks.

REFERENCES

AOAC. 1984. Official Methods of Analysis. 14th edn. Association of Official Analytical Chemists, Washington, DC.

Bidlingmeyer, B. A., S. A. Cohen and T. L. Travin. 1984. Rapid analysis of amino acids using pre-column derivatization. J. Chromatogr. 336:93-104.

Bolton, W. and R. Blair. 1974. Poultry Nutrition. 4th Ed. Ministry of Agriculture, Fisheries and Food. Bulletin No. 174, HMSO, London.

Cao, J., X. G. Luo, P. R. Henry, C. B. Ammerman, R. C. Littell and R. D. Miles. 1996. Effect of dietary iron concentration, age, and length of iron feeding on feed intake and tissue iron concentration of broiler chicks for use as a bioassay of supplemental iron sources. Poult. Sci. 75:495-504.

Chong, C. H., R. Blair, I. Zulkifli and Z. A. Jelan. 1998. Physical and chemical characteristics of Malaysian palm kernel cake (PKC). In: Proceedings of the 1998. Malaysian Society of Animal Production Annual Conference, Putrajaya, Malaysia. pp. 62-63.

Daud, M. J. 1992. Nutritional Improvement of Palm Kernel Cake for Poultry Diets. Ph.D. Thesis, University of Glasgow, Scotland, United Kingdom.

Farhat, A. L. Normand, E. R. Chavez and S. P. Touchburn. 1998. Nutrient digestibility in food waste ingredients for Pekin and Muscovy ducks. Poult. Sci. 77:1371-1376.

Hill, F. W. and D. L. Anderson. 1958. Comparison of metabolizable energy and productive energy determinations with growing chicks. J. Nutr. 64:587-603.

King, D., D. Ragland and O. Adeola. 1997. Apparent and true metabolizable energy values of feedstuffs for ducks. Poult. Sci. 76:1418-1423.

Leclercq, B. and H. de Carville. 1986. Dietary energy, protein and phosphorus requirements of Muscovy ducks. In: Duck Production: Science and World Practice (Ed. D. J. Farrell and P. Stapleton). University of New England. pp. 58-69.

Mohamed, K., B. Leclercq, A. Anar, H. El-Alaily and H. Soliman. 1984. A comparative study of metabolisable energy in ducklings and domestic chicks. Anim. Feed Sci. and Technol. 11:199-205.

National Research Council. 1994. Nutrient requirements of poultry. 9th Ed. National Academy Press, Washington, DC.

Onifade, A. A. and G. M. Babatunde. 1998. Comparison of the utilisation of palm kernel meal, brewers' dried grains and maize offal by broiler chicks. Br. Poult. Sci. 39:245-250.

Ravindran, V. and R. Blair. 1992. Feed resources for poultry production in Asia and the Pacific. II. Plant protein sources. World's Poult. Sci. J. 48:3, 205-231.

Sibbald, I. R. 1980. The effect of dietary cellulose and sand on the combined metabolic plus endogenous energy and amino acid outputs of adult cockerels. Poult. Sci. 59:836-844.

SPSS, 1999. Statistical Package for Social Scientists. SPSS Inc., Chicago, IL.

Sugden, L. G. 1974. Energy metabolized by bantam chickens and blue winged teal. Poult. Sci. 53:2227-2228.

Thomas, R. L., R. W. Sheard and J. R. Moyer. 1967. Comparison of convention and automated procedures for nitrogen, phosphorus and potassium analysis of plant material using a single digestion. Agron. J. 59:240-243.

Van Soest, P. J. 1963. Use of detergents in the analysis of fibrous feeds. 2. A rapid method for the determination of fiber and lignin. J. Assoc. Off. Anal. Chem. 46:829-835.

Van Soest, P. J. and R. H. Wine. 1967. Use of detergents in the analysis of fibrous feeds. IV. Determination of plant cell wall constituents. J. Assoc. Off. Anal. Chem. 50:50-55.

Yeong, S. W. 1983. Amino acid availability of palm kernel cake, palm oil sludge and sludge fermented product (PROLIMA) in studies with chickens. MARDI Research Bulletin, 11:1, 84-88.

Yeong, S. W., T. K. Mukherjee and R. I. Hutagalung. 1981. 4. The nutritive value of palm kernel cake as a feedstuff for poultry. In: Proceedings of the national workshop on oil palm by-product utilization. Kuala Lumpur, Malaysia. pp. 100-107.