CONTRIBUTION OF CASSAVA LEAVES USED AS A VEGETABLE TO IMPROVE HUMAN NUTRITION IN INDONESIA

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ABSTRACT

Young cassava leaves are a popular vegetable in Indonesia due to their high content of protein, minerals and vitamins compared to those in other vegetables. Malnutrition, such as anemia, vitamin A and protein deficiencies, affect one hundred million, nine million and twelve million people, respectively. These nutritional problems could be reduced by introducing young cassava leaves as a vegetable in the diet. Production of cassava leaves as a vegetable for human consumption in Indonesia is estimated at 0.5-0.7 million tonnes/year. Removing some young leaves every week did not affect the cassava root yield, so cassava leaves for use as a vegetable could be available after the first five months. Consumption of 400 g cassava leaves per capita per day would be equivalent to a protein intake of 45-50 g. Utilization of cassava leaves as a supplement in the diet to solve nutritional problems, methods of cooking, as well as cropping patterns, will be discussed.

INTRODUCTION

Malnutrition, especially protein and vitamin A deficiencies and anemia, is a serious public health problem in Indonesia. During the last decade, there is an indication that the prevalences of protein malnutrition and anemia were declining. However, the economic crisis of 1997 resulted in a progressive reduction in food consumption and procurement of nutritious food (Untoro, 2002).

Among the interventions aimed at promoting increased availability of protein and micronutritients in the diet, fortifying common food items with high content of protein, micronutrients and vitamins have proved to be the most sustainable and cost-effective strategy for delivering these nutritients to people in industrialized countries. In Indonesia, rural, remote and marginal populations, who are most vulnerable to protein and micronutrient deficiencies, do not have access to manufactured or processed foods. Technological initiatives for rural communities, such as small-scale fortification using several vehicles, like composite flour products, indicate their important role in the fight against deficits of energy, protein as well as micronutrients. It also includes diversification of food to include vegetables which are high in protein and micronutrients, such as leaves of cassava as well as legumes. Young cassava leaves are a popular food in Indonesia because of their high content of protein, iron and vitamins A and C; they are also cheap and available in rural, remote and marginal communities. Therefore, production of cassava leaves, and their utilization as a supplement in the diet, will be discussed in this paper.

Young Cassava Leaves Contribution in the Human Diet

Malnutrition resulting from inadequate levels of energy and protein in the diet, and anemia are serious public health problems in Indonesia. A survey in various regions of Indonesia indicate that the consumption of non-animal protein varied from 17 to 37 g/person/day (**Table 1**), while that of iron was 13 g/person/day (Untoro, 2002). Among vegetables, cassava leaves have a high content of protein, micronutrients such as iron, and vitamins (**Table 2**). The protein supplied by young cassava leaves in the diet depends on

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the type of staple food consumption: when rice is the staple food, about 75% of the protein requirement is supplied already; on the other hand 75% of the iron requirement should be met from cassava leaves if 20% of rice is substituted by cassava roots. The amount of cassava leaves increase when the staple food has an increasing proportion of cassava roots (**Table 3**). As cassava roots are low in protein content; therefore, the higher the proportion of cassava roots in the diet the more cassava leaves are needed to increase the protein required. In general, consumption of 75 to 100 grams of cassava leaves/capita/day is advised to supply the protein and iron required in the diet.

The benefit of consuming cassava leaves as a protein source, especially of varieties with yellow roots such as Adira 1, is their high content of vitamins A and C as well as iron (Dit Gizi, 1987). **Table 2** shows that consumption of cassava leaves and fermented soybean can supply the protein and iron required in the diet (CBS, 2000; Untoro, 2002). **Table 4** shows that the protein content of cassava leaves depends on the variety: Adira 1 (yellow fleshy roots) had the highest protein content, followed by BIC 137.

The advantage of using young cassava leaves in the diet are: 1. cassava is able to produce high yields in infertile soils, so it is available for farmers in remote and marginal conditions; 2. it has a higher content of protein, iron, calcium and, vitamins A and C as compared to other vegetables; 3. it can be grown in small areas for daily supply; and 4. it can also be grown commercially to increase farmer's income.

Table 1. Total protein consumed and the proportion as vegetable protein in various regions of Indonesia.

	Daily protein consumed in the diet		
	Total protein	Vegetable protein	
Region	(g/person)	g/person	(% of total)
Sumatra	49.45	33.25	67.25
Java	47.81	31.08	65.00
Bali & Nusa Tenggara	49.67	36.76	74.01
Kalimantan	51.36	30.94	60.25
Sulawesi	52.25	31.74	60.75
Maluku & Irian Jaya	39.96	17.17	42.96

***Source**: CBS, 2000.*

Table 2. Nutritional content of some vegetables and staple foods.

	Nutritional content (per 100 g edible portion)				
Vegetables/Staple foods	Calories (cal)	Protein (g)	Iron (mg)	Vit. A (SI)	Vit C (mg)
Cassava leaves	131	12.7	3.9	13,000	58
Spinach	30	3.5	3.9	6,090	80
Fermented soybean	149	18.3	10.0	50	50
Rice	360	6.8	0.8	0	0
Cassava roots	145	0.8	0.7	385	30

***Source:** Dit Gizi, 1987.*

Table 3. Nutritional status of several food scenarios in the per capita daily diet.

Staple food/ vegetable	In proportion (%)	Available		Substituted by cassava leaves [1)]	
		Protein (g)	Iron (mg)	Protein (g)	Iron (mg)
Rice	100	30.94	3.64	-	100
Rice + cassava roots	80 + 20	26.50	4.49	35	75
	60 + 40	20.74	5.34	80	30
	40 + 60	17.70	6.55	104	0
Cassava roots	100	9.03	7.91	170	0

[1)] ***Source:*** *calculated from CBS, 2000 and Dit Gizi, 1987.*

Table 4. Protein content of young cassava leaves of ten varieties, harvested at four months after planting in Bogor in 2002.

Varieties	Protein content (% of dry matter)
No. 40.3.3	24.68
No. 50.2	32.86
No. 39.1.1	33.12
BIC 319	33.09
BIC 109	32.69
BIC 137	35.49
BIC 317	33.35
BIC 323	32.20
Adira 1	35.86
Adira 4	32.12

Production of Young Cassava Leaves

The actual yield of young cassava leaves to be used as a vegetable and a source of protein and micronutrients in the diet depends on the way the leaves are harvested and on the cultural practices used. There are basically two ways of harvesting young cassava leaves as a vegetable: one is at weekly intervals and the other at root harvest.

The growth rate of cassava increases rapidly between four and seven months after planting. During the first six months, dry matter accumulated is used mainly for growth of leaves and stems, while after six months it is used mainly for the development of roots (Hozyo, 1984; Wargiono, 1986). The reasons why farmers harvest cassava young leaves weekly between four and seven months after planting are: 1. easy to harvest (plant height is 0.75 to 1.5 meters); 2. good quality (large leaf blades); and 3. no branches. Farmers do not harvest young cassava leaves weekly after seven months because: 1. difficult to harvest (plant height more than 1.5 meters); 2. not good quality leaves (fewer and smaller); and 3. the number of branches per plant increases. Cassava grown under intercropping systems is normally planted at a population of 5,000 to 10,000 plants/ha, while for monoculture 10.000 to 12.000 plants/ha. In Indonesia cassava is generally managed so as to leave two shoots or stems per plant. The estimated weekly production of leaves harvested before seven months old, based on the plant population of intercropped and monoculture cassava, will be 4.45 million tonnes and 5.67 million tonnes of fresh young leaves, respectively,

while young cassava leaf production when harvested at the time of root harvest will be only 0.37 million tonnes of fresh young leaves. So, the total production of young cassava leaves to be used as vegetable could be as high as 6.04 million tonnes/year. This would be equivalent to 78.8 g/capita/day. The problem is that good quality young leaves for vegetables are available for only three months, from the 4th to the 7th month. Since the requirement for non-animal protein is about 35 g/capita/day, this could be achieved by growing cassava in the backyard or in other unused land. Using young cassava leaves in the diet will help to reduce the prevalence of protein deficiency and anemia.

Contribution of Young Cassava Leaves to Farmers' Income

Results of a study on young cassava leaves used as vegetable in Bogor, West Java, indicate that farmers divide their upland areas into two parts for planting cassava. One part for commercial production of young leaves as vegetable and the other for commercial production of both roots and young leaves at the harvesting of roots.

Planting cassava for commercial vegetable production

Information on the planting of commercial vergetable is based on a case study at Bogor, West Java, in 2002. The planted area varied from 200 to 500 m^2. Cassava was planted in strips of four rows, each strip one meter wide and 10 to 20 meter long; the 40 cm space between strips was used as a drainage canal. Shoots with five leaves are harvested daily**.**

The cultural practices are:

- Plant spacing : 25 x 25 cm
- Fertilization : 4 kg urea/400 m^2 applied monthly after each harvest of young leaves, and 40 kg cattle manure at time of soil preparation (depends on farmer's capital)
- Harvesting : Daily/2 strips starting at 2 months after planting, followed by application of urea.
- Daily yield : 6 bundles/2 strips with the price Rp 400,-/bundle at the farmer's field
- Harvesting duration : 1-1.5 years (depends on water availability)
- External input : Urea = 11 x 4 x Rp 1200 = Rp 52,800 per year/400 m^2
- Cattle manure : 40 x Rp 400 = Rp 16,000
- Cost of production without labor (family labor): Rp 78,800
- Gross income : 6 x 30 x 11 x Rp 400 = Rp 792,000
- Net income : Rp 792,000 - Rp 78,800 = Rp 713,200/year/400 m^2 or Rp 59,433/month/400 m^2

When this production system is calculated on a hectare basis using external labor the production costs are Rp 7,625,000, the gross income is Rp 19,800,000 and the net income Rp 12,175,000/ha/month or only Rp 40,583/400 m^2/month. This is the reason that farmers plant cassava for vegetable in only small areas without using external labor. Planting 500 to 1000 m^2 can be managed with family labor and this system produces a high income.

Planting cassava for root yield

Most farmers that plant cassava for root yield on an area of more than 0.25 ha use external labor for land preparation and harvest. The production cost and net income shown in **Table 5** are based on the case study in Bogor, West Java, in 2002.

Table 5. Production costs and gross and net income (Rp/ha/year) from the production of either cassava roots and leaves (at root harvest) or from the continuous harvests of young leaves as a vegetable in Bogor, W. Java, Indonesia in 2002.

Items	Commercial roots and leaves	Commercial vegetable
Land preparation	Rp. 420,000	Rp 420,000
Stake preparation	Rp. 70,000	Rp 100,000
Planting	Rp. 113,500	Rp 227,000
Fertilizer application	Rp. 196,000	Rp 217,000
Weeding	Rp. 342,000	Rp 634,000
Harvest	Rp. 295,000	Rp 4,320,000
Fertilizers : Urea	Rp. 240,000	Rp 1,707,000
SP36	Rp. 170,000	
Total production costs	Rp 1,846,500	Rp 7,625,000
Gross income - roots	Rp 4,589,000	
-leaves	Rp 320,000	Rp 19,800,000
-total	Rp 4,909,000	
Net income (per ha/year)	Rp 3,062,500	Rp 12,175,000
Net income (per ha/month)	Rp 255,208	Rp 1,014,583
B/C Ratio	1.66	1.60

Theoretically, growing cassava as a vegetable is more profitable than commercial root and leaf production. The problems are that farmers have limited capital for production (external inputs) and the marketing of a daily yield of 300-400 bundles of young leaves is difficult. Each seller at the city market can only sell 10 to 15 bundles/day, while traditional restaurants buy about 4-6 bundles/day. B/C ratio of planting cassava for both commercial vegetable and root yield were 1.60 and 1.66 respectively. It means that planting cassava for both root yield and leaves as vegetable are feasible to be developed.

Young cassava leaves harvested daily from their commercial root production field is suitable for farmers living in the village because: 1. available from their upland production area or backyard; 2. they are in fresh condition; 3. have high quality (young, large leaf blades); and 4. cheap. The demand of cassava young leaves for each family is about 300 g/day, which is equivalent to 38 plants. To supply that demand about 200-300 plants/family are needed, with the upper leaves of each plant harvested at weekly intervals. By using cassava leaves as vegetable the family's expenditure for protein can be reduced.

Protein and Iron Contribution of Cassava Leaves in the Diet

The implementation of introducing young cassava leaves to solve malnutrion of protein and anemia due to iron deficiency will be through a food diversification program that promotes the planting of about 300 cassava plants as vegetable in the backyard or in upland areas. This program should be promoted through the media such as TV, newspapers and others.

To produce the necessary amounts of staple food (rice and cassava flour), soybean or fermented soybean and young cassava leaves, the following cropping patterns could be established

- Cassava intercropped with rice, followed by soybean
- Cassava intercropped with maize, followed by soybean
- Cassava intercropped with soybean

Young cassava leaves and fermented soybean are popular vegetable and side-dishes in Indonesia. Young cassava leaves can be prepared as soup, or made into a ball with a small dry fish inside which are boiled together to produce a popular dish that is high in both animal and vegetable protein. In general, cooking young cassava leaves as a soup, a fish ball and just boiled are:

- Water + baking powder or salt (0.5 g/ kg of leaves to maintain the green color of cassava leaves), heat until boiling point, put in the young cassava leaves, wait for about 15 minutes (make sure that the color does not change to brown), and wash in cold water to reduce the HCN content.
- These washed and boiled cassava leaves are made into a ball with a small dry fish inside; these are cooked in coconut milk + spices (shallots, garlic, coriander powder, curcuma, sugar and salt with the amount dependent on personal taste) until just boiling. Fermented soybean can be cooked as a soup (same process as cassava leaves) or fried dry in small or big size.

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