Journal of Animal and Veterinary Advances 11 (20): 3749-3754, 2012
ISSN: 1680-5593

Evaluation of the Palatability of Palm Oil Decanter Meal Preserved with Ground Cinnamon Stick (*Cinnamomum burmannii*) on Goat

[1,3]M. Afdal, [1]Azhar Kasim, [1]A.R. Alimon and [2]N. Abdullah
[1]Department of Animal Science, Faculty of Agriculture,
[2]Department of Biochemistry, Faculty of Biotechnology and Biomolecular Science,
Universiti Putra Malaysia, 43300 Selangor, Malaysia
[3]Faculty of Animal Husbandry, Jambi University Kampus Mandalo Darat, 36361, Indonesia

Abstract: The aim of this study was to recognize the palatability of Ground Cinnamon (GS) treated Oil Palm Decanter Meal (OPDM) on goats. Goats were placed in an individual cage attached with 3 separated adjustable feed containers. It was spent for adaptation period of 7 days to familiarize animal with the experimental feed. Then all animals were offered with three alternatives feed namely RS as a standard feed, untreated OPDM (UDM) and GS treated OPDM (GDM) over a 15 days experimental period. The chemical composition including ash, Organic Matter (OM), Crude Protein (CP), Ether Extract (EE), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) of both GDM and UDM was not significantly different ($p>0.05$) among experimental feed. Intakes on day 1 and average on day 5, 10 and 15 were significantly different ($p<0.05$) among four different experimental feeds. After removing of RS on day 5, intake of GDM significantly ($p<0.05$) increased and be the highest in comparison with UDM and NG. In conclusion, the chemical composition of GDM was not different from that of UDM therefore GDM could be used as animal feed. GDM could be accepted as edible feed for goat as it was higher intake of than that of UDM.

Key words: Oil palm decanter meal, cinnamon stick, palatability, intake, goats

INTRODUCTION

Oil Palm Decanter Meal (OPDM) is a pasty-type, by-product derived from mechanical extraction of crude palm oil (Afdal *et al*., 2011). It is a solid type, the product of decanting, centrifuging and thermal application. Sulong (1991) mentioned that OPDM was aroused as a result of decanting, centrifuging and thermal application at the plant having facility of 3rd phase (decanter) that can separate OPDM from oil palm sludge. This product has potential value as sources of feed for domestic livestock or wildlife as Stanton (1983) and Chavalparit *et al*. (2006) recommended the use of OPDM as animal feed. Some studies were done to utilize fresh OPDM for cow (Pimpa *et al*., 2009), sheep and goat (Manso *et al*., 2006; Utomo, 2001), buffalo (Mahyuddin and Praharani, 2010) and poultry (Isika *et al*., 2006).

The weakness of OPDM is easy to turn rancid when kept at open air. Rancidity was judged to be related to the subjective organoleptic consideration of the off flavor quality of food and usually it was an unpalatable odor and flavor of the oils (Hamilton, 1994). OPDM would turn rancid and mouldy when allowed to stand on open air for few days (Afdal *et al*., 2011). This might be due to the fact that OPDM still consisted of 1.5% crude palm oil therefore, it turned rancid when kept on open air yeast and fungi also start to grow. Many experimental research have been done concerning the antioxidant activity from natural sources (Tangkanakul *et al*., 2005) such as cinnamon, turmeric, clove, black pepper, nutmeg, dry ginger, rosemary, sage and paprika (Chang *et al*., 1977; Nakatani *et al*., 1986; Kikuzaki and Nakatani, 1993; Tomaino *et al*., 2005). Many plant extracts were efficiently applied in fats and fat containing food (Bracco *et al*., 1981) added that rosemary and sage plant could prolong the induction period in chicken fat and show antioxidant activity comparable with butylated hydroxyanisole and Butylated Hydroxytoluen (BHT). Ground cinnamon stick (*Cinnamomum burmannii*) (GS) had successfully been used to preserve OPDM in which it could reduce 55% of rancidity of OPDM after 10 days collected from palm oil mill in comparison with control (Afdal). As far as, we know, there was no information concerning the palatability of OPDM preserved with GS on any animals.

Corresponding Author: M. Afdal, Department of Animal Science, Faculty of Agriculture, Universiti Putra Malaysia, 43300 Selangor, Malaysia

This information can be very useful to maximize the utilization of preserved OPDM as feed. For these reasons, the aim of this study was to recognize the palatability of GS-preserved OPDM on goat.

MATERIALS AND METHODS

Feed and animals: About 100 kg of OPDM were treated with 200 g of GS (0.2% w/w) for 10 days. Some other 100 kg of untreated samples were kept at a fridge at -20°C prior to be used. Rice Straw (RS) was collected from Tanjungkarang and Napier Grass (NG) was harvested from the Farm 2, Universiti Putra Malaysia. Both RS and NG were chopped in 3 cm length.

Four Kacang Boer cross goats aged 1-2 years old were placed in 2×1 m individual cage attached with 3 separated adjustable feed containers. Each container was placed for each different experimental feed.

Experimental procedure: This experiment followed the cafeteria method created by Salem *et al.* (1994). Approximately 7 days prior to data collection it was spent for adaptation period to familiarize animal with the experimental feed. All animals were offered with three alternatives feed namely RS as a standard feed, untreated OPDM (UDM) and GS treated OPDM (GDM) >15 days experimental period. From days 1-15 of experimental period, animal received *ad libitum* all three experimental diets. RS was prepared at the amount of 600 g per goat per day during the first 5 days (days 1-5) and from days 6-15 RS was removed. All feed were offered once daily at 08.00. In addition, animal also received 2.4 kg of fresh NG allowing them to meet their requirement (at least maintenance) at the end of the day (at 17.00). Order of distribution feeds was randomly changed three times a day at 08.00, 11.00 and 14.00 in order to avoid habit reflex. All animals access to water *ad libitum*.

Measurement and chemical analysis: Offered feeds and refusal related to each feed sample were collected for each animal. All collected samples were oven-dried at 105°C for the Dry Matter (DM) determination. Subsample of each feed were pooled by combination, dried at 60°C in an oven, ground through 1 mm screen and then stored for next analysis. Organic Matter (OM) calculated as DM minus ash content, Crude Protein (CP) determined by Micro-Kjeldah Method and calculated as the conversion from nitrogen multiplied with a factor of 6.25 and Crude Fat (CF) calculated as DM minus residue from ether extract (AOAC, 1990). Neutral Detergent Fiber (NDF) based on the ability of neutral detergent to solubilize non-fibrous component and Acid Detergent Fiber (ADF) based on the ability of acid detergent to solubilize non-fibrous component were determined by method described by Van Soest (1963).

OM digestibility of experimental feed was measured by nylon bag technique (Orskov *et al*., 1980). Goats fitted with rumen cannula and fed with RS based diet and 800 g of concentrate (65% hay grain) was used for this purpose. The feed sample were ground through 1 mm screen and 3 g sample were placed in duplicate in nylon bags (6.5×11 cm, pore size 50 μ) (International Feed Resources Unit, Aberdeen, UK) and incubated for 24 and 48 h. After incubation, bags were washed and dried for 24 h at 105°C in order to determine the undegraded fraction. Residues were thereafter ashed (550°C) in order to determine OM content.

Parameter measured and calculation: The following parameters were measured in this present study included RS intake on day 1 (g DM) (HI_1), feed sample intake on day 1 (g DM) (I_1), average RS intake on the first 5 days period (g DM) (HI_5), average feed sample intake on the first 5 days period (g DM) (I_5), average feed sample intake on the second 5 days period (g DM) (I_{10}), average feed sample intake on the third 5 days period (g DM) ($I1_5$), amount of RS offered on day 1 (HD_1), average amount of RS offered on the first 5 days period (HD_5), amount of feed sample offered on day 1 (D_1), average amount of feed sample offered on the 1st 5 days period (g DM) (D_5), average amount of feed sample offered on the second 5 days period (g DM) (D_{10}) and average amount of feed sample offered on the third 5 days period (g DM) (D_{15}). Some ratios of feed intake and offered were then calculated as I_1/D_1, I_5/D_5, I_{10}/D_{10}, I_{15}/D_{15}, $(I_1/D_1)/(HI_1/HD_1)$ and $(I_5/D_5)/(HI_5/HD_5)$.

Statistical analysis: This study was run in completely randomized design with 4 treatments including GDM, UDM, RS and NG and 4 goats as replicate. Anova followed by Duncant test was applied. Regression analysis was also applied on each parameter measured. All statistical tests were conducted at 95% confidence level using SAS (2008) (SAS Inst. Inc., Cary, NC, USA).

RESULTS AND DISCUSSION

Chemical composition: The chemical composition of experimental feed including GDM, UDM, RS and NG is shown in Table 1. The DM composition of both GDM and UDM is slightly higher than that of NG but it is lower than that of RS, a standard feed. The chemical composition including ash, OM, CP, EE, NDF and ADF, of both GDM and UDM was not significantly different (p>0.05). CP content was considered moderate and NDF and ADF

Table 1: Mean of chemical composition and *in sacco* Dry Matter Digestibility (DMD) of experimental feed

	Nutrient content (%)						DMD (%)		
Feed	DM	Ash	OM	CP	EE	NDF	ADF	24 h	48 h
GDM	28.08	12.43	97.57	12.89	8.09	64.58	44.09	36.76	57.45
UDM	27.23	12.44	97.56	11.71	7.31	65.70	45.96	36.49	57.65
RS	98.41	20.34	79.66	5.57	0.13	83.02	64.32	35.45	49.97
NG	24.29	11.46	78.54	6.13	1.19	62.70	43.25	58.76	73.21

Table 2: Feed intake of experimental goats

	Feed				
Feed intake	GDM	UDM	NG	RS	p-values
Intake (kgDM day^{-1})					
I_1	211.16 ± 72.28^{ab}	362.74 ± 92.50^{a}	273.31 ± 42.52^{ab}	86.11 ± 21.31^{b}	0.0548
I_5	288.08 ± 57.45^{b}	355.59 ± 5.370^{a}	234.88 ± 11.49^{b}	42.45 ± 11.66^{c}	<0.0001
I_{10}	499.24 ± 39.38^{a}	285.88 ± 18.44^{b}	153.72 ± 22.03^{c}	-	<0.0001
I_{15}	487.75 ± 21.47^{a}	287.85 ± 12.24^{b}	156.52 ± 23.34^{c}	-	<0.0001
Intake (% of offered)					
I_1/D_1	39.03 ± 10.44	69.14 ± 17.98	69.60 ± 10.44	68.75 ± 6.25	0.2488
I_5/D_5	48.68 ± 8.430^{ab}	64.49 ± 2.430^{a}	65.19 ± 5.920^{a}	38.16 ± 8.33^{b}	0.0314
I_{10}/D_{10}	57.46 ± 5.950	62.87 ± 2.400	52.98 ± 6.400	-	0.4340
I_{15}/D_{15}	81.93 ± 1.900^{a}	66.11 ± 1.100^{b}	46.30 ± 4.570^{c}	-	<0.0001
Itake (% of rice straw intake)					
R1	55.20 ± 12.13	108.4235.290	100.09 ± 8.910	100	0.2448
R2	122.64 ± 22.93	168.51 ± 41.23	157.90 ± 21.77	100	0.2686

Different superscript within a column is significantly different; I_1: Intake at day 1, I_5: Average intake at day 5, I_{10}: Average intake at day 10, I_{15}: Average intake at day 15, D: Diet offered, R1 = (I1/D1)/(HI1/HD1), R2 = (I5/D5)/(HI5/HD5), HI: Rice straw intake. GDM: Treated Decanter Meal, UDM: Untreated Decanter Meal, RS: Rice Straw, NG: Napier Grass

content were considered high in agreement with McDonald *et al*. (1988). Benchamaporn *et al*. (2009) stated that CP content and energy of OPDM are similar to rice bran. Harfiah (2007) stated that the chemical composition of OPDM was comparable to that of rice bran containing 13.26% of CP so OPDM could be possible used as replacement of rice bran. McDonald *et al*. (1988) and Utomo *et al*. (2004) suggested that ruminant could tolerate feed containing high in fibre and low CP. Fermented GDM might be possibly applied in non ruminant diet as Umar and Rahmatsyah (2006) fermented OPDM with *Aspergillus niger* in duck feed. It might also be possibly prepared as a single feed or as a mixed diet for animal feeding (Abubakr *et al*., 2012; Alimon *et al*., 2012).

The DMD of all feed at 24 and 48 h incubations was not similar (Table 1). It was higher DMD at 48 h than those at 24 h as a time effect. DMD of both GDM and UDM was at least around 57% after 48 h incubation. It was higher than that of RS, a standard feed but lower than that of NG. This might be due to that the different kind of feed as the chemical composition effect. High NDF and ADF content might influence on DMD. DMD of both GDM and UDM might be classified moderate according refer to Salem *et al*. (1994).

Intake and palatability results: Intake of each experimental feed is shown in Table 2. It describes intake on day 1, average intake up to day 5, 10 and 15. Intakes on day 1 and average on day 5, 10 and 15 were significantly different ($p<0.05$) among four different experimental feeds. Intake of RS, a standard feed was less than GDM, UDM and NG. This was different from results studied by Salem *et al*. (1994), in which the standard feed was the highest intake in comparison to the rest of the feeds during first 5 days period. This might be indicating that GDM, UDM or NG looked more palatable than standard feed. The intake of each single feeds is obviously different as those feed at the present study contains a different chemical composition. Intake might be linked that four experimental feeds were different taste, texture and chemical composition. Abdel-Moneim and Abd-Alla (1999) reported that intake was affected by feed characteristics such as taste, texture and morphological structure.

During 15 days of this present study, it was divided into three subperiod of 5 days, the intake of GDM looks increase but those of other feeds including UDM, RS and NG seems decrease (Fig. 1). During first 5 days subperiod, the highest intake was UDM and for second and thirrd 5 days subperiod, the highest intake was GDM. After removing of RS, intake of GDM increased and intake of each UDM and NG decreased at the same time. Preference of goat to eat UDM in first subperiod might be possibly because of the characteristic of UDM might not be relatively change or still fresh yet as UDM was neither rancid nor change in chemical composition yet. Decruyenaere *et al*. (2009) reported that factors affecting animal to eat feed including flavor (taste and smell), appearance, texture and by the post-ingestive feedback occurring after its intake.

Intake of NG was less in comparison with both intake of GDM and UDM. This might be due to the fact that NG was fed at 17.00 in which animals were full as animals were previously fed other diets from morning. Yearsley *et al.* (2001) stated that on a requirement theory basis, the animal eats in order to maximize its production potential under some constrains such as its gut volume and diet quality.

After removing of RS on day 5, intake of GDM significantly ($p<0.05$) increased and be the highest in comparison with UDM and NG. This might be GDM had been already preserved with ground cinnamon stick as it was less rancidity and less chemical composition exchange in comparison with UDM without preservation. Therefore, animals prefer to eat GDM as by the post-ingestive feedback reason (Decruyenaere *et al*., 2009).

Table 3 shows the correlation coefficient among intake parameter during experiment. For all experimental feed offered in the presence of rice straw (during the first 5 days), a much close relationship ($r = 0.97$) was found between measurement of RS intake for day 1 and for average of experimental feed during first 5 days subperiod (Table 3). A relationship was also found between I_5 and I_{10} ($r = 0.76$) or I_{15} ($r = 0.38$). A close relationship was also observed between I_{10} and I_{15} ($r = 0.48$).

The regression equation of calculated intake of experimental feed during 15 days can be seen in Table 4. Base on the equation, the prediction of intake during 15 days (I_{15}) was less correlated and not significant in comparison with results found by Salem *et al.* (1994). They reported that increasing of the measurement duration up to 15 days improved the prediction rate slightly but significantly. The reason might be possibly due to the fact that feed tested in this present studies were only four feeds including GDM, UDM, RS (standard feed) and NG (supplement feed). It is therefore difficult to clarify since palatability is complex and controlled by many factors (Allison, 1985). Baumont (1996) also explained that palatability depended on what intake or behavioral parameters are recorded and whether only one or more than one feed is offered. It might be probably less important when no choice is given to a stall fed animal. In this present study during day time goats were only provided by GDM (treated) and UDM (untreated) while NG was available at 17.00.

Effect of quantity of feed offered on intake: Intake is closely linked to the amount of food offered. Table 2 and Fig. 1 show percentage the amount of feed offered. I_1/D_1 was correlated to I_5/D_5, I_{10}/D_{10} and I_{15}/D_{15}. These ratio is also correlated to $(I_1/D_1)/(HI_1/HD_1)$ and $(I_5/D_5)/(HI_5/HD_5)$ ratio. The index for palatability ranking of experimental feed based on standard feed Salem *et al.* (1994) with slightly modified with RS as standard. The ration $(I_1/D_1)/(HI_1/HD_1)$ might be retained for ranking range of experimental feed.

Figure 1 shows the percentage of intake of feed offered. During 15 days of observation the percentage of intake of GDM seems increase but it looks decrease for UDM, NG and RS, a standard feed. The increment of percentage intake of GDM might be due to the fact that GDM had already preserved and had no or less chemical changed. It therefore increased the GDM intake. Nevertheless, there was an exchange on chemical composition of UDM as it was not preserved. Baumont (1996) mentioned that chemical characteristic of feed influenced the feed intake

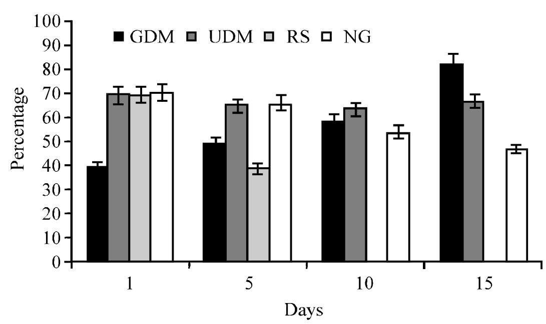

Fig. 1: Percentage of feed intake offered by goats

Table 3: Correlation coefficient between intake parameters for goats

No.	Parameters	1	2	3	4	5	6	7	8	9	10
1	I_1	1.00	0.97*	0.71*	0.27	0.47	0.49	0.41	0.16	0.46	-0.02
2	I_5		1.00	0.76*	0.38	0.33	0.42	0.41	0.23	0.36	-11.00
3	I_{10}			1.00	0.48	0.28	0.38	0.79*	0.40	0.39	0.08
4	I_{15}				1.00	-0.48	-0.33	0.19	0.92*	-0.54	-0.65*
5	I_1/D_1					1.00	0.93*	0.52	-0.37	0.83*	0.79*
6	I_5/D_5						1.00	0.60*	-0.22	0.74*	0.75*
7	I_{10}/D_{10}							1.00	0.27	0.49	0.47
8	I_{15}/D_{15}								1.00	-0.52	-0.50
9	$(I_1/D_1)/(HI_1/HD_1)$									1.00	0.80*
10	$(I_5/D_5)/(HI_5/HD_5)$										1.00

Table 4: Linier regression between intakes on day 15 (y) and day 1 or day 5 (x)

Relationship	Equation	R^2	Significant
I_{15} and I_1	y = 418.89-0.3183x	0.0568	NS
I_{15} and I_5	y = 331.05-0.0070x	<0.0001	NS
I_{15}/D_{15} and I_1/D_1	y = 83.44-0.3095x	0.1367	NS
I_{15}/D_{15} and I_5/D_5	y = 77.74-0.212x	0.0357	NS

I_n: Intake on day n; I_n/D_n: Percentage of intake on day n; NS: Not Significant

and this also affected to palatability of feed. There is no information concerning the effect of rancidity on chemical composition and palatability of feed.

CONCLUSION

The chemical composition of GDM was not so different from that of UDM therefore GDM could be used as animal feed. GDM could be accepted as edible feed for goat as it was higher intake than that of UDM. GDM might be given as single feed or part of diet on goats.

REFERENCES

AOAC, 1990. Official Method of Analysis. Association of official Analytical, Washington, USA.

Abdel-Moneim, A.Y. and M.S. Abd-Alla, 1999. Feed preference by baladi goats. Applied Anim. Behav. Sci., 65: 63-72.

Abubakr, A.R., A.R. Alimon, H. Yaakub, N. Abdullah and M. Ivan, 2012. Rumen cellulolytic bacteria and methanogenic archaea population in goats received palm oil by-product. Proceeding of the 5th International Conference on Animal Nutrition, April 24-26, 2012, Malacca, Malaysia, pp: 133-137.

Afdal, M., K. Azhar, A.R. Alimon and N. Abdullah, 2011. The peroxide value and thiobarbituric acids profiles of palm oil decanter meal kept over extended time. Proceedings of the Conference on British Society of Animal Science, April 4-6, 2011, Cambridge University Press, Nottingham, UK., pp: 264.

Alimon, A.R., A.R. Abubakr, H. Yaakub, N. Abdullah and M. Ivan, 2012. Digestibility, rumen protozoa population and rumen fermentation in goats received palm oil by-product. Proceeding of the 5th International Conference on Animal Nutrition, April 24-26, 2012, Malacca, Malaysia, pp: 138-142.

Allison, C.D., 1985. Factors affecting forage intake by range ruminants: A review. J. Range Manage., 38: 305-311.

Baumont, R., 1996. Palatability and feeding behaviour in ruminant: A review. Ann. Zootech., 45: 385-400.

Benchamaporn, P., S. Reungsuwan and O. Pimpa, 2009. Physical and chemical characteristics of by-products from-palm oil mill for ruminants feed. Proceeding of the 1st Agricultural Seminar, January 26-27, 2009, Khon Kaen University, Thailand, pp: 221-223.

Bracco, U., J. Loliger and J.L. Viret, 1981. Production and use of natural antioxidants. J. Am. Oil Chem. Soc., 58: 686-690.

Chang, S.S., B.O. Matijasevic, O.L. Hsieh and C.L. Huang, 1977. Natural antioxidants from rosemary and sage. J. Food Sci., 42: 1102-1106.

Chavalparit, O., W.H. Rulkens, A.P.J. Mol and S. Khaodhair, 2006. Options for environmental sustainability of the crude palm oil industry in Thailand through enhancement of industrial ecosystems. Environ. Dev. Sustainability, 8: 271-287.

Decruyenaere, V., A. Buldgen and D. Stilmant, 2009. Factors affecting intake by grazing ruminants and related quantification methods: A review. Biotechnol. Agron. Soc. Environ., 13: 559-573.

Hamilton, R.J., 1994. The Chemistry of Rancidity in Foods. In: Rancidity in Foods, Allen, J.C. and R.J. Hamilton (Eds.). 3rd Edn. Blackie Academic and Professional, Glasgow, UK., pp: 1-21.

Harfiah, 2007. Dried palm oil sludge as nutrient resource of the ruminant. Bull. Nutrisi Makanan Ternak, 6: 27-30.

Isika, M.A., E.A. Agiang and B.I. Okon, 2006. Palm oil and animal fats for increasing dietary energy in rearing pullets. Int. J. Poult. Sci., 5: 43-46.

Kikuzaki, H. and N. Nakatani, 1993. Antioxidant effects of some ginger constituents. J. Food Sci., 58: 1407-1410.

Mahyuddin, P. and L. Praharani, 2010. Effect of oil palm solid waste on milk production of Murrah buffalo. Proceedings of the 9th World Buffalo Congress, April 25-28, 2010, Buenos Aires, Argentina, pp: 644-648.

Manso, T., T. Castro, A.R. Mantecon and V. Jimeno, 2006. Effects of palm oil and calcium soaps of palm oil fatty acids in fattening diets on digestibility, performance and chemical body composition of lambs. Anim. Feed Sci. Technol., 127: 175-186.

McDonald, P., R.A. Edwards and J.F. Grennhalgh, 1988. Animal Nutrition. Longman Scientific and Technical, Essex, UK.

Nakatani, N., R. Inatani, H. Ohta and A. Nishioka, 1986. Chemical constituents of peppers (*Piper* spp.) and application to food preservation: Naturally occurring antioxidative compounds. Environ. Health Perspect., 67: 135-142.

Orskov, E.R., F.D.D. Hovell and F. Mould, 1980. The use of the nylon bag technique for the evaluation of feed stuffs. Trop. Anim. Prod., 5: 195-213.

Pimpa, O., S. Reungsuwan and B. Pimpa, 2009. Utilization of decanter cake from oil palm mill for concentrate and urea molasses multinutrient block production for beef cattle. Proceedings of the 2nd International Conference on Sustainable Animal Agriculture for Developing Countries, November 8-11, 2009, Kuala Lumpur Malaysia, pp: 150-151.

SAS, 2008. SAS 9.2 TS level 1MO. SAS Institute Inc., Cary, NC., USA.

Salem, H.B., A. Nefzaoui and H. Abdouli, 1994. Palatability of shrubs and fodder trees measured on sheep and dromedaries: 1. Methodological approach. Anim. Feed Sci. Technol., 46: 143-153.

Stanton, W.R., 1983. Fermentation assisted byproduct recovery in the palm oil industry. Agric. Wastes, 6: 31-63.

Sulong, M., 1991. Current status of decanters for palm oil clarification. Proceedings of the Seminar on Developmants in Palm Oil Milling Technology and Environmental Management, May 16-17, 1991, Kuala Lumpur, Malaysia, pp: 1-10.

Tangkanakul, P., G. Trakoontivakorn and C. Jariyayattanavijit, 2005. Extracts of Thai indigenous vegetables as rancid inhibitor in a model system. Kasetsart J. Nat. Sci., 39: 274-283.

Umar, Y.S. and M. Rahmatsyah, 2006. Utilization of fermented solid decanter and supplementation of Zn in diet on carcass weight of 12-week-old Peking duck. J. Agribisnis Peternakan, 2: 1-5.

Utomo, B.N., 2001. Potential of oil palm solid wastes as local feed resources for cattle in Central Kalimantan, Indonesia. M.Sc. Thesis, Wageningen University, The Netherland.

Utomo, B.N., E. Widjaja, A. Hartono, E. Sintha and Adriansyah, 2004. A final report of technology exibition: The utilisation of solid sawit by-product as broiler feed. BPTP Central Kalimantan, Palangkaraya Indonesia.

Van Soest, P.J., 1963. Use of detergents in the analysis of fibrous feeds. II. A rapid method for the determination of fibre and lignin. J. Assoc. Official Agric. Chemists J., 46: 829-835.

Yearsley, J., B.J. Tolkamp and A.W. Illius, 2001. Theoretical developments in the study and prediction of food intake. Proc. Nutr. Soc., 60: 145-156.