Potential Use of Agro-Industrial By-Products as Dairy Cattle Feed in Northern Thailand.

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Abstract

Dairy cattle raising has long been practiced under smallholder systems for over four decades in Chiang Mai Province, Northern Thailand. Under integrated farming systems the farmers established pasture only on a small area less than 0.3 ha. Apart from using pastures agro-industrial by-products play very important roles as alternative feed resources for dairy cattle. The series of study were to investigate the potential use of agro-industrial by-products from the factories in the surrounding areas as dairy cattle feed. The chemical composition and nutritive values of the by-products were analyzed by conventional methods and in sacco nylon bay technique and Hohenhein gas test technique were also used. It was found that some of the by-products such as fresh soybean pod husk, passion fruit peel were relatively high in CP and energy. It could be directly used as sources of roughages or in the form of silage such as passion fruit peel silage and passion fruit peel + 4% rice bran silage. Some other by-products such as dry malt residue from the brewery and soy source residue from soy source factory were relatively high in CP contents so they would probably used as sources of protein up to 20-30 percent in the concentrate mixtures. The preliminary studies an using dry malt residue and soy sauce residue as sources of protein showed a tendency of higher milk production and could reduce the cost of feed up to more than 20 percent. It could be concluded that smallholder dairy systems in Chiang Mai areas are rely mainly on agro-industrial by-products as basal feed resources and established pasture to a lesser extent.

Key words : Agro-industrial by-products, fresh soybean pod husk, passion fruit peel, dry malt residue, soy sauce residue, feed resources.

Introduction

Dairy production in Thailand has long been established among the Indians who moved to live in the Kingdom since early 20th century. Later in 1961 the Thai-Danish Dairy Project in Muak Lek, Saraburi and in 1964 the Thai-German Dairy Project in Chiang Mai were established to promote Thai farmers through dairy cattle breeding, dairy demonstration farm, training and extension services programmes in the surrounding areas. Since then the dairy industry in Thailand are wide spread throughout the country but mainly near a big city, such as Muak Lek-Saraburi, Nong Pho-Ratchaburi, Ayudhaya, Lopburi, Petchaburi, Nakornpathom and Chiang Mai. At present, the dairy industry in Chiang Mai areas is cooperated with about 1,800 farmers, which produces around 70 tonnes of fresh milk daily from a total of over 15,000 dairy cattle.

Nevertheless, the dairy industry in Chiang Mai areas is an integral part of smallholder farming systems. The basal feed resources for dairy cattle available are mainly from crop residues, pasture from infertile land, for example communal land, or agro-industrial by-products. Under the integrated farming systems with about 0.5 ha of crop land the farmers established pasture only on a small area less than 0.3 ha. Thus, apart from using pasture under cut-and carry system, the agro-industrial by-products from the factories in the surrounding areas play very important roles as alter native feed resources for dairy cattle.

The series of study at Department of Animal Science, Faculty of Agriculture, Chiang Mai University were concentrated on how to use the agro-industrial by-products as alternative feed resources for dairy cattle in Chiang Mai areas. The experiments were conducts by using the methods of *in sacco* / *in situ* nylonbag technique (Mehrez and Ørskov, 1977) and *in vitro* Hohenheim gas test technique (Menke and Steingass, 1988). The agro-industrial by-products using in the studies were passion fruit peel, fresh soybean pod husk, dry malt residue and soysauce residue.

Sources of agro-industrial by-products.

The availability of agro-industrial by-products is influenced to a very large extent by seasons of the year and the areas near by the factories. Some commonly used agro-industrial buy-products by dairy farmers in Chiang Mai areas are as follows :-

1. Passoin Fruit Peel

Passion fruit is generally grown in the upland areas of Northern Thailand for over 20 years, mostly in the areas under the responsibility of the Royal Project Foundation. The production of passion fruit is around 400-600 tonnes annually. Normally, passion fruit will be harvested and send to the factories nearby from August to February. The dairy farmers feed the passion fruit peel, the waste product from the factory which comprises approximately 70 percents to the dairy cows together with other sources of roughages. Sithiwong (2001) reported that the milk production of the dairy cows from the dairy farms in Chaiprakarn District, Chiang Mai, fed with passion fruit peel was about 1 kilogramme higher than the cows that fed with other sources of roughages (14.4 vs 13.3 kg/cow/day, $p<0.05$). Sithiwong (2001) also tried to ensiled passion fruit peel in order to keep and feed to the dairy cows during the dry season.

2. Soybean pod husk

In northern Thailand soybean is grown by the farmers either for seed or fresh soybean pod to freeze for export especially to Japan and other countries. It was estimated that Thailand exports approximately 900 tonnes of frozen fresh soybean pod yearly. In Chiang Mai, it was found that the percentages of discarded frozen boiled soybean pod husk, frozen boiled soybean pod and fresh soybean pod from the factory were 19.0-21.7, 2.7-3.1 and 0.8-1.0, respectively (Cheetarak, 2000). So it would be expected to have over 200 tonnes of by-products from the frozen fresh soybean pod processing factories each year.

3. Dry malt residue

For the last few decades the beer industry in Thailand has been surprisingly increased from 617,100,000 litres in 1995 to 1,035,141,000 litres of beer produced in 1999 (Statistic Bureau, 1999), in the brewing processes the initial step involves the malting of barley. Upon germination, the enzymes convert starch to malt sugar. The partially-germinated barley is barley malt. The sprouted barley is dried by heating to stop enzymatic activity. Malt sprout and malt hulls are then separated. Barley malt is mixed with other grains, generally corn or rice, and a flavouring agent, hops to form a mash. This mash is pressed and filtered to give the wort as end-product and brewers' grains as residue (see Figure 1). It has been reported to produce 1 litre of beer there would be about 100 grammes of brewers' grains residue or malt residue which was about 10 percent.

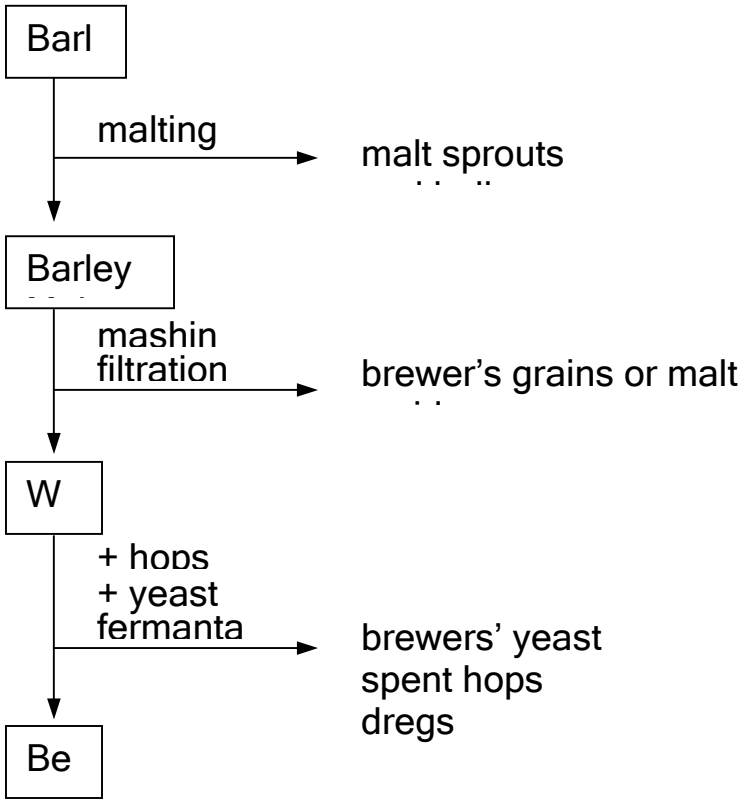

Figure 1. Brewery flow diagram.

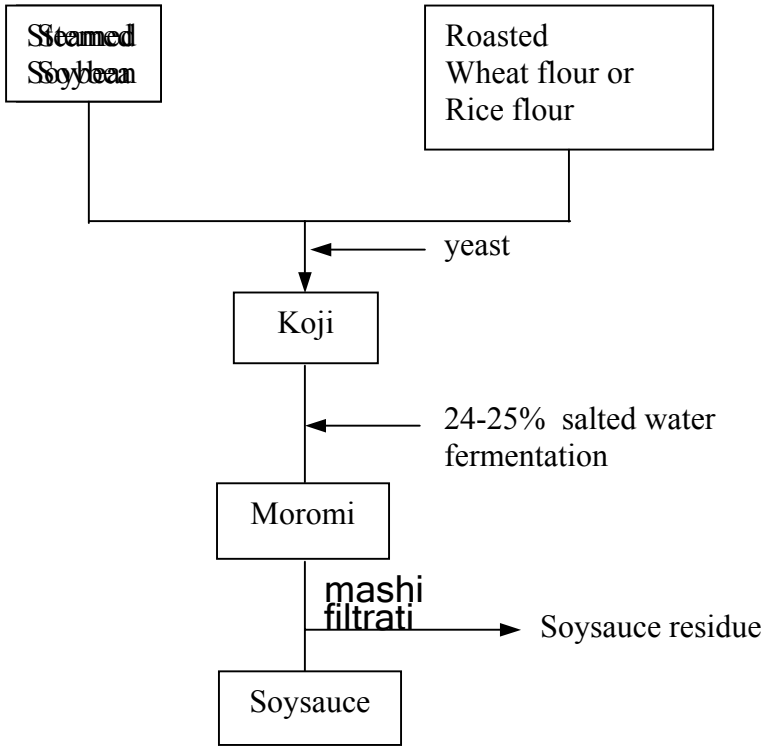

Figure 2. Soysauce production flow diagram.

So it would be more than 100 tonnes malt residue produced from the beer industry each year. This would be beneficial to use malt residue as an alternative source of protein for dairy caltle feed.

4. Soy sauce residue

The soysauce industry in Thailand mainly uses soybean, wheat flour or rice flour, salt and water as materials to produce soysauce. The flow diagram of soysauce production process is shown in Figure 2. the steamed soybean mixed with roasted wheat or rice flour and yeast is stored at 30^{o}C and 100% moisture for 1 week. This step called Koji, then Koji is fermented further in 24-25% salted water for 8-12 months (Moromi). The soysauce residue is then separated from soysauce by filtration. At present, there are approximately 68 soysauce factories throughout Thailand. It is estimated that about 1,600 tonnes of soysauce residue is produced each year (Statistic Bureau, 1999). The soysauce residue should be a good source of protein fer dairy cattle feed. Due to the high content of salt in the soysauce residue, some precaution must be born in mind not to use soysauce residue at a too high level in the concentrate mixtures.

Nutritive vaules of agro-industrial by-products

1. Chemical composition

The series of study at Chiang Mai University were conducted to evaluate agro-industrial by-products from the factories surrounding Chiang Mai areas. It was found that some of the by-products such as soybean pod husk (Cheetarak, 2000) and passion fruit peel (Sitthiwong, 2001) were relatively high in CP and CF contents. So it could be directly used as a source of roughages. To improve the nutritive values of passion fruit peel, it could be ensiled with 4% rice bran or 4% corn (Sitthiwong, 2001).

Another group of agro-industrial by-products such as dry malt residue and soysauce residue are relatively high in CP content (approximately 19-22%) and low in fibre content so it would be readily used as sources of protein in the concentrate mixtures of dairy cows Patsara, 2002; Khunpanya, 2002). The chemical composition of the by-products used in the study are shown in Table 1.

Table 1 Chemical composition of some agricultural by-products from the factories around Chiang Mai.

Items	DM (%)	OM	CP	EE	CF	NDF	ADF
			% of DM				
Frozen boiled soybean pod husk	17.38	86.60	19.18	6.03	23.89	40.38	25.00
Fresh soybean pod	20.51	86.65	24.49	8.30	20.89	35.45	22.44
Frozen boiled soybean pod	22.62	87.10	26.90	11.99	15.76	29.17	17.49
Passion fruit peel	13.67	90.56	6.80	0.95	-	43.81	37.96
Passion fruit peel silage	11.46	83.31	9.97	1.28	-	48.23	42.01
Passion fruit peel+3% urea+10% rice straw silage	19.41	82.69	11.67	1.01	-	45.11	38.53
Passion fruit peel+4% rice bran silage	16.04	86.16	11.78	3.04	-	44.85	39.76
Passion fruit peel+4% corn silage	14.13	84.73	8.47	3.46	-	57.13	43.66
Passion fruit peel+1% formic acid+10% rice straw silage	17.55	81.73	6.05	1.78	-	56.12	43.56
Dry malt residue	85.95	80.19	18.55	2.32	13.13	51.85	22.69
Soysauce residue	77.79	92.51	22.30	22.95	17.43	-	-

2. Protein degradation and energy values

The protein degradation parameter of the agro-industry by-products was measured by *in situ* / *in sacco* nylonbag technique (∅rskov and McDonald, 1979). The energy values as ME and NEL was measured by *in vitro* gas production technique (Menke and Steingass, 1988). It was found that the potential degradation (A+B,%) of soybean pod husk, passion fruit peel, passion fruit peel silage, passion fruit peel + 4% rice bran silage and passion fruit peel +4% corn silage were well over 81-90%. In contrast, the potential degradation of dry malt residue was some what lover (74.40%) than other by-products. Dry malt residue are reported to resistance to degradation in the rumen, it is supported by Patsara (2002) who found that the effective degradation of CP at 0.05 h was only 36.6%.

The ME and NEL values of most of the by-products were relatively low except for soybean pod husk (15.0 and 9.6 Mg/kg DM, respectively).

The potential degradation (A+B, %), OMD, ME and NEL of the agro-industrial by-products from the factories around Chiang Mai are shown in Table 2.

The *in vivo* studies of dry malt residue inclusion in the concentrate mixtures at different levels (0, 20, 30 and 40%) by Patsara (2002) also concluded that in the concentrate mixed with dry malt residue could maintain the levels of NEL values at about 8.4 MJ/kg DM when compared with conventional feed except at 40% it had a tendency of lower values (7.56 MJ/kgDM).

Table 2 Potential degradation (A + B, %), OMD, ME and NEL of agro-industrial by-products from the factories around Chiang Mai.

Items	A + B (%)	OMD (%)	ME (MJ/kgDM)	NEL (MJ/kgDM)
Frozen boiled soybean pod husk	83.9	95.86	14.97	9.56
Fresh soybean pod	86.6	92.18	14.39	9.15
Frozen boiled soybean pod	89.0	95.26	14.90	9.50
Passion fruit peel	80.69	-	-	-
Passion fruit peel silage	81.97	57.65	9.88	6.09
Passion fruit peel + 3% urea + 10% rice straw silage	69.30	45.00	8.07	5.19
Passion fruit peel + 4% rice bran silage	85.16	61.40	10.09	7.20
Passion fruit peel + 4% corn silage	90.21	56.94	9.22	5.70
Passion fruit peel + 1% formic acid + 10% rice straw silage	74.75	46.10	8.35	3.77
Dry malt residue	74.40	33.45	7.30	3.94

3. Effects of dry malt residue and soysauce residue on milk production.

The effects of dry malt residue and soysauce redidue at different levels in the concentrate mixtures on milk production are shown in Table 3 (Patsara, 2002) and in Table 4 (Khunpanya, 2002), respectively.

It was found that to replace the conventional protein sources by dry malt residue and soysauce residue could maintain the milk production of Holstein Friesian cows. It could also reduced the cost of feed, therefore, increased the net income. Further study to determine the optimum levels of replacement must take into consideration.

Conclusion

The dairy farmers in Chiang Mai, northern Thailand rely mainly on crop residues or agro-industrial by-products for their dairy cattle feed. The studies showed that the

Table 3 Effects of levels of dry malt residue in the concentrate mixtures on milk production of purebred Holstein Friesian cows.

Items	T1[1/]	T2	T3	T4
No. of cows	7	7	7	7
Milk yield (kg/d)	10.5	10.0	11.2	9.7
Feed intake (kg/d)	8.4	8.2	8.6	8.2
Cost of feed (Baht/head/d)	39.36a	30.68b	30.52b	27.87b
Income (Baht/head/d)	125.88	119.52	134.16	116.04
Net income (Baht/head/d)	86.52	88.84	103.64	88.17

1/ T1 - commercial concentrate (CP005-16) T3 - 40% dry malt residue
T2 - 30% dry malt residue T4 - 50% dry malt residue
a>b ($p<0.05$)
Milk price - 12 Baht/kg
Dry malt residue - 21.6% CP, 14% CF, 2.7% EE, 6.7% Ash

Table 4 Effect of soysauce residue supplementation in the concentrate mixture on milk production of crossbred dairy cows

Items	conventional feed	20% soy sauce residue
No. of cows	6	6
Milk yield (kg/d)	10.1 ± 1.9a	12.7 ± 1.9b
4% FCM (kg/d)	9.2 ± 1.5a	11.3 ± 1.2b
Cost of feed (Baht/head/d)	49.30a	40.29b
Net income (Baht/head/d)	51.96a	84.12b

a < b ($p<0.05$)

Milk price - 11 Baht/kg

agro-industrial by-products such as soybean pod husk and passion fruit peel could be directly used as sources of protein and energy. The ensiled passion fruit peel could improved the nutritive values and could be kept for dry season feeding. From the preliminary studies on using dry malt residue and soysauce residue to replace conventional protein sources at different levels in the concentrate mixtures could maintain the milk production and could reduce the feed cost up to more than 20 percent.

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