NUTRITIVE VALUE OF AGRICULTURAL BY-PRODUCTS USED IN MALAYSIA

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ABSTRACT

An important aspect of animal production is to produce human food from the resources which cannot be used directly for human consumption. The effective utilization of agricultural by-products as animal feed is indispensable to develop animal production with a minimum amount of imported feed. Determination of the nutritive value of some tropical agricultural by-products was carried out by chemical analysis and feeding experiments and the following results were obtained.

1 Rice and by-products: Broken rice, rice bran, and rice straw are widely used and are important feeds. Crude fiber content of rice bran ranged from 4 to 33% due to the incomplete separation of husks from the bran.

2 Cassava and by-products: Cassava pellets are the most promising substitutes for corn in animal feed when suitable protein sources are supplied. Crude protein content of cassava leaf is about 25%. Leaf meal could be utilized as feed. For the intensive utilization of cassava as feed it is necessary to use cassava varieties with low hydrocyanic acid content. Cassava starch extraction residues contain 80% water but only a small amount of this product is used.

3 Palm oil by-products: Press fiber and palm oil sludge are not commonly used. Palm oil sludge contains about 5% of solid material. Dried sludge which contains 7-31% fiber, 12-20% ash, 17-30% oil and 10% protein, holds a high potential as animal feed provided that the drying cost is lowered. Press fiber is not commonly used as feed. Palm kernel meal and Kopra cake are widely used as important local animal feeds.

4 Pineapple wastes: About 50% of pineapple fruit is discarded at the time of processing. A small amount of wet waste is used nearby farms. In many cases the high cost of drying restricts the extensive use of wet by-products.

5 Rubber seed meal, kapock meal, ipil-ipil, cocoa pod, borneo tallow nut, etc. which are produced in small quantities are also valuable. These products and their wet by-products which are not easily marketed as feed can be effectively utilized in backyard farming systems.

Introduction

Rubber and oil palm are the two most important tree crops in Malaysia. They contribute 47% of the whole agricultural production. The contribution of the animal production sector is about 10% of the total production. Poultry and pig production which depends on imported feed ingredients is well developed although dairy and beef production which mainly depends on domestically produced feed is still in the growing stage. To increase cattle production, the development of grasslands is an important part of the feed supply. However in Malaysia there is a competition between grasslands and tree plantations which give higher returns. Under these conditions it is important to promote animal production in combination with the prevailing agricultural systems. In Malaysia many cattle are grazing in the daytime and kept in a barn at night. These cattle are users of roadside grass, leftovers and by-products. These are some agricultural by-products that are potentially useful as animal feed although they have not been used efficiently hitherto.

For the intensive use of these by-products as feed, it is necessary, as a first step, to evaluate their nutritive value. Although the major chemical components of the feeds used in Malaysia have been analysed, data obtained from animal experiments are still limited.

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Determination of the nutritive value of some agricultural by-products was carried out by chemical analysis and feeding experiments using laying hens.

Materials and methods

Local agricultural by-products and feed ingredients were collected and air-dried samples were subjected to proximate analysis and metabolizable energy determination using laying hens. For the metabolizable energy determinations, samples were mixed with a basic diet which contains chromic oxide as an indicator. The feed was given to six White Leghorn layers individually caged. Droppings were collected for 24 hours after a six-day period of adaptation. Droppings were dried in a forced draft oven. Moisture, nitrogen content, gross energy value, and chromium oxide levels of the feed and droppings were determined. Gross energy of the sample was measured with a vacuum flask adiabatic calorimeter.

Results and discussion

1 Rice by-products

As rice is the most important food crop in Malaysia, various rice by-products are produced, of which rice bran is the most important one as a source of feed.

Results of proximate analysis are shown in Table 1. Rice bran contained 4.6-13.6% crude protein, 0.7-11.8% crude fat, 4.3-33.7% crude fiber, 6.3-14.9% crude ash, 33.6-54.9% nitrogen free extract.

Significant differences in the content of protein, ash and fiber were observed. It was observed that the separation of the hull from the bran was inadequate. The variations in quality are ascribed mainly to the differences in the rice polishing methods applied.

Two processes are carried out when white rice is produced from hulled rice. The first stage is the separation of husks from paddy rice, and the next consists of the separation of the outer coat and the germ from dehusked rice. When the whole process is carried out

Table 1 Rice by-products

Sample	Moisture %	crude protein %	Crude fat %	Crude fiber %	Crude ash %	NFE %
Rice bran						
(Malaysia)	10.5	9.3	7.1	21.8	8.9	42.4
(Malaysia)	10.9	11.8	11.8	4.3	6.3	54.9
(Sarawak)	8.8	4.6	1.4	33.7	14.9	33.6
(Indonesia)	10.8	10.9	7.4	18.5	14.3	38.1
(India)	10.3	13.6	0.7	13.3	14.4	47.7
Dehulled rice						
(Malaysia)	11.9	9.6	2.5	0.1	1.3	74.6
Broken rice						
(Malaysia)	10.9	9.8	1.6	0.2	0.9	76.6
Rice bran						
(Japan)	12.6	14.5	17.3	7.5	8.7	39.4
(Japan)	12.6	17.8	2.5	8.6	11.5	47.0
Dehulled rice						
(Japan)	13.5	8.4	2.5	1.0	1.6	73.0

successively, the by-products consist of a mixture of husk, bran, germ and broken rice. On the other hand, since dehusking and polishing are performed separately, husks can be easily separated from the other by-products. Oil in the bran is a good energy source for the animals but is easily oxidized and is often toxic to them. Raw rice bran must be used within a short time. In Malaysia, the annual production of rice bran is about 150 thousand ton.

Although broken rice is often used as animal feed, the use of dehulled rice or "padi" rice has not been reported. The annual production of rice straw which is also an important by-product of rice amounts to approximately 860 thousand ton. For intensive use, straw must be carried from the field to the site where the animals are kept. Introduction of intensive rice production systems such as double cropping and machine harvesting, hampers the intensive utilization of this by-product. Based on a long-term forecast indicating that rice may be produced as feed, basic studies on the utilization of rice as a substitute for corn were conducted at MARDI. From the view point of effective use of the resources, straw and ground hulled rice, and dehulled rice are recommended for ruminant and non-ruminant animals, respectively.

2 Starch by-products

Cassava tuber and sago palm are used to produce starch in Malaysia. Proximate analysis data and processing diagram of these products are shown in Table 2 and Fig. 1.

Main component of cassava is starch which is classified as NFE in proximate analysis. The content of the other nutrients is low.

Starch extraction wastes are mainly composed of fiber and NFE.

Dried cassava tuber is commonly used in the form of pellets in the world market. About 7 million ton of this product are produced in Thailand and consumed in the European countries. Cassava which is not used much in Malaysia presently may become an important source of energy in feed as a substitute for corn. The shortcomings in the utilization of cassava are related to its content in hydrocyanic acid (HCN) which is toxic and the supply of cheap suitable protein sources to use in combination. By-products of cassava starch are waste water and cassava starch residues. Only a small amount of the residue is used in the wet form nearby piggeries. Cassava leaf is rich in protein, with a crude protein content of about 20%, which is comparable to that of grass meal. If the content of hydrocyanic acid were lowered this leaf could be used as forage, since animals are able to detoxify certain levels of HCN. Thus cassava with a sub-toxic level of HCN could be offered to the animals. For intensive use of cassava as animal feed, development of low HCN varieties and

Table 2 Starch by-products

Sample	Moisture %	Crude protein %	Crude fat %	Crude fiber %	Crude ash %	NFE %	ME cal/g
Cassava							
Chips	13.5	4.4	0.9	3.4	2.5	75.3	2,672
Pellets	12.5	2.7	0.6	4.0	5.5	74.7	
Leaf meal	10.6	18.0	8.4	11.5	8.3	43.2	
Sago							
Rasped	8.0	1.3	0.3	4.2	3.5	82.7	
Young pith	9.9	7.0	2.6	10.9	8.8	60.8	
Starch	11.4	0.2	0.1	0.1	0.8	87.4	
Starch	13.8	0.2	0.4	0.3	0.2	85.1	3,374
Waste	11.4	1.1	0.3	6.1	6.8	74.4	
Waste	19.5	2.2	0.1	7.6	7.3	63.3	

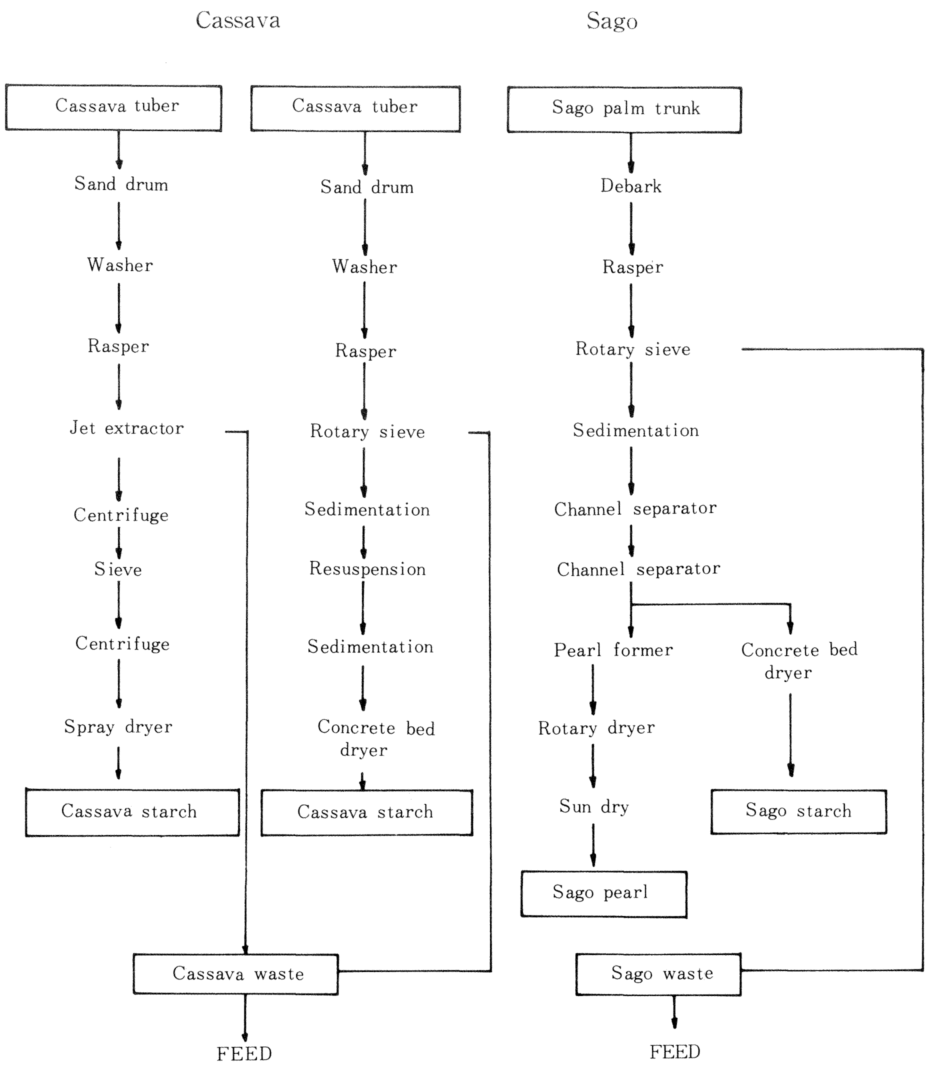

Fig. 1 Starch extraction and by-products.

production of domestic sources of protein to be mixed with cassava are necessary.

Sago palm is an important starch resource in swampy areas, where no other crops can be grown. Commercial scale production of starch from the palm takes place in Batu Pahat, in Peninsular Malaysia and in Sarawak. Fresh or sun-dried rasped sago palm is produced for use as animal feed. Only a small amount of the waste and rasped palm is used as feed by backyard pig farmers or duck keepers presently, the rest being discarded. Studies on the utilization of rasped sago palm in pig feed is showing that the bulky nature and low digestibility of this product are limiting factors. In any case, sago palm is not as important as cassava as a feed resource.

3 Oil seed by-products

Oil palm, coconut, rubber seed, and Borneo tallow nut are used for oil extraction.

Palm oil production is the largest followed by coconut while production of other oil seeds is negligible. By-products of palm oil recovered from mill consist of empty bunches, press fibers, palm kernel cake, and palm oil sludge. Copra cake and rubber seed meal are the by-products of coconut oil and rubber seed oil extraction, respectively. Borneo tallow nuts are seeds of dipterocarp trees which are collected for extraction of oil in Sarawak. Results of proximate analysis and palm oil production scheme are shown in Table 3 and Fig. 2. Both copra cake and palm kernel cake are widely used as dairy cattle feed. Quality of palm kernel meal does not vary much as palm kernels are processed at the solvent extraction plant, unlike the quality of copra cakes, since in the latter case press extraction is performed by small oil millers. Empty bunches are burnt and the ash is used as fertilizer for the palm. Most of the press fibers are used as fuel at the oil mill. Attempts to use press fibers as feed are being made and alkali treatment has been reported. Press fibers are convenient resources because a large amount can be obtained from the factory attached to the plantations all the year round.

Palm oil sludge. This watery waste contains about 5% of solid material and the removal of the remaining 95% of water is a difficult undertaking. Once this waste is dried it can be easily used as feed. Fiber content and fat content of the by-products vary although the energy content is relatively high. Attempts to produce dry products, by means of press filtration

Table 3 Oil by-products and others

Sample	Moist. %	C. Prot. %	C. Fat. %	C. Fiber %	C. Ash %	NFE %	ME cal/g
Oil palm							
Palm oil	9.2	10.5	23.8	7.3	14.7	34.5	2,768
sludge	6.0	11.9	33.6	15.2	12.1	21.2	
	7.1	13.2	16.6	31.9	19.8	11.4	
	6.6	13.2	18.6	31.0	16.5	14.1	
Yeast							
(From sludge)	14.9	46.3	5.3	7.0	12.4	14.1	
Kernel cake	8.1	13.5	1.1	15.9	3.3	58.1	
	9.2	14.4	3.2	17.4	3.3	52.5	1,218
	12.7	16.2	2.5	12.2	3.6	52.8	974
Coconut							
Copra (ext.)	11.4	20.5	3.4	8.3	5.2	51.2	2,224
(press)	12.0	19.1	11.4	8.5	5.2	43.8	
(press)	10.6	18.4	16.8	8.2	5.4	40.6	
Rubber	5.0	18.6	46.6	3.3	3.3	23.2	
Seed	7.8	13.7	5.8	33.4	3.1	36.3	2,111
R.S. meal	8.0	15.7	4.5	37.7	3.3	30.8	995
	11.0	28.9	12.6	6.1	5.9	35.5	
Borneo tallow nut							
Nut	4.9	5.6	50.2	1.2	2.1	36.0	
	6.0	7.8	45.3		1.6		
Pineapple							
Bran	10.3	5.5	0.8	20.7	3.3	59.4	
Ipil ipil							
Leaf	13.4	19.7	8.8	10.5	8.5	39.1	
Seed	9.4	26.2	5.5	13.2	3.4	42.3	

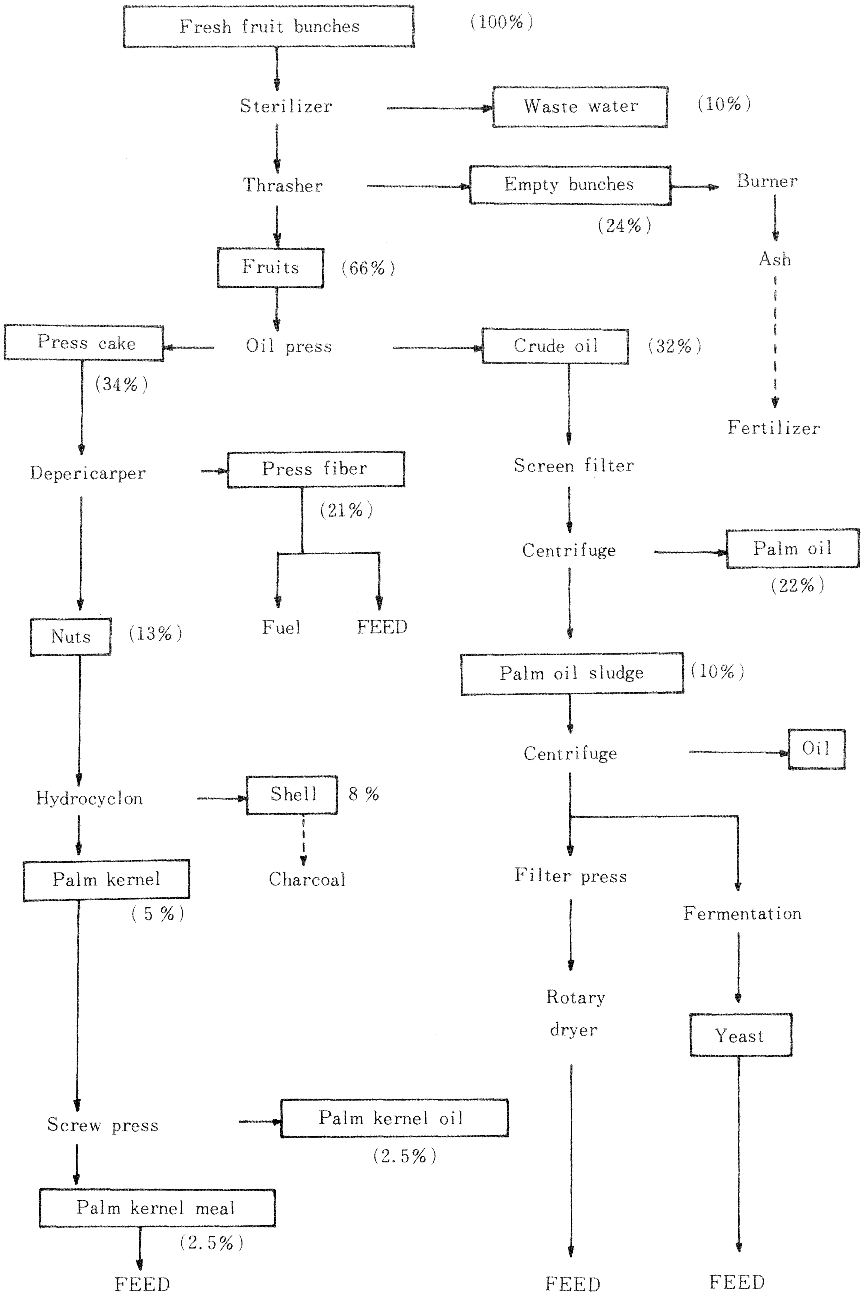

Fig. 2 Palm oil production and by-products.

combined with centrifugal separation or mixture with grain and grass meal have been reported. Fermentation technology as a method of waste water treatment is also applied and feed yeast has been produced experimentally. In these cases high drying cost is always the major limiting factor for practical use of this waste.

4 Rubber seed meal

Although Malaysia has the world's largest rubber plantation acreage, utilization of rubber seed has not been intensive until recently. The rubber seed meal sample used in the experiment showed low protein and high fiber contents compared to the values reported. It is assumed that shelled seeds are subjected to press extraction of oil. Protein content of this meal is the same as that of palm kernel meal or coconut cake. Oil content varies depending on the extraction method. Rubber seeds contain a glucoside which produces hydrocyanic acid when hydrolyzed. During the drying, storage, and heating procedures for oil extraction hydrocyanic acid in the seeds is decomposed. As a result the meal used as animal feed contains small amounts of hydrocyanic acid. Although there are reports indicating that fertility and hatchability are reduced in pigs and hens, recent reports indicate that such effects are not observed in laboratory animals. Some studies on the effects of remaining hydrocyanic acid, oil or other substances in the meal should be conducted before extensive use of this by-product. If seeds could be collected at a low cost and rubber oil could be easily marketed, more than 30 thousand ton of the meal could be made available each year for feed, from the 2 million hectares of rubber plantations in Malaysia.

5 Pineapple by-products

In Malaysia pineapples are produced for canning purpose in the southern part of the Peninsula and a pineapple bran factory is attached to a cannery.

More than 50% of each pineapple brought into the cannery is discarded as wet waste which contains 90% water, has a high content of sugar, low content of protein and is highly fermentable.

Pineapple waste contains unripened, over-ripened, damaged fruits, tops, bases, peeling, cores and juice residues. The nutritive value of the dried by-product which is called pineapple bran is well known in the world.

At present pineapple bran is not practically used by small holders in Malaysia. There is a feedlot near the cannery where this wet waste is used as major feed combined with palm press fibers and poultry litter, etc.

6 Cacao by-products

About 70% of the cacao fruit remains as empty pod after cacao beans are removed. Inner layer of this fibrous waste material contains mucilage rich in sugar, which becomes easily rotten.

Presently a small amount of raw waste is used as cattle feed, but for extensive use the product should be dried. Use of this by-product is becoming increasingly important because the production of cacao is expanding rapidly in Malaysia.

7 Kapok meal

Although kapok trees are grown in Malaysia, oil extraction residues are not available.

8 Ipil-ipil

This legume shrub has been introduced to Malaysia recently and research work is in progress. However this plant is not used as forage in farms.

Conclusion

As mentioned above, a large amount of various resources which could be used as feed are wasted and sometimes cause environmental pollution, due to the scattering of the production sites, the seasonal supply or high drying cost of these products. Effective use of wet waste is an important subject of study as well as the development of dry products with a low cost. To eliminate the transport problems or drying cost, animals should be brought to the site where these waste materials are produced. In this regard it will be necessary to reevaluate the advantages of the backyard farming system and to ask the producers to take care of their waste materials which, if properly treated, could be converted into valuable animal feed.

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Discussion

Siregar, M. E. (Indonesia): Are these by-products used for the farmers or on a commercial basis?

Answer: If the products were dried they could be marketed. I would like to mention that before the farmers use the fresh products they should be informed of the possible risks associated with the toxicity of some of the products, such as *Leucaena* which contains mimosine.

Jayawardana, A. B. P. (Sri Lanka): Rice bran quality appears to be different in Japan and Malaysia. This difference may be related to the fiber content which is higher when hulls and bran are not adequately separated by machines.

Answer: Indeed, in Japan, Korea and Taiwan, hulls and bran are separated during the processing of rice. If improved hullers were used, bran could be separated for bran is an important product from which oil can be extracted.

Manidool, C. (Thailand): Is there any way of upgrading the quality of rice straw before feeding it to the animals?

Answer: At MARDI experiments on alkali treatment of straw are being carried out. From the start rice straw is not a very good product unless 100% of the nutrients are digested. Methods for improving the treatment of straw should be developed.