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Degradation Characteristic of Tomato Pomace, Soybean Hull and Peanut Pod in the Rumen Using Nylon Bag Technique

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Abstract: Degradation characteristics of three by-product, were studied using the nylon bag technique. Nylon bags technique were conducted in two rumen fistulated Brahman-Thai native crossbred steers. They were offered *ad libitum* rice straw and received concentrate at 0.5% BW. Nylon bags containing 3.0 g of each by-product were immersed in duplicate at each time point in the ventral rumen of each steer for 3, 6, 12, 24, 48 and 72 h. The data were fitted to the equation $P = a+b\ (1-e^{-ct})$ and effective degradability were calculated using a theoretical rumen out flow rate of k = 0.05/h. The treatments were 1) tomato pomace, 2) soybean hull and 3) peanut pod assigned according to a completely randomize design with four replication. The results indicate that the rapidly soluble fraction (a), potentially degradable fraction (b), degradation rate (c) and potential degradation (a+b) of DM, OM and CP were different among treatments ($p<0.01$). The effective degradability of DM, OM and CP are the same between soybean hull and peanut pot, but differences with tomato pomace. This data is necessary to screen by-product for nutritive value before using them in ruminant production systems.

Key words: Degradation, nylon bag, tomato pomace, soybean hull, peanut pod

INTRODUCTION

The importance of degradation occurring in the rumen influence the utilization of nutrient in feedstuffs. Therefore reliable, fast and inexpensive technique is required to quantify both rate and extent of nutrient degradation from difference ingredients in the rumen. The nylon bag technique has proved to be a potentially useful technique for feed evaluation (Ørskov and McDonald, 1979). Tomato pomace, soybean hull and peanut pod are agro industrial by-product. They are commonly use as ruminant feeds. Limited information on kinetic of degradation is available. The aim of the current study was to assess the chemical composition and nutritive value using nylon bag technique of three agro industrial by-product commonly available in Thailand.

MATERIALS AND METHODS

Agro industrial by-product preparation and analysis: The agro industrial by-products, namely 1) tomato pomace, 2) soybean hull and 3) peanut pod were collected from the North-East of Thailand. All feedstuffs samples (Table 1) were ground to pass through a 2 mm screen for the nylon bag technique incubation and 1 mm screen for chemical analysis. The samples were analyzed to determine Dry Matter (DM), Crude Protein (CP) and ash content (AOAC, 1990). Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) were assayed using the method proposed by Van Soest *et al.* (1991).

***In sacco* degradation procedure:** Ruminal degradation measurement using the nylon bag technique was carried out in Brahman-Thai native crossbred (315±12 kg) fitted with permanent rumen cannula after a two weeks adaptation period and they were offered *ad libitum* rice straw and received concentrate at 0.5% BW (concentrate mixture: 49.80% cassava chip, 17.5% rice bran, 14.60% palm meal, 7.0% soybean meal, 1.40% urea, 0.4% salt, 1.0% mineral premix and 8.30% sugarcane molasses). Approximately 3.0 g of DM test feed was introduced into synthetic bag with a mean pore size of 45 µm. They were placed into the rumen of two beef steer, 30 min after the morning meal and retrieved after a period of 3, 6, 12, 24, 48 and 72 h (four bags of each feed for each period). After removal from the rumen, the bags were washed by hand under tap water until the water became clear. To determine the content of water soluble material bags, representing 0 h disappearance also underwent the same washing procedure as the incubated bags. Dried residues (65°C, 48 h) of each incubation time were pooled by feedstuff, in order to analyze OM and CP. Dry matter, OM and CP disappearance values were fitted to the equation $P = a+b\ (1-e^{-ct})$ (Ørskov and McDonald, 1979), where P is the amount degraded at time t, *a* is the rapidly soluble fraction, b is the potentially degradable fraction, c is the rate of degradation of fraction b. The effective degradability was calculated as $ED = a+b\{c/(c+k)\}$, where k = fractional passage rate (0.05/h).

Statistical analysis: All data obtained were subjected to the analysis of variance (ANOVA) procedure according to

Table 1: Chemical composition of tomato pomace, soybean hull and peanut pod

	By-product		
Chemical composition	Tomato pomace	Soybean hull	Peanut pod
DM	88.8	89.7	90.8
Ash	6.3	5.8	9.9
CP	22.0	10.2	10.3
NDF	47.3	58.4	88.0
ADF	38.6	42.3	77.0
ADL	7.7	3.7	27.5

Where: DM = dry matter, CP = crude protein, NDF = neutral detergent fiber, ADF = acid detergent fiber and ADL = acid detergent lignin

the complete randomized design. Treatment means were compared using Duncan's New Multiple Range test. Probabilities less than 0.05 were considered to be significant.

RESULTS AND DISCUSSION

Chemical composition of by-product: The chemical compositions of by-products are presented in Table 1. Generally, wide variations existed in the chemical composition of the investigated by-products. The crude protein ranged from 10.2 for soybean hull to 22.0% for tomato pomace. The result of this study agrees with reports by Maghsoud *et al.* (2008), who reported that most by-products were low in protein and high in fibrous content. The crude protein content of soybean hull was lower than that reported by Nguyen *et al.* (2007); Chumpawadee *et al.* (2007) and Wolf *et al.* (2002). However, the crude protein content of soybean hull was similar to that reported by Chumpawadee and Pimpa (2008). In addition, crude protein content of tomato pomace was similar to that reported by Taghizadeh *et al.* (2008). There are many factors that affect crude protein content such as stage of growth (Promkot and Wanapat, 2004) maturity and species or variety (Von Keyserlingk *et al.*, 1996) and soil types (Baloyi *et al.*, 1997). Those factors may partially explain differences in crude protein content between our study and others.

Ash content of by-product was ranged from 5.8-9.9%. Tomato pomace had the lowest ash content, while the peanut pod had the highest. The ash content of tomato pomace was lower than that reported by Maghsoud *et al.* (2008). However, ash content of tomato pomace was similar to that reported by Chumpawadee and Pimpa (2008). In addition, ash content of soybean hull was similar to that reported by Nguyen *et al.* (2007). The difference of ash content was probably due to variety of by-product or soil and sand contamination.

Neutral detergent fiber content of by-products ranged from 47.3-88.0%. Tomato pomace had the lowest NDF content, while peanut pod had the highest. The neutral detergent fiber content of tomato pomace was lower than that reported by Taghizadeh *et al.* (2008), but similar to that reported by Chumpawadee and Pimpa (2008). Additionally, a neutral detergent fiber content of soybean hull was lower than that previous report (Nguyen *et al.*, 2007).

Acid detergent fiber content of by-product ranged from 38.6-77.0%. Tomato pomace had the lowest acid detergent fiber content while the peanut pod had the highest acid detergent fiber content. The acid detergent fiber content of tomato pomace was lower than that reported by Taghizadeh *et al.* (2008) and Maghsoud *et al.* (2008), but similar to reports by Chumpawadee and Pimpa (2008). The acid detergent fiber content of soybean hull was similar to that reported by Nguyen *et al.* (2007).

Acid detergent lignin content of by-product ranged from 3.7-27.5%. Soybean hull had the lowest acid detergent lignin content, while the peanut pod had the highest. The acid detergent fiber content of tomato pomace was lower than that previous report (Chumpawadee *et al.*, 2007).

There are many factors that may affect fibrous content such as stage of growth, maturity and species or variety (Agbagla-Dohnani *et al.*, 2001), dried method and growth environment (Mupangwa *et al.*, 1997) and soil types (Thu and Preston, 1999). These factors may partially explain differences in fibrous content between our study and others.

Degradability characteristics: The rapidly soluble fraction (a fraction), potentially degradable fraction (b fraction), rate of degradation of *b* fraction (c) and potential degradation (a+b) are presented in Table 2. Dry matter *a* fraction was highest ($p<0.01$) for peanut pod and lowest for soybean hull. In this study dry matter a fraction for peanut pod was highest as compared to other by product; possibly because fine dusty particles are OM and CP readily soluble in the rumen. Peanut pod had the highest ($p<0.01$) organic matter a fraction and soybean hull had the lowest. The organic matter a fraction of tomato pomace, soybean hull peanut pod were; 14.9, 11.9 and 27.3%, respectively. Peanut pod also had the highest ($p<0.01$) crude protein *a* fraction and tomato pomace had the lowest. The crude protein *a* fraction of tomato pomace, soybean hull and peanut pod were; 11.6, 14.5 and 27.6%, respectively. Crude protein *a* fraction for tomato pomace was similar to that reported by Taghizadeh *et al.* (2008). Very fine particles would be rapidly fermented or else washed out of the nylon bag unfermented (Von Keyserlingk *et al.*, 1996). In this experiment, peanut pod was very fine dusty particles, which would easily be lost in the rumen. Variation in *a* fraction between studies could be due to differences in feed particle size and processing methods or differences in analytical technique (Batajoo and Shaver, 1998). Feed particle size did not affect rate of dry matter and crude protein degradation in some studies (Nocek, 1985), but others NRC (2001) reported large difference in disappearance of substrate with difference particle

Table 2: Degradation characteristics of tomato pomace, soybean hull and peanut pod

	By-product			
Parameter	Tomato pomace	Soybean hull	Peanut pod	SEM
DM degradation characteristics				
a, %	14.9[b]	11.9[b]	27.3[a]	3.0
b, %	48.6[b]	57.4[a]	40.2[c]	3.3
c, h^{-1}	0.024[c]	0.035[b]	0.040[a]	0.0
a+b, %	63.5[b]	69.3[a]	67.5[a]	3.8
EDDM, %	29.6[b]	37.8[a]	38.9[a]	2.9
OM degradation characteristics				
a, %	15.8[b]	13.7[b]	23.2[a]	1.6
b, %	45.8[b]	56.3[a]	32.2[c]	3.5
c, h^{-1}	0.024[c]	0.035[b]	0.070[a]	0.0
a+b, %	61.6[b]	70.0[a]	55.7[b]	3.4
EDOM, %	30.9[b]	34.6[a]	38.6[a]	2.4
CP degradation characteristics				
a, %	11.6[b]	14.5[b]	27.6[a]	2.3
b, %	58.2[b]	85.4[a]	37.5[c]	3.4
c, h^{-1}	0.046[a]	0.021[b]	0.020[b]	0.0
a+b, %	69.8[b]	99.9[a]	65.1[a]	4.3
EDCP, %	34.3[b]	42.3[a]	45.2[a]	3.0

[a,b,c,d]Means within a row different superscripts differ (p<0.01), Where: DM = dry matter, CP = crude protein, EDDM = effective degradability of dry matter, EDOM = effective degradability of organic matter, EDCP = effective degradability of crude protein, a, b, c are constants in the exponential equation, $P = a+b\ (1-e^{-ct})$ Where a = the rapidly soluble fraction, b = the potentially degradable fraction, c = the rate of degradation of fraction b, a+b = potential degradation

size. Even if the samples were milled in the same mill the differences in small particle proportion would probably depend on the vegetal structure of by products, i.e. degree of lignifications and fragility. It is well know that difference between forages in small particles occur during the milling process, even in the same equipment and screen size (Olivera, 1998). In addition, the small particles produced by grinding dried samples may result in an overestimation of zero time losses (Lopez *et al*., 1995).

The dry matter b fraction for all by products ranged from 40.2-57.4%. The organic matter b fraction for all feeds ranged from 32.3-56.3%. Organic matter b fraction was highest for soybean hull and lowest for peanut pod, possibly because peanut pod had the highest ash content and a high rapidly soluble fraction, which intern affected the organic matter b fraction. The crude protein b fraction ranged from 37.5-85.4%. Crude protein b fraction was highest for soybean hull and lowest for peanut pod. The crude protein b fraction for tomato pomace was similar to those in previous studies (Taghizadeh *et al*., 2008).

Degradation rate (c) of dry matter was fastest (p<0.01) in peanut pot follow by the soybean hull and tomato pomace. Degradation rate of dry matter for by- products in this study were slower than compared concentrate feedstuffs (Woods *et al*., 2003). This is possibly due to the fact that fibrous content and degree of lignifications in by-products were higher than concentrate feedstuffs. This structure is difficult for attach by microorganism, leading to slow rate of degradation. Degradation rate of organic matter of by-products are similar to the degradation rate of dry matter. In exception, the degradation rate of organic matter for peanut pod was fastest than degradation rate of dry matter, possibly because of disturbance by ash content (Table 1). Degradation rate of crude protein was fastest for tomato pomace and slowest for peanut pod. The degradation rate of crude protein for tomato pomace was faster than those in previous studies (Taghizadeh *et al*., 2008). The rate of degradation (c) is an important as the potential degradability in determining both effective degradation as well as rumen fill. Rate of degradation exerts a direct effect on intake (Khazaal *et al*., 1995) which represents the nutrient availability of forages.

The potential degradation (a+b) of dry matter, organic matter a crude protein were significantly different between by-products (p<0.01). Potential degradation of organic matter and crude protein were highest for soybean hull and peanut pod had the lowest. Remarkably, crude protein content of by-products was found to be very low (Table 1). Such low values of crude protein are known to depress DM and crude protein degradability and result in low intake (Shem *et al*., 1995) and also high NDF, ADF and ADL values may result into low degradability and induce low intake.

Effective degradability of DM, OM and CP are also presented in Table 2. Rate of passage (k) was assumed at 0.05/h for the calculation of effective degradability. The effective degradability of DM, OM and CP was significant differences among by-product (p<0.01). Effective degradability of crude protein was highest for soybean hull. Numerous factors had effect on *in sacco* degradability, such as bag pore size (Vanzant *et al*.,

1998), sample size (Nocek, 1985), washing procedures (Cherney *et al.*, 1990), grinding, diet of host animal, species of animal, sample preparation, incubation time and washing method (Olivera, 1998).
The results in this study indicated that by-products have a potential degradation ranked from the highest to the lowest were; soybean hull, tomato pomace and peanut pod. By-products had low value of crude protein and high fibrous content.

Conclusion: By-products showed a great variation in chemical composition and degradability. The results in this study indicated that by-products have a degradability ranked from the highest to the lowest were; soybean hull, tomato pomace and peanut pod, respectively.

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