PRODUCTION AND USE OF CASSAVA FLOUR: A NEW PRODUCT OF FUTURE POTENTIAL IN INDONESIA

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ABSTRACT

Cassava is a perishable commodity. Over-supply occurs every year during the peak harvest season, with varying severity. To overcome the above problem, processing cassava into flour can be an alternative solution. The cassava flour production system in Indonesia is designed as a nucleus-plasma model. Cassava flour can substitute for wheat and rice flours as well as cassava starch at varying levels according to the kinds of food products. However, there are still problems in its marketing and distribution. A study on consumer acceptance has been conducted in West Java (115 households) and East Java (100 households and 25 small-scale food industries). Three visits to each respondent were made to collect information on the socio-economic situation, cassava flour utilization, and the level of cassava flour used in the processing of traditional foods, cookies, cakes and crackers. In the various food industries cassava flour was mostly processed into cakes, traditional foods and noodles. Substitution levels ranged from 20 to 100%, depending on the product. The contribution of cassava to the total carbohydrate intake in the diet of urban and rural households was 2.5 and 23%, respectively.

INTRODUCTION

Rapid urbanization in Indonesia has increased the consumption of processed food and bakery products, as well as increased the demand for imported products. To reduce imports and to save foreign exchange, it has been proposed that wheat flour be substituted by local products, such as maize, rice, sorghum, cassava and sweetpotato flours.

In Indonesia cassava is grown on about 1.4 million ha annually and its roots are used for food, feed and as raw material for starch extraction (Damardjati *et al*., 1990). The cassava market is unstable, and there are no attractive economic incentives for farmers to produce more cassava. At present, the low price is associated with limited demand. Since 1990 there has been over-supply because no new marketing opportunities have been created. Wheat is not produced commercially in Indonesia, but is imported as grain. There are three big wheat-milling factories, located in Jakarta, Surabaya and Ujungpandang, to produce wheat flour. The consumption of wheat in Indonesia has increased sharply from 125,000 tonnes in 1972 to 2.995 million tonnes in 1996. Wheat-based products are important, even though they do not dominate the national diet. In 1988, average per capita wheat consumption contributed only 66 Kcal/day or 2.4% of the calorie intake, and 1.6 g/day or 2.7% of the protein intake of the total national consumption (CBS, 1990). 1996 statistics show that wheat consumption had increased sharply to 40.8 g/day, contributing 149 Kcal and 3.6 g of protein per day. The properties of cassava flour are rather similar to those of wheat flour, and therefore cassava flour can partially substitute for wheat flour in many wheat-based products.

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CASSAVA FLOUR PRODUCTION

Cassava flour production is divided into three distinct operations as follows (Damardjati *et al*., 1990a):

1. Harvesting and Handling of Fresh Cassava Roots

This is conducted fully at the farm level to produce fresh roots for the market, for temporary storage, or for processing to semi-processed products.

2. Production of Dry Cassava Chips

This is conducted at the farm level, either by individual farmers or in a group. The production of dry cassava chips follows several steps, i.e. peeling, washing and soaking, shredding or chipping, pressing and drying. Dry chips and flour will have a good quality when the raw materials are fresh (processed not more than 24 hours after harvest).

Peeling

Simple peeling of cassava can be done manually, using a knife. This traditional method results in good quality peeled cassava, but needs more labor and time than when using a peeling machine.

Washing and Soaking

Peeled cassava should be washed immediately, and then soaked in water. The purpose of this step is to remove the mucilage and reduce released HCN. Soaking can be done in a washing tank or by flowing water.

Shredding or Chipping

Several prototypes of cassava chipping machines have been introduced. Some of the machines are:

1. Manual chipping machine (designed by Sukamandi Research Institute for Food Crops, SURIF)

The equipment has replaceable blades depending on the purpose: to slice, shred, chip, or rasp. The capacity of this machine is 30 kg fresh cassava/hour operated by two persons.

2. Pedal chipping machine (designed by SURIF)

The capacity of this machine, which has a feed hopper, is about 100 to 120 kg/hour operated by two persons. By using an engine of 0.5 hp its capacity can be increased to 200-250 kg/hour/person.

3. Power chipping machine (designed by Maros Research Institute for Food Crops, MORIF)

The CSM-1 and CSM-2 models are designed with an engine of 0.5 hp, and have capacities of 170 and 370 kg chips/hour/person, respectively.

4. Large-scale chipping machine

Mariza company, a private enterprise, produces cassava chipping machines on a large scale to meet the demand of five national companies. Its machines are distributed in five provinces. The Type M5 # 16 cm chipping machine has a capacity of 300-400 kg chips/hour. Using pedal power, its capacity is 150 to 200 kg. The Type M5 # 32 cm chipping machine, with an engine of 2 hp, has a capacity of 2 t/hour.

The purpose of shredding or chipping is to convert the whole root into thin slices, of approximately 0.2-0.5 cm width, 1-5 cm length and 0.1-0.4 cm thickness.

Pressing

There are two purposes to pressing, i.e. to increase the drying rate and to reduce the HCN content, especially in bitter cassava varieties. The drying time for unpressed chips is about 30-40 hours, while pressed chips require only about 14-16 hours.

Drying

Pressed chips have to be dried immediately. Sun-drying is preferred because it is cheap and simple. During the rainy season, drying can be done by using an artificial dryer. Drying is complete when the chip moisture content has reached 14% or less. Dry chips are packed in plastic bags and can be stored for up to six months.

3. Milling

The manufacture of flour is done in a factory managed by cooperatives or by private companies with a larger capital.

To produce cassava flour, dry chips are milled with a disk mill, usually used for rice flour production. In order to maintain its quality, cassava flour should be packed in plastic bags and kept in a good quality warehouse.

AGRO-INDUSTRIAL MODELS

The development of models places emphasis on the operation of the systems at the farm level. It is expected that these farm products will be absorbed by the industrial sector, giving added value to the farmers.

The cassava flour production system in Indonesia is designed as a nucleus-plasma model. The cassava flour agro-industry can be developed in any area which is able to supply about 10 tonnes of fresh roots per day for five months operation in a year.

In an area of 1,000 ha, producing 15,000-20,000 tonnes of cassava/year, 5% of this production can be used for the development of a cassava flour agro-industry. A production level of about 1,500 to 2,000 tonnes/year is equivalent to about ten tonnes roots/day processed over five months.

In such an area, three main models of agro-industry can be proposed, depending on farmer capability, capital and distribution/marketing of the value-added product.

Model I: Home agro-industry for individual farmers

A family consisting of 2-3 persons can process 200 kg of fresh cassava roots/day and produce about 70 kg of dry chips. The investment is about Rp 750,000[1] to buy one unit of a hand-chipping machine, washing tanks, and sun-drying equipment (Damardjati *et al*., 1992b). The dry chips produced can be absorbed by Model III.

If two tonnes of fresh cassava roots/day are available, ten families can be involved in Model I, producing about 700 kg of dry chips/day.

[1] In 1992 the exchange rate was about Rp 2000 per US dollar.

Model II: Agro-industry for farmer groups

A group consisting of 10-12 persons can process 1 tonne of fresh cassava roots/day to produce about 300 kg dry chips. The investment is about Rp 5,500,000 for buying one unit of a pedal-operated chipping machine, washing tanks, and sun-drying equipment (Damardjati *et al*., 1992b). The dry chips can be absorbed by Model III.

If five tonnes of fresh cassava are available per day, five groups of farmers can be involved, resulting in a total production capacity of about 1.5 tonnes of chips/day.

Model III: Nucleus cassava flour agro-industry.

The plant requires about 20-25 laborers and has a processing capacity of 3-5 tonnes cassava flour/day. Dry chips and cassava flour are the end-products. This milling unit mainly processes dry chips from neighboring farmers. Model III is mainly to produce cassava flour, and is responsible for marketing. Investment for the equipment is estimated at Rp 90,000,000 to buy a power chipping machine, two units of pressing equipment, drying equipment, and two units of milling equipment (Damardjati *et al*., 1992b).

Model III can absorb 1 to 2 tonnes fresh cassava/day, to be processed into dry chips, as well as absorb about 2 to 3 tonnes dry chips/day produced by Models I and II

CONSUMER ACCEPTANCE OF CASSAVA FLOUR

Cassava flour, which is processed from dry chips or dry shredded cassava, is a relatively new product in Indonesia. Research has been conducted since 1990 (Damardjati *et al*., 1990). Case studies to gather information on consumer preference for cassava flour and its products have been conducted in West Java (Damardjati *et al*., 1992a) and in East Java (Martini, 1992). The study in West Java involved 115 respondents based on their income level and the women's education level. In East Java, the study involved 100 respondents, divided into two categories, i.e. rural and urban/city respondents. Each respondent was visited three times to collect the data.

Consumer Preference in Cassava Flour Utilization

All the cassava samples for the cooking trials, which were supplied by interviewers during the first visit, were utilized by the respondents to prepare snacks within two weeks. The different income levels of respondents tended to be associated with the different types of food preparations from cassava flour

Traditional foods were preferred by most of the respondents (ranging from 53 to 76%) in all income levels over other processed foods made from cassava flour. The consumers stated that preparing traditional foods was simpler, and that they were more familiar with the products. For the high-income group of consumers, 43% of respondents preferred to process cassava flour into cakes; this compared to 22% in the medium and 30% in the low-income groups. Preference for traditional foods by the high-income consumers tended to be less. Ingredients such as margarine, butter, flavoring agents and dried fruit may be added in the cake preparation. These ingredients are relatively expensive. Therefore, the highest percentage making cakes came from the high-income consumers. The interest in cakes among the low- and medium-income consumers was not much different (**Table 1**).

Table 1. Preference of 115 consumers of various socio-economic and educational classes for making various products using cassava flour samples supplied by the interviewers (West Java).

Respondent group	n[1)]	Choice of consumer (% of respondents) for			
		Traditional foods	Cookies	Cakes	Crackers *(krupuk)*
Income group					
-Low	39	67.6	16.2	29.7	2.7
-Medium	46	75.6	12.2	21.9	2.4
-High	30	53.3	13.3	43.3	0.0
Educational level					
-Elementary	55	76.5	3.9	23.5	1.9
-Junior high school	25	73.9	13.0	34.8	0.0
-Senior high school	35	47.0	29.4	32.4	2.9

[1)] sample size

Source: *Damardjati et al., 1992a.*

The consumer's education level also affected their preference for certain food products. However, in general all respondents tended to process cassava flour mainly into traditional foods. More than 70% of those with elementary and junior high school education processed cassava into traditional foods. The simple process involved might be the reason. Those with a higher education level seemed to use cassava flour in preparing more types of products.

The kinds of processed foods in the rural areas were slightly different compared to those from an urban/city area (**Table 2**).

Table 2. Preference of consumers in rural and urban areas for making various products using cassava flour samples supplied by the interviewers (East Java).

Processed Food	Rural respondent		Urban respondent	
	n*	%	n	%
1. Steamed	38	76	38	76
2. Fried food	33	66	38	76
3. Crackers *(krupuk)*	8	16	15	30
4. Traditional foods	20	40	42	84
5. Cakes	4	8	6	12
6. Meal *(tiwul)*	44	88	7	14

*sample size

Source: *Martini, 1992.*

Table 2 shows that in both rural and urban areas, cassava flour was mostly used for steamed and fried foods. Crackers and traditional foods which were preferred by urban respondents, were mostly used as supplementary food. In the rural areas, cassava meal is still widely used as a staple food, and most respondents (88%) processed cassava flour into meal (*tiwul*), considered as a source of carbohydrate equal to rice for rice eating people. As a staple food, cassava contributed 23 and 2.5% to the carbohydrate intake in the diets of rural and urban households, respectively.

In East Java, information on cassava flour acceptance was also collected from 25 small-scale food industries; these were for processing of traditional foods (36%), cookies (32%), cakes (4%), crackers (24%) and noodles (4%). Most of them used cassava flour as a partial substitute of wheat flour (Martini, 1992)

Consumer Acceptance of Cassava Flour for Long-term Consumption

On the second visit to the respondents, there were evaluations on the acceptance by consumers for the kinds of food products made from cassava flour and consumed over a long period. **Table 3** shows the consumer acceptance for different kinds of food products made from cassava flour.

Table 3. Consumer acceptance for food products made from cassava flour.

Acceptance	Consumer acceptance (% of respondents) for			
	Traditional foods	Cookies	Cakes	Crackers
Like very much	6.6	1.6	3.3	0.0
Like	50.4	9.9	20.5	1.6
Slightly dislike	3.3	0.0	0.9	0.0
Dislike	0.0	0.9	0.9	0.0

Source: *Damardjati et al., 1992a.*

Most of the respondents (more than 50%) mixed cassava flour with other flours such as wheat flour, cassava starch or rice flour when preparing traditional foods and cakes. Cassava flour was not utilized much for cookies and crackers. The reason might be the lack of knowledge or capability of the respondents in utilizing cassava flour in these forms. Damardjati *et al*. (1992a) reported that cassava flour substitution up to 60% resulted in high quality of various types of cookies. Cassava flour and starch mixed in a 1:3 ratio can also be used in making crackers, and the product was well accepted by panelists (Suismono and Wheatley, 1991).

A second cooking trial, conducted by 115 respondents, indicated that cassava flour was accepted by 84.4% of respondents, while 15.6% of the respondents rejected the flour. Cassava flour consumption by most respondents was about 4 to 7 kg/family/month. The highest consumption was recorded by consumers with medium income levels. Most consumers processed cassava flour into traditional food products (41.7%) and cakes (21.7%).

FOOD PREPARATION METHODS

Most respondents preferred to process cassava flour into traditional foods, cakes, cookies and crackers. The ingredients and processing methods are shown in **Table 4**.

Table 4. Composition of products processed from cassava flour.

	Traditional foods	Cookies	Cakes	Crackers
Basic ingredients	Wheat flour, Rice flour	Wheat flour	Wheat flour	Cassava starch
Additional ingredients	Margarine, Eggs, Sugar, Vegetable/s, Coconut milk	Margarine, Eggs, Sugar	Margarine, Eggs, Sugar	Sugar
Other ingredients	Salt, Artificial coloring	Leavening, Flavoring	Leavening, Artificial flavoring	Salt, Spices, Flavoring
Process	Steamed, fried or roasted	Oven-baked	Oven-baked	Steamed, prior to frying

Source: *Damardjati et al., 1992a.*

Traditional Foods

Several kinds of traditional foods, which are usually prepared from wheat flour, rice flour or maize starch, were made using cassava flour as a partial or total substitute for these ingredients. The traditional foods were *bala-bala*, *nagasari*, *cimplung* and *bika ambon* (**Table 5**).

Cakes

The basic procedure for cake preparation is mixing together sugar, eggs and a leavening agent. Composite flour and melted margarine are then added and mixed thoroughly into a dough. The dough is poured into a pan already swiped with margarine and coated with wheat flour, then baked for approximately 30 minutes. There are many flavors of cakes, such as coconut cake, palm sugar, pineapple, etc. There is also a type of roll called *bolu gulung*. Several respondents made cakes from 100% cassava flour, and others from 50% each of cassava and wheat flours.

Cookies

Three kinds of cookies were made by the respondents, i.e. cheese-sticks, *aster* cookies and *nastar*. Each was made from 100% cassava flour. Cheese-sticks were made by mixing cassava flour, egg yolks, salt, coconut milk and margarine. The homogenized dough was sheeted, cut and then deep-fried. *Aster* cookies were made by mixing refined sugar and margarine, then adding eggs one by one, followed by vanilla, baking powder and roasted cassava flour, and mixing thoroughly. The dough was molded then baked for approximately 25 minutes. The basic procedure for making *nastar* is similar to that for *aster* cookies.

Table 5. Percentage substitution by cassava flour in several types of traditional foods and their method of preparation in Indonesia.

Local name	% substitution by cassava flour	Other flours	Brief description of preparation method
Bala-bala	50	Wheat	- Mixture of flour, water, vegetables and spices - Fried
Cimplung	50	Wheat	- Mixture of flour, water, sliced jackfruit and salt - Fried
Nagasari	70	Maize	- Cassava flour mixed with coconut milk, salt, vanilla, maize flour, and cooked - Wrapped in banana leaf, stuffed with banana slices
Jongkong	50	Rice	- Dough mix of flour with coconut milk and salt, and cooked - Filled with sliced palm sugar, drenched with thick coconut milk, and wrapped in banana leaf - Steamed
Ongol-ongol	65	Wheat	- Flour mixed with water and sugar, then cooked - Formed, cooled and sliced - Served with grated coconut
Dodongkal or *awug*	100	-	- Cassava flour mixed with water and salt, then cooked - Dough filled with shredded palm sugar - Served with grated coconut
Biji salak	100	-	- Small balls made from cassava flour dough, and cooked - Served with sweetened coconut milk and sliced jackfruit
Bika ambon	35	Rice	- Flour mixed with egg, fermipan and coconut water, and worked into a dough (I) - Sugar and coconut milk cooked together until oily (II) - I and II mixed together - Baked

Source: *Damardjati et al., 1992a.*

Crackers

Crackers are processed by mixing eggs, sugar, salt, ground garlic, water and composite flour. The dough is wrapped and shaped into a solid roll, then placed on banana leaf and steamed. When the steamed dough has cooled, it is sliced, dried and deep-fried. The composite flour consists of 50% cassava flour and 50% cassava starch.

CONCLUSIONS

Cassava flour production in Indonesia represents an alternative means of diversifying cassava products. It has the potential to increase farmer's income, extend marketing, support food diversification and reduce wheat imports. Cassava flour processing involves the development of technologies and equipment for peeling, washing, soaking, chipping, pressing, drying and milling.

The cassava flour agro-industry system is designed as a nucleus-plasma model. Cassava flour was accepted by 84% of surveyed respondents. It can be processed into six groups of food products, i.e. traditional foods, cookies, cakes, crackers, noodles and cassava meal. Cassava flour can substitute for wheat and rice flours. The level of substitution ranges from 20 to 100%, depending on the product.

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