

Net Energy of Sweet Corn Husk and Cob Silage Calculated from Digestibility in Cows

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ABSTRACT

Sweet corn husk and cob (SC) which is a residue of sweet corn cannery contained 19.75% dry matter (DM). The nutrient composition on DM basis was 6.86% CP, 3.21% EE, 3.97% ash, 70.89% NDF, 35.61% ADF and 15.07% NFC. The silage (SCRB) was made by mixing SC with rice bran (RB) on fresh weight 86:14 and adding 4.38 g of formalin/kg fresh weight then filling it in 2 layered plastic bags. After filling, the inner bag was vacuumed and tied while the outer was sewed. Each bag contained 30 kg. They were kept for 40 days before determining digestibility in 4 cross bred Holstein Friesian cows at nonpregnant and nonlactating stage.

After a 14 day adaptation period, the cows were fed with the silage *ad libitum* for another 14 days followed by a 6 day collection period. Feed intake and faeces output were recorded and sampled for chemical analysis. Digestibility of nutrients and TDN were calculated while DE was also directly determined. ME and NE were calculated from TDN and DE using NRC equations (1988).

The result revealed that SCRB was a good quality silage with 28.34% DM. The content of other nutrients on DM basis was 10.91% CP, 11.71% EE, 57.95% NDF, 28.87% ADF, and 12.28% NFC. The digestibility of these nutrients was 58.50, 56.26, 84.68, 58.97, 51.30 and 70.68% respectively. Nonpregnant dry cows consumed the silage on dry matter basis 0.91% BW or 41.81 g/kgW^{0.75}. The silage had 71.31% TDN, 3.10 DE, 2.68 ME and 1.60 NEL (Mcal/kgDM) respectively.

Key words : silage, sweet corn husk and cob, digestibility, net energy, dairy cow

INTRODUCTION

Sweet corn husk and cob is a residue of sweet corn cannery plants. The proportion of this residue is around 65.8% of the whole ear (Thiraporn and Setabandhu, 1994). The estimated amount of this residue in Thailand is around 173,727 tons/year or 476 tons/day. Although the residue is an attractive feed for ruminants, in the wet season when plenty of green feed is available the residue may be left over

and causes pollution problem. It should be preserved as a silage for using in the dry season. Unfortunately its moisture content is appreciably high (79-82%) therefore it should be mixed with some absorbent such as cassava chip, ground corn or rice bran. Cheva-Isarakul (1990) reported that baby corn husk which contained 86.4% moisture could be well preserved as a silage by mixing with either 20-25% of rice bran or ground corn. Performance of native cattle being fed with this kind of silage as a roughage

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was superior than the group fed with Napier grass.

Pumisutapool *et al.* (2000) reported that SC ensiled with 14% rice bran either with or without formalin was a good quality silage. However its nutritive value has not been investigated. Therefore the objective of this experiment was to determine the digestibility and energy value of sweet corn husk and cob silage (SCRB).

MATERIAL AND METHOD

Ensiling process

Sweet corn husk and cob from a cannery plant in Chiang Mai, Thailand was chopped into 1-2 cm length. It was mixed with rice bran at the ratio of 86:14 (fresh weight basis). Then 4.38 g formalin/kg fresh weight was added, mixed thoroughly and filled in 2 layered vacuumed plastic bags. The inner bag was tied while the outer bag was sewed and kept for 40 days. Each bag contained 30 kg of the material (SCRB).

Digestibility trial

Four heads of dry nonpregnant crossbred Holstein Friesian cows with average body weight 455.9 ± 42.2 kg were kept individually in a metabolism stall. They were weighed for 3 consecutive days at the beginning and the end of the experiment which lasted 39 days. The animals were fed twice daily at 8.30 and 16.00 hrs. Water was freely accessed. Mineral mix was added on top of the feed at 100 g/day. The first 14 days was a transition period during which feed was gradually changed to SCRB silage. For the next 14 days, SCRB silage was given as a sole diet *ad libitum* in order to determine voluntary feed intake (VFI). The following 5 days feed was restricted to 90% of VFI in order to avoid feed ort. The last 6 days were a collection period during which feed intake, feed ort, faeces and urine were recorded and sampled. The faeces was separated from the urine by a harness with a specially designed funnel which covered the vulva of the cows. Urine was collected

in a bag in which 100 ml of 18 N H₂SO₄ was added as a preservative. All samples were kept in a freezer (-20°C) before being subjected to chemical analysis (AOAC, 1984 and Goering and Van Soest, 1970)

Apparent nutrient digestibility and total digestible nutrient (TDN) was calculated as follows:-

$$\text{Apparent digestibility (\%)} = \frac{\text{Nutrient intake} - \text{Nutrient in faeces}}{\text{Nutrient intake}} \times 100$$

$\text{TDN (\%)} = \text{DCP} + \text{DNDF} + \text{DNFC} + (\text{DEE} \times 2.25)$
where DCP, DNDF, DNFC and DEE were digestible crude protein, neutral detergent fiber, non fiber carbohydrate and ether extract respectively (g/100 g DM of feed)

Digestible energy (DE), metabolizable energy (ME) and net energy for lactation (NEL) were calculated from total digestible nutrient (TDN) using NRC (1988) equations as follows:-

$$\text{DE (Mcal/kg DM)} = 0.04409 \times \text{TDN (\%)} - 0.12$$

$$\text{ME* (Mcal/kg DM)} = -0.45 + 0.0445309 \times \text{TDN (\%)} - 0.12$$

$$\text{NEL (Mcal/kg DM)} = 0.0245 \times \text{TDN (\%)} - 0.12$$

In addition ME and NEL were also calculated from DE, which was determined directly, as follows:-

$$\text{ME (Mcal/kg DM)} = -0.45 + 1.01 \text{ DE}$$

$$\text{NEL* (Mcal/kg DM)} = 0.5557 \times \text{DE} - 0.12$$

NB.* adapted from NRC (1988)

RESULT AND DISCUSSION

The chemical composition of sweet corn residue and its silage either without or with additives is shown in Table 1.

Sweet corn cob had higher dry matter (DM), organic matter (OM), crude protein (CP) and ether extract (EE) but lower neutral detergent fiber (NDF) and acid detergent fiber (ADF) than the husk. It might be due to the partial attachment of the kernel which had higher nutritive value than the husk.

Sweet corn husk and cob had higher EE and

Table 1 Chemical composition (% DM basis) of sweet corn residues.

Sweet corn residue	DM	OM	CP	EE	NDF	ADF	NFC	pH
Husk	17.79	96.13	5.41	1.51	77.48	38.73	11.73	-
Cob	24.24	97.52	6.11	4.44	68.50	33.48	18.47	-
Husk and cob	19.75	96.03	6.86	3.21	70.89	35.61	15.07	-
Husk and cob silage ^{1/}	21.98	96.90	6.27	2.28	77.32	33.90	11.03	4.21
SCRB silage ^{2/}	28.34	92.85	10.91	11.71	57.95	28.87	12.28	4.98

%ash = 100 - %OM

^{1, 2} are from different experiments.

SCRB silage is sweet corn husk and cob ensiled with rice bran and formalin.

NDF but lower CP than baby corn husk (Cheva-Isarakul, 1990). Dry matter content of both residues was similar. SCRBR which is the ensiling product of SC with rice bran and formalin had higher DM, CP and EE but lower NDF and ADF than the original sample. It might be due to the higher nutritive value of rice bran, The ratio of RB : SC at 14 : 86 seems to be optimum since DM of the mixture was in proper range for ensiling (25-35%). DM and CP of SCRBR silage was similar to baby corn husk ensiled with 25% ground corn (Cheva-Isarakul, 1990). In addition it was also similar to Ruzi grass (Waipanya *et al.*, 1999)

Nonpregnant dry cows consumed SCRBR silage of 4.13 kg DM/day which was equal to 0.91% BW or 41.81 g/kg BW^{0.75}. This value is lower than Jaster *et al.* (1983) who reported that dry matter intake (DMI) of heifers consuming sweet corn and cob silage was 1.5% BW. The low DMI in this experiment might be due to the high fat and high energy content of the feed, as well as the fact that animals were at a nonpregnant and nonlactating stage and thus only required nutrients for maintenance. In addition the high moisture and acidity of the feed may restrict feed intake. Cheva-Isarakul (1990) reported that DMI of sheep consuming baby corn husk was 2.7% BW or 65.4 g/kg W^{0.75} when the material was in dry form but in a fresh form DMI decreased to 1.6% BW or 32 g/kg

W^{0.75} and as silage the animal consumed only 1.2% BW or 27.9 g/kg W^{0.75}.

Yammuen-Art *et al.* (2000) and Wongjarearn *et al.* (2001) also found a low DMI for cows which consumed sweet corn stalk silage and whole corn silage at the rate of 0.97 and 1.14% of BW respectively.

Digestibility of nutrient

Nutrient digestibility and energy value of SCRBR as well as nitrogen balance of dry cows fed SCRBR as a single feed are shown in Table 2.

Dry matter digestibility of silage was 58.50% which was similar to SC silage of Jaster *et al.* (1983, 59.1%) but lower than that of sweet corn stover silage (65.5%; Yammuen-Art *et al.*, 2000) although NDF and ADF of both reports were higher than SCRBR in this experiment. This might be due to the inhibitory effect of formalin as observed by Brown and Valentine (1972) in sheep and Valentine and Radcliffe (1975) in *in vitro* digestibility trial.

Since the digestibility of energy of SCRBR was 63.09%, therefore its DE content was 3.05 Mcal/kg DM. Average protein intake of the cows was 403.07 g/day which was slightly higher than the requirement (341-364 g/day) of nonpregnant cows at 450-500 kg BW (NRC, 1988). Although DMI of the cows was only 0.91% BW, nitrogen balance was slightly negative (-0.53 g/day).

Table 2 Digestibility of nutrient, energy and N-balance of HCRB in dry cows.

Nutrient	% Digestibility	Nutrient	% Digestibility
Dry matter	58.50	Acid detergent fiber	51.30
Organic matter	63.45	Non fiber carbohydrate	70.68
Crude protein	56.26	Total digestible nutrient	71.31
Ether extract	84.68	Digestible energy (Mcal/kgDM)	3.05
Neutral detergent fiber	58.97	N-balance (g/day)	-0.53

Table 3 TDN and DE from direct measurement as well as DE, ME and NEL from calculation.

Energy (Mcal/kgDM)	<i>In vivo</i> measurement	Calculated from		Average
		TDN	DE	
TDN (%)	71.31	-	-	-
DE	3.05	3.14	-	3.10
ME	-	2.73	2.63	2.68
NEL	-	1.63	1.57	1.60

Energy content of SCRB

TDN calculated from digestibility, DE from direct measurement and from TDN as well as ME and NE calculated from both values are shown in Table 3. It is noticed that ME and NEL calculated from DE are slightly lower than from TDN. At the same time DE calculated from TDN is slightly higher than the direct measurement (3.14 vs 3.05 Mcal/kg DM). The result is similar to Yammuan-Art (1999) in rice straw and Vasupen (2000) in dry sugarcane stalk. The average values (Mcal/kg DM) of HCRB from both calculations are 3.10 DE, 2.68 ME and 1.60 NEL which are similar to those of sweet corn stover silage (Yammuan-Art, 2000) i.e. 3.09, 2.67 and 1.60 Mcal/kg DM.

CONCLUSION

Sweet corn husk and cob (SC) had 19.75% DM and 6.86% CP (on DM basis). Good quality SCRB silage could be obtained by ensiling SC with rice bran (RB) at 86.14 plus 4.38 g formalin/kg

fresh weight and filled tightly in 2 vacuumed layered plastic bags. The silage had 28.34% DM and 10.91% CP.

The digestibility of most nutrients were 51-59% except EE and NFC which were 84.68 and 70.68% respectively. Dry matter intake of SCRB by dry cows was 0.91% BW or 41.81 g/kg W^{0.75}. The silage had high TDN (71.31%). The DE, ME and NEL were 3.10, 2.68 and 1.60 Mcal/kg DM respectively.

The ensiling might be done without formalin. In addition the cob should be hammered before ensiling in order to prevent feed selection by animals.

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