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Chemical Composition and Metabolizable Energy of Mustard Meal

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Mustard meal (MM), which is a residue of essential oil extraction, had high moisture content (77%). It took 3 days to dry under the sun or 48 hours to dry in an electrical oven at 65℃ or 8 hours in a gas heated pan of initial temperature 120–140℃. The chemical composition of MM from the 3 drying processes was similar. It contained on DM basis 30–32% CP with relatively high EE (19–22%) and CF (12–13%), while ash and NFE were 5–6% and 28–31%. Metabolizable energy (ME) of the samples from the 2 among the 3 drying processes was determined. The result revealed that although the CP content of MM was only 50% of soybean meal (SBM), it had higher EE. Therefore its ME value was higher than SBM. The apparent ME and true ME of sun-dry MM was 2.888 and 3.348 kcal/g DM (or 2.724 and 3.161 kcal/g air dry), while those of gas dried meal was lower, i.e. 2.435 and 2.892 kcal/g DM (or 2.328 and 2.765 kcal/g air dry), respectively.

Key words : mustard meal, plant protein, chemical composition, metabolizable energy, poultry

Introduction

The main plant protein source in animal feed is soybean meal, which is produced insufficiently in Thailand. It has to be imported around 1.0–1.5 million tons yearly. At the same time other plant protein sources such as sunflower meal, peanut meal and rape seed meal are also imported at 0.04, 0.1 and 0.06 million tons in the year 1999 (Center of Agricultural Statistics, 1999). Foreign currency being spent for these importation was over 5.51, 21.47 and 7.84 million $US, respectively (1 $US=43 Baht). Therefore if local agro-industrial by-products are investigated and being use as animal feed, they should reduce feed price and save foreign currency.

At present, Thailand has a factory of high capacity to produce essential oil from mustard seed for export. Around 5,000 tons of mustard seed (*Brassica juncea* or *B. nigra*), which is the same genus as rape seed (*B. napus* or *B. comprestris*), is imported from Canada and Australia yearly. The seed contains 35% oil in which 22–23% is extracted. The meal (4,000 tons/year) is subjected to further extraction processes for

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essential oil and hot flavor by steaming for 4 hours (Fig. 1). Only 1% of the substances is extracted at this step. Therefore, high amount of residue is left over. During processing the seed is mixed with 4 times of water (w/w) thus causes a partial loss of soluble nutrient while water is removed. However the residue, which is mainly seed coat and partial kernel content still, has high amount of nutrient. Inspite of high water content (60–70%), it should has a potential use as animal feed.

Newkirk *et al.* (1997) investigated 4 varieties of mustard meal (*Brassica juncea*) (MM) which contain low glucosinolate, and found that the meals contained 45.0–46.3% CP, 0.4–0.6% EE, 19.8–21.9% NFE, 12.2–13.3% ADF and 25.6–27.9% total dietary fiber. The toxic substance glucosinolate in these meals was higher than canola meal (*B. napus* and *B. rapa*) i.e. 34.6 vs 21.8–25.5 mole/g. However nitrogen corrected apparent metabolizable energy (AME_n) content of mustard meal was also higher than canola meal (2,216+140.5 vs 1,557–1,832 kcal/kg). The calculated apparent metabolizable energy (AME) of mustard meal was 2,114 kcal/kg.

Göhl (1981) reported that mustard seed contained on DM basis 23.4% CP, 46.7% EE, 8.6% CF, 5.1% ash and 16.2% NFE, while the meal contained 26.0–38.5% CP, 2.3–10.7% EE, 3.5–18.2% CF, 7.6–9.9% ash and 37.4–45.9% NFE. Protein content of MM was 11–23% lower while EE was 3–11 times higher than soybean meal. The variation is due to oil extraction process and the contamination of seed coat. When compare to soybean meal, mustard meal had higher methionine plus cystine (2.21 vs 1.44%) but lower lysine (2.22 vs 3.02%) and other amino acids.

The nutrient content in mustard meals is quite variously. CP content reported by Göhl (1981) was similar to Johri *et al.* (1988 ; 36.4%) while that of Newkirk *et al.*

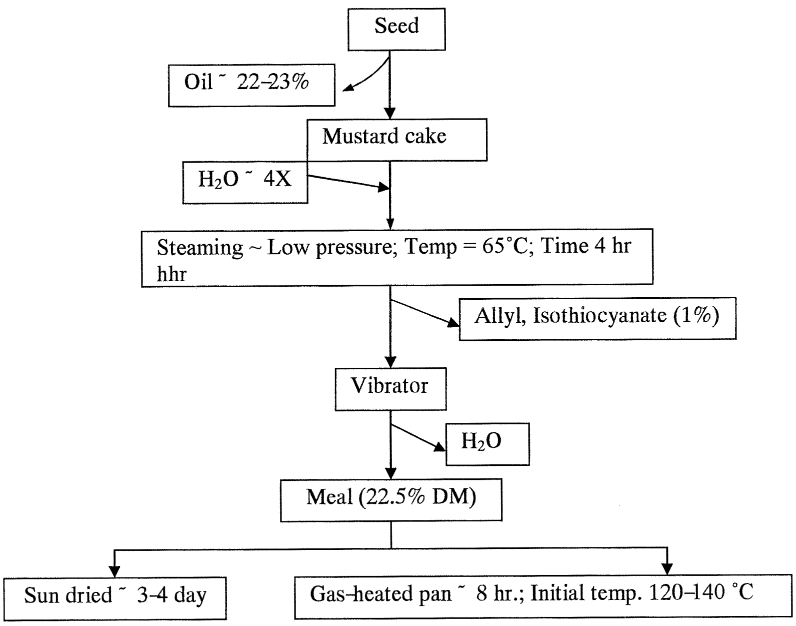

Fig. 1. Essential oil processing.

(1997 ; 45.7%) was similar to Bell *et al.* (1981 ; 42.2%). This variation might be owing to variety, cultivation, extraction process and amount of seed coat contaminated. Since mustard meal from this essential oil factory contained high moisture, it is easily rotted. In addition the high oil content may have toxic substances (*e.g.* glucosinolate and erucic acid) and the nutritive value may differ from foreign literature. Therefore the experiment should be conducted to determine ME of MM. The data are necessary for feed formulation.

Materials and Methods

Chemical composition

MM from Lana Product Co, Ltd., (Lamphun province, Thailand) was subjected to 3 drying processes, i.e. sun dry or oven dry (by hot air at 65℃) or roasting (in a big pan). They were milled through 1 mm sieve before subjected to proximate analysis (AOAC, 1984).

Metabolizable energy determination

Nine heads of egg type cockerels, 6 months old, being kept individually in a metabolic cage in which excreta was collected in a pan under the cage. They were fed *ad libitum* for 7 days of adaptation period. Then they were fasted for 24 hours in order to clear the gastrointestinal tract. The birds were divided to 3 groups. Group 1 and 2 were force fed at 16.00 h with 30 g of MM being dried by sun and gas roasting. An excreta was collected for 24 hours at 9.00 and 16.00 o'clock. The third group was fasted for another 24 hours. The excreta from this group is considered as endogenous loss which will be subtracted from excreta of the fed group for the calculation of true metabolizable energy (TME). At the same time AME is calculated without the subtraction of endogenous loss (Sibbald, 1977 a, b).

The excreta was dried at 62℃ before milling through 1 mm sieve while DM was determined at 102℃. Gross energy was determined by Adiabatic Bomb Calorimeter (Model IKA 400℃).

The work has been carried out at Chiang Mai University Farm during August 1999 - January 2000.

Results and Discussion

Chemical composition

The MM had high moisture content (77%). It needed 3 days to be completely dried under the sun or 2 days in a hot air oven at 65℃. However by gas drying in a big pan at 120–140℃ it needed only 8 hours. Chemical composition of the meal being dried by 3 different processes was similar. It contained on DM basis 30–32% CP, 19–22% EE and 12–13% CF (Table 1). These meals had higher oil but lower CP content than those reported by Göhl (1981), Bell *et al.* (1981, 1984) and Newkirk *et al.* (1997). It might be due to the inefficient oil extraction of the plant. CP content of MM in the above mentioned literatures was between 39–51% of DM except the high fiber type which had 26% CP (Göhl, 1981).

When compared to soybean meal, the MM in this study had lower CP but higher

Table 1. Nutrient composition (% DM basis) and energy value of sun-dried, electrical and gas dried mustard meals compared to soybean meal (SBM)

	Mustard meal			SBM
	Sun dry[1/]	Electric dry[2/]	Gas dry[3/]	(NRC, 1994)
Dry matter (DM) :				
-From fresh sample	—	22.90	—	—
-From air dry sample	90.92	95.84	90.82	89.0
Crude protein (CP)	31.79	30.09	32.48	49.4
Ether extract (EE)	18.77	20.27	22.07	0.9
Crude fiber (CF)	12.47	12.47	12.73	7.9
Ash	5.77	5.76	5.03	n.a.
Nitrogen free extract (NFE)	31.20	31.40	27.69	n.a.
Organic matter (OM)	94.23	94.24	94.97	n.a.
Gross energy (GE ; kcal/g.)	5.710	n.a.	5.423	n.a.
AME (kcal/g air day)	2.724±0.174	n.a.	2.328±0.188	n.a.
(kcal/g DM)	2.888±0.187		2.435±0.197	
TME (kcal/g air day)	3.161±0.174	n.a.	2.765±0.188	n.a.
(kcal/g DM)	3.348±0.184		2.892±0.197	

n.a.=No data available.
[1/] 3 days sun dried. The values investigated in this experiment.
[2/] 65 OC for 2 days.
[3/] 120-140 OC for 8 hours by gas machine. The values investigated in this experiment.

CF, which limits their potential use as monogastric feed. However the high oil content may be advantage since it is a good source of energy.

Metabolizable energy

The result from force-feeding indicated that AME and TME of MM, which was dried under the sun, was higher than the gas type (2.89 and 3.35 vs 2.44 and 2.89 kcal/g DM ; Table 1). This might be owing to the high temperature of the gas roasting which partially destroyed nutrient availability. Therefore optimum temperature should be adjusted for a proper commercial drying process. However, small farm holders may use sun drying because it does not require an expensive equipment although it is laborious, time consuming and weather dependent.

AME of MM in this experiment was higher than those of Newkirk *et al.* (1997). The AMEn of his 4 mustard varieties ranged 2,011–2,382 kcal/kg (average 2,216.5±140.5). His calculated AME was equal to 2,114 kcal/kg. The high AME value of our meals might be due to the high EE content (19–22% vs 0.4–0.6% of Newkirk *et al.,* 1997). In addition, AME (kcal/g air dry) of MM in this experiment (2.33–2.72) was also higher than other plant protein sources being used in Thailand such as soybean meal (2.24 ; NRC, 1994), rape seed meal (1.60 ; Tangtaweewipat *et al.,* 1988) and sunflower meal (1.8 ; Samart, 2000). Therefore, it is possible to be used as animal feed to substitute other plant protein sources.

In conclusion, the MM needed 3 days to dry under the sun or 48 hours in a hot air oven at 65℃ or 8 hours by roasting in a big pan at 120–140℃. Chemical composition of the meals on DM basis was 30–32% CP, 19–22% EE, 12–13% CF, 5–6% ash and 28–31% NFE. AME and TME, determined by force feeding to cockerels, of the sun dry MM was 2.89 and 3.35 kcal/g DM (which were equal to 2.72 and 3.16 kcal/g air dry respectively). Those of gas dry meal were lower, i.e. 2.44 and 2.89 kcal/g DM (or 2.33 and 2.77 kcal/g air dry). However, metabolizable energy of MM was higher than soybean meal, rape seed meal and sunflower meal.

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