EFFECTS OF OVEN-DRYING AND AUTOCLAVE HEAT TREATMENTS ON RUMEN DEGRADABLE PROTEIN AND INTESTINAL DIGESTIBLE PROTEIN OF KAPOK SEED MEAL

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ABSTRACT

The experiment aimed to study effects of different temperature and pressure during heating on rumen degradable protein (RDP) and intestinal digestible protein (IDP) of kapok seed meal (KSM). KSM were oven dried at 136; 146 and 156 °C and were heated in autoclave at 0; 0.5; 1.0 and 1.5 atm for 30 minutes. Three rumen fistulated crossbred Friesian Holstein were used and they were given Elephant grass and concentrates. Protein degradation values were measured at 0; 4; 8; 16; 24; 48 and 72 hours after incubation in the rumen using the following equation: $p=a+b(1-e^{-ct})$. *In-vitro* CP digestibility values in small intestine were measured using *in-sacco* residues (16, 24 and 48 hours incubation) treated by HCl-pepsin-trypsin. Values of RDP a, b and c were significantly affected by oven-drying heating ($P<.05$) and autoclave heating ($P<.01$) but value af a+b was not affected. Increased in temperature and pressure during heating increased b value, but decreased a and c values, whilst a+b value did not change. A more drastic decreased in c value was observed in autoclave heating relative to oven-drying heating. Increased in temperature and pressure during heating significantly increased ($P<.01$) IDP. In conclusion, heating decreased solubility value (a), rate of degradation value (c), but increased value of potential degradability (b). Oven-drying heating at 146 °C and autoclave heating at 1.5 atm were found to have lowest c values 6.06% and 3.19%/hour respectively. IDP values of autoclave heating were higher than oven-drying heating. Autoclave heating at 1.5 atm was found to have highest IDP (79,87 %).

INTRODUCTION

Kapok seed production in East Java and Central of Java has been reported being 22,412.86 tonnes/year (Anonymous, 1994a) and 30,346,000-37,932,00 tonnes/year (Anonymous, 1994b) respectively. After being processed for oil, kapok seed meal (KSM) as a waste product, is usually used for supplement of ruminant ration. Kapok seed meal contained 31.05% crude protein, 25.66% crude fibre, 26.14% nitrogen free extract, 9.29% ether extract, 7.86% ash, gross energy of 4.67 Kcal/kg DM (Hartutik, 1997), metabolisable energy of 2.18 Mcal/kg DM, digestible crude protein of 74.10%, 0.39% Ca (Bo Gohl, 1981) and 0.83% P (Hartadi *et al.*, 1988).

It has been recommended that the use of KSM for ruminants should be limited due to the presence of anti-nutritive factors known as Cyclopropenoic fatty acids (CPFA) and gossypol as much as 0.0032% (Sihombing *et al.*, 1974) and 0.0052% (Malik, 1993) respectively. However, empirical data reporting effect of those anti-nutritive factors on ruminants are not known.

Lay (1986) reported values of rumen degradable organic matter (RDOM) and rumen degradable protein (RDP) for KSM being 64.49% and 94.03% respectively. This RDP value is considered high so that heat treatment is needed to decrease solubility and RDP values of KSM as well as its anti-nutritive factors which is ultimately aimed at increasing its intestinal digestible protein

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(IDP) value. To achieve a high animal production level protein contribution of rumen microbial should be coupled by availability of adequate amount of by pass protein.

MATERIALS AND METHODS

Materials used in this experiment included chemically extracted KSM (To) and mechanically extracted KSM oven dried at 0 °C (T1), 136 °C (T2), 146 °C (T3) and 156 °C (T4) and those autoclaved at 0, 0.5, 1,0 and 1.5 atm for 30 minutes. Three rumen fistulated crossbred Friesian Holstein steer weighing approximately 298±7.75 kg were used for *in sacco* degradability measurements. The animals were given elephant grass (*Pennisetum purpureum*) *ad libitum* and 3 kg concentrate mixture consisting of 23% rice brand, 45% pollard, 15% coconut cake, 15% soybean meal and 2% mineral. Protein degradation values were measured at 0, 4, 8, 16, 24, 48 and 72 hours incubation in the rumen. The residues were then treated by HCl-pepsin trypsin for 16, 24 and 48 hours to measure *in vitro* CP digestibility in small intestine (IDP). The results of *in sacco* degradability were analysed mathematically using non-linear regression following the model of Ørskov and McDonald (1979) as follows:

$$p = a + b\,(1 - e^{-ct})$$

where :

p = degradation at time t (%)
a = intercept Y-axis at t=0 (%)
b = potential degradability (%)
a + b = total potential degradability (%)
c = rate of degradation (%/h)
t = incubation time (0-72 hours).

The *in sacco* degradability results were analyzed statistically by analysis of variance taking into account the factors of oven-drying (4) or autoclave heat treatments (4) and group of animal (3). Meanwhile, the results of IDP were analyzed statistically by analysis of variance involving the factors of oven-drying (4) or autoclave heat treatment (4), group of animal (3) and time of incubation (3). Levels of significance were tested using Duncan Multiple Range Test (DMRT) among the treatment (Steel and Torrie, 1982).

Table 1. Degradation factors of CP (RDP) and intestinal digestible protein (IDP) value of oven dried KSM at different temperatures.

Heat Treatment	RDP				IDP (g/100 g)
	a (g/100 g)	b (g/100 g)	a+b (g/100 g)	c (%/h)	
To(Chem.extract.)[1)]	29.61[a]	61.49[b]	91.10	13.29[b]	37.27[b 2)]
T1(Mech.extract.)	54.87[b]	35.42[a]	90.29	12.14[b]	36.58[a]
T2 (136°C,30')	56.83[b]	36.00[a]	92.83	7.44[a]	45.56[c]
T3(146 °C,30')	48.90[b]	41.97[a]	90.87	6.06[a]	51.98[c]
T4(156 °C,30')	45.59[ab]	48.55[ab]	94.14	6.07[a]	52.24[c]
Significance	**	*	NS	*	**

Values followed by different superscript are significantly different (P<.05) except for a+b values that were not different.

* = P<0,05 ; ** = P<0,01 ; NS = Not Significance

[1)] Mean of 3 (n = 3); [2)] Mean of 9 (n = 9)

Table 2. Degradation factors of CP (RDP) and intestinal digestible protein (IDP) value of KSM given autoclave-heat treatment at different pressures.

Heat Treatment	RDP				IDP
	a (g/100 g)	b (g/100 g)	a+b (g/100 g)	c (%/h)	(g/100 g)
Po(Chem.extract.)[1)]	29.61[a]	61.49[c]	91.10	13.29[b]	37.27[a 2)]
P1(Mech.extract.)	54.87[bc]	35.42[ab]	90.29	12.14[b]	36.58[b]
P2(0 atm,100°C)	68.48[c]	23.25[a]	91.73	9.74[b]	44.84[c]
P3(0.5atm,108 °C)	43.75[ab]	49.25[bc]	93.00	4.87[a]	57.06[c]
P4(1.0atm,156 °C)	31.569[a]	61.56[c]	93.25	4.34[a]	59.24[c]
P5(1.5atm,124 °C)	30.81[a]	64.05[c]	94.86	3.19[a]	79.87[d]
Significance	**	**	NS	**	**

Values followed by different superscript are significantly different (P<.01) except for a+b values that were not different.

** = P<0,01 ; NS = Not Significance

[1)] Mean of 3 (n = 3) ; [2)] Mean of 9 (n = 9)

RESULTS AND DISCUSSION

Crude protein degradation factors calculated using the exponential equation of $p=a+b\ (1-e^{-ct})$ and values of intestinal CP digestibility (IDP) of KSM heated at different temperature is presented in Table 1, whilst those heated in autoclave at different pressure is presented in Table 2.

Tables 1 and 2 show that oven-drying significantly affected a, b and c values of CP (P<.05), whilst effects of autoclave heat treatment on a, b and c values of CP were highly significant (P<.01). However, both oven- drying and autoclave heat treatments did not significantly affect values of a+b. Values of a and c decreased, b values increased and a+b value tended to be constant as temperature and pressure during heating were increased. Browning reaction involving reaction between reductable sugars and protein may be responsible for the decrease of a and c values and increase of b value which brought about the increase in IDP value. Another reason may be the occurrence of protein denaturation which led to inactive condition of protein inhibitor, hence increasing susceptibility of protein to be digested enzimatically in the small intestine (Virobean, Bertrand, Selter and Delort-Laval cited by Widyobroto *et al.*, 1994; Satter *et al.*, 1985).

Relative to oven-drying treatment, the decrease in a and c values of CP was more pronounced by autoclave heat treatment at similar temperature. This may be due to the fact that autoclave heating coupled with pressure resulted in increase of IDP value and the presence of moisture was able to maintain the nutritive value of KSM, especially its CP. The lowest c values occurred to KSM that were oven-dried at 146°C for 30' (6.06%/h) and KSM that were autoclave-heated at 124°C for 30' with 1.5 atm (3.19 %/h). However, the highest IDP values occurred to KSM given oven-drying heating at 156°C for 30' (52.24%) were not significantly different compared to those given oven-drying heating at 146 °C for 30' (51.98%) and autoclave heating at 124 °C for 30; with 1.5 atm (79.87%).

CONCLUSION

In conclusion, heating treatment decreased solubility (a) and rate of degradation (c) values, but increased value of potential degradability (b), whilst a+b value

was not affected. Oven-drying heating at 146°C and autoclave heating at 1.5 atm were found to have lowest a and c values (6.06%/h and 3.19%/h, respectively). IDP values of KSM given autoclave heating were higher than oven-drying heating. Autoclave heating at 1.5 atm was found to have highest IDP value (79.87%).

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