

WHEAT FLOUR SUBSTITUTION USING SWEET POTATO OR CASSAVA IN SOME BREAD AND SNACK ITEMS

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ABSTRACT

Cassava and sweet potato flour were processed and used to substitute wheat flour from 20 to 100% level in some yeast breads (pan de sal and hot rolls); quick breads (paborita, cheese crackers and coconut cookies) and snack items (polvoron, gollorias and doughnut). Cassava and sweet potato flour have a coarser texture than wheat flour; however, cassava flour approximates the color of wheat flour. Cassava flour has almost similar chemical properties as wheat flour except for protein and crude fiber; sweet potato flour differed in protein, texture and color. Preference tests showed that products with root crop flour, except doughnut, were preferred by consumers. Based on cost analysis, root crop flour is a good substitute for wheat flour.

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KEY WORDS: Cassava. Cassava flour. Sweet potato. Sweet potato flour. Wheat flour. Composite flours. Substitution. Processing. Bakery products. Analysis. Laboratory tests. Taste panel. Costs.

INTRODUCTION

The Philippines is continually importing wheat flour for its production of bread and other baked products. In view of the nation's foreign exchange problems, particularly the devaluation of the local

currency, the linear increase of demand for wheat should be reduced.

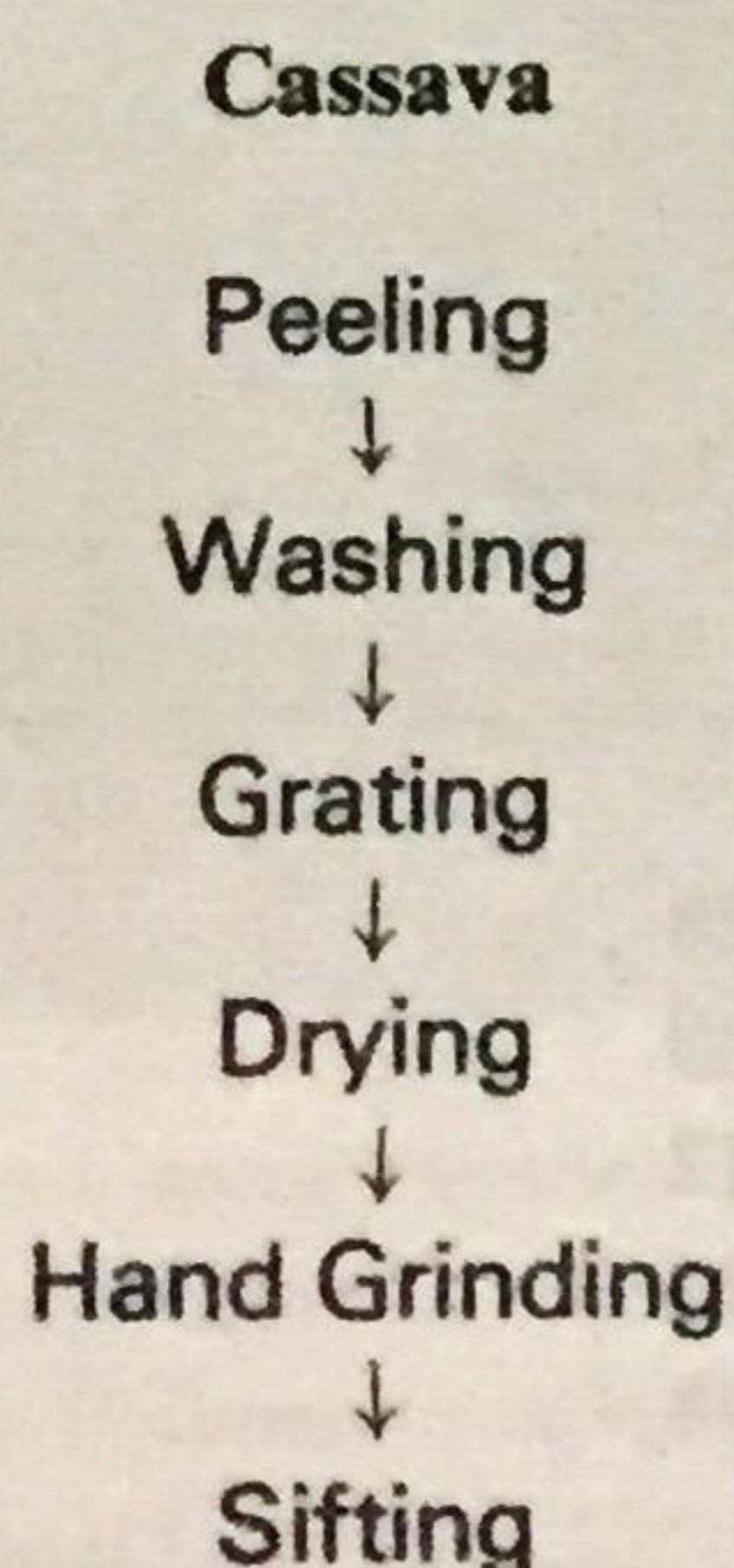
Studies on wheat flour extenders using cassava and sweet potato are being undertaken in many countries of Asia, Africa and Latin America. About 3-30% of cassava flour has

been tried as substitute of wheat flour in the baking process. In other recipes like cookies and some snack items, 3-100% of cassava flour could even be used. Because cassava and sweet potato flours have lower nutrient contents than wheat flour, fortification with other materials may be necessary. These possibilities may bring about eventual support and patronage for cassava and sweet potato flour from Philippine consumers.

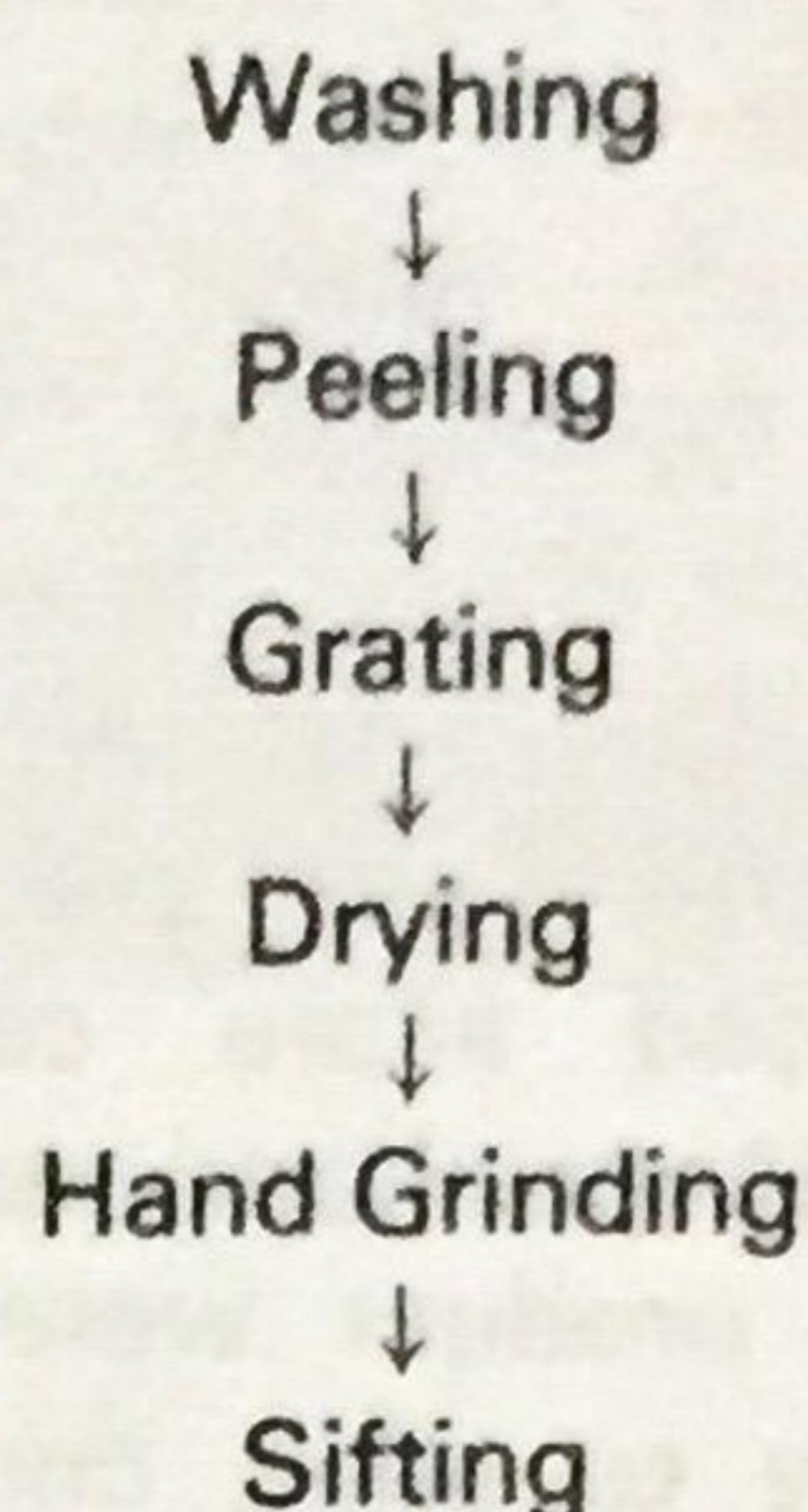
This study presents 1) an assessment of the proximate chemical composition of cassava and sweet potato flour; 2) the acceptability and consumer acceptance on some bakery products utilizing 20-100% sweet potato or cassava flour in terms of color, aroma, flavor, and texture; and 3) the cost of producing such products.

MATERIALS AND METHODS

Flour Processing and Chemical Analysis.— Cassava and sweet potato flours were processed in the laboratory. In the absence of a flour mill, the following steps were followed:



Sweet Potato



Proximate analysis was done on the processed flour following the procedures set by the A.O.A.C. (1975).

Product Development.— *Pan de sal* and hot rolls were made with 20% substitution of wheat flour using processed sweet potato or cassava flour. The standard procedure of the ViSCA Foundation Bakery which involved baking at 475°C for 15 min was used.

Laboratory Taste Panel Testing.— Laboratory tests were conducted to determine the acceptance level of wheat flour substitution for quick breads such as *paborita*, cheese crackers and coconut cookies, and snack items such as *polvoron*, *gollorias* and doughnut.

Different levels of substitution (20, 40, 50, 75, and 100%) were made on the different products which were presented to a taste panel consisting of 7-8 members who evaluated the products for color, aroma, flavor, and texture using a 9-point hedonic scale.

Consumer Testing. — A taste panel composed of 100 randomly selected adult residents in Baybay, Leyte and 45-48 grade school children of ViSCA Foundation Elementary School was chosen to evaluate the products (*pan de sal*, hot rolls, *paborita* and cheese crackers) using standardized score cards. Both samples (control and experimental) for each product were presented separately to adult consumers to determine their acceptance. A comparative preference test was subsequently done between the two samples. Coconut cookies, *polvoron*, *gollorias* and doughnut were evaluated by randomly selected members of the faculty, staff and students in ViSCA, Baybay, Leyte using test and score cards.

Cost Accounting. — Cost and return analysis to determine the profitability of the products was made during the second replication.

RESULTS AND DISCUSSION

Physical and Chemical Properties of the Different Types of Flour.

Both sweet potato and cassava flours have coarser textures than wheat flour (Fig. 1). The coarse texture may be attributed to the hand-grinding method used in making the root crop flour as compared to the use of a flour mill for the wheat flour. Sweet potato flour also appears darker than either wheat or cassava flour due to the presence of catecholase which causes the darkening of the flesh after exposure to air (Walker, 1959). Cassava approximates the color of wheat.

There was no variation in chemical composition among the different flours except for crude protein (Table 1). Cassava and sweet potato flours have lower protein content than wheat flour (14.78%) with cassava having the lowest value (2.08%).

Laboratory Taste Panel Testing.

1. *Quick Breads*

Paborita. — There were three cassava flour substitution levels used in *paborita* (20, 40 and 50%)

Table 1. Chemical composition (%) of the different flours used in the formulation of the baked products.

Parameter	Kind of Flour		
	Wheat	Cassava	Sweet Potato
Moisture	12.76	13.18	12.26
Crude protein	14.78	2.08	2.34
Crude Fat	1.04	1.12	0.86
Crude fiber	0.51	2.24	3.40
Ash	0.40	0.98	1.26



Fig. 1. Three types of flour used in the preparation of bread and snack items. Left to right: wheat, cassava and sweet potato flour.



Fig. 2. Some recommended products utilizing cassava flour alone or in combination with wheat flour (A) Coconut cookies with 50% wheat flour and 50% cassava flour; (B) Polvoron made from 100% cassava flour; (C) Pan de sal composed of 80% wheat flour and 20% cassava flour.

with 100% wheat flour as the control. There was no significant difference among the four treatments although 50% level of substitution received the highest preference (Table 2). This result shows

least preferred sample. The decrease in sensory scores was directly proportional to the level of substitution used. Lower color scores were noted among samples with sweet potato flour. A peculiar flavor was

Table 2. Mean taste panel scores on *paborita* using cassava flour.

Sensory Qualities	100%	Cassava Flour Substitution Level		
	Wheat Flour (Control)	20%	40%	50%
Color	6.45	6.70	6.70	6.95
Aroma	6.70	6.75	6.85	6.95
Flavor	6.50	6.95	6.55	7.40
Texture	6.20	6.85	6.40	7.40

that wheat flour can be substituted with cassava flour in *paborita* making.

However, sweet potato flour was found to be a poor substitute for wheat flour in *paborita* making (Table 3). The control (100% wheat flour) received the highest scores in all the sensory qualities evaluated. The sample with the highest level of substitution received the lowest scores which means that it is the

observed on the sweet potato flour which might have influenced the tasters in evaluating the product. Furthermore, root crop flour has a coarse texture thereby giving it a sandy taste sensation, a feature not acceptable to consumers.

Cheese Crackers. — Cassava flour as used in cheese crackers was found to be a good substitute for wheat flour up to 50% level of

Table 3. Mean taste panel scores on *paborita* using sweet potato flour.¹

Sensory Qualities	100%	Sweet Flour Substitution Level		
	Wheat Flour (Control)	20%	40%	50%
Color	7.94a	6.47b	5.35c	4.91c
Aroma	7.75a	5.88b	4.66c	4.41c
Flavor	7.91a	5.78b	4.85bc	4.38c
Texture	7.16a	5.57b	4.41b	4.25b

¹ Means in the same row followed by common letters are not significantly different at 5% level using DMRT.

Table 4. Mean taste panel scores on cheese crackers using cassava flour.

Sensory Qualities	100% Wheat Flour (Control)	Cassava Flour Substitution Level		
		20%	40%	50%
Color	7.0	7.19	7.13	7.50
Aroma	6.5	6.90	6.80	7.19
Flavor	6.4	6.56	6.56	6.89
Texture	5.5	6.69	5.13	6.75

substitution (Table 4). The sample with the highest percentage of cassava flour received the highest scores for all the sensory qualities evaluated.

Coconut Cookies.— Sweet potato flour was found to be a good substitute for wheat flour in coconut cookies (Table 5). Significant differences in sensory scores were found for both color and aroma with 50% level of substitution receiving the

The possibility of substituting wheat flour with cassava in coconut cookies (Fig. 2a) was also proven in this study. There was no significant difference between the four samples with different levels of substitution, although 50% level of substitution received the highest scores in almost all the qualities evaluated.

2. Snack Items

Polvoron.— The highest possible

Table 5. Mean taste panel scores on coconut cookies using sweet potato flour.¹

Sensory Qualities	100% Wheat Flour (Control)	Sweet Potato Flour Substitution Level		
		20%	40%	50%
Color	6.11a	6.17a	5.39a	7.72b
Aroma	6.50a	6.39a	5.94a	7.56b
Flavor	6.17	6.17	5.61	7.45
Texture	6.22	5.83	5.78	7.35

¹ Means in the same row followed by common letters are not significantly different at 5% level using DMRT.

highest value. However, no significant difference was found for both flavor and texture although the sample with 50% level of substitution still received the highest value.

level of wheat flour substitution (100%) in *polvoron* using cassava flour was proven (Fig. 2b). Although the scores were not significantly higher than the control (100%

Table 6. Mean taste panel scores on *gollorias* using cassava and sweet potato flour.¹

Sensory Qualities	100% WF (Control)	50% WF + 50% CF	50% WF + 50% SPF
Color	7.06ab	7.90b	6.80a
Aroma	7.80b	7.70b	6.60a
Flavor	7.40	7.80	6.60
Texture	7.80b	7.80b	6.03a

¹Means in the same row followed by common letters are not significantly different at 5% level using LSD.

WF - Wheat Flour

CF - Cassava Flour

SPF - Sweet Potato Flour

wheat flour), the sample with cassava flour was more acceptable than that with wheat flour, except for aroma.

Gollorias. Cassava flour was shown to be a better wheat flour substitute than sweet potato flour (Table 6). Samples with 50% wheat flour and 50% cassava flour received the highest scores in all qualities evaluated except for aroma but it

was not significantly lower than the score received by the control samples. The difference might be attributed to the crude cassava processing used including heat fluctuation (sunlight) during drying.

Samples with 50% sweet potato flour received the lowest scores for all the sensory qualities evaluated. However, the scores were within the "like slightly" to "like moderate-

Table 7. Mean taste panel scores on doughnut using cassava flour and sweet potato flour.¹

Sensory Qualities	100% WF (Control)	50% WF + 50% CF	50% WF + 50% SPF
Color	7.50a	7.30a	5.90b
Aroma	7.30	6.60	6.13
Flavor	6.80	7.10	6.60
Texture	6.80	7.00	6.60

¹Means in the same row followed by common letters are not significantly different at 5% level using LSD.

WF - Wheat Flour

CF - Cassava Flour

SPF - Sweet Potato Flour

ly" category. If the color and the aroma of the sweet potato flour would be improved, the samples with sweet potato flour might be as acceptable as the other samples.

Doughnut. Doughnut, another snack item tested in the study, can be substituted with root crop flour especially cassava flour up to 50%. However, samples with cassava flour were not found acceptable by the panelists in terms of aroma (Table 7). Samples with sweet potato flour still received the lowest scores especially in color.

Consumer Testing

Consumer tests were done to measure consumer reaction. There is a need to test products of commercial impact to ensure salability of the products once these are produced in commercial scale.

Adults

Yeast Bread.— *Pan de sal* and hot rolls, the two breads in which the level of substitution (20%) was previously determined in an earlier

Table 8. Preference and chi-square tests between the control and experimental products used in the study.

Name of Product	Observed preference of judges/ Expected preference of judges		X ² c
	Control ¹	Experimental ²	
Yeast Breads			
Pan de Sal (Cassava)	20/50	80/50	36 **
Pan de Sal (Sweet Potato)	46/50	54/50	0.5818ns
Hot Rolls (Cassava)	50/50	50/50	0.0ns
Hot Rolls (Sweet Potato)	20/50	80/50	36 **
Quick Breads			
Paborita	36/50	64/50	7.84 **
Cheese Crackers	17/50	83/50	43.56 **
Coconut Cookies	35/50	65/50	9.00 **
Snack Items			
Polvoron	24/24.5	25/24.5	0.0204
Gollorias	30/24.5	19/24.5	2.46ns
Doughnut	35/24.5	14/24.5	9.0 **

¹ - 100% Wheat Flour

² - With Root Crop Flour

** - Highly Significant

ns - Not Significant

study, were consumer tested.

Of the 100 adult tasters, 62% liked the *pan de sal* samples with 100% wheat flour, 24% disliked and 14% were undecided; 95% liked the *pan de sal* samples with 80% wheat + 20% cassava flour, 2% disliked while 3% were undecided. However, when asked to compare between the two samples, most of the consumers (80%) preferred *pan de sal* with 80% wheat + 20% cassava flour (Fig. 2c) over the 100% wheat flour sample. Based on chi-square analysis, the preference difference was highly significant (Table 8).

Majority (73%) liked *pan de sal* samples in which sweet potato flour was used instead of cassava. A comparative preference test showed that 54% of the tasters liked the sample with sweet potato flour while 46% liked the samples with wheat flour alone. Although there was a little difference in favor of the second sample, the difference was not significant.

In hot rolls, most of the consumers liked the samples with wheat flour alone or with cassava flour substitution. The other set of samples of hot rolls (100% wheat flour and 80% wheat flour + 20% sweet potato flour) when tasted separately were both liked by consumers. A comparative preference test showed that the second sample (with sweet potato flour) was more preferred. The difference was highly significant.

Quick Breads. — The *paborita* sample with 50% wheat + 50% cassava

flour was liked more than the control (100% wheat flour). Comparative preference test showed that samples with 50% cassava flour were highly liked than the wheat flour sample. The difference in preference was highly significant.

Cheese cracker samples were liked by the consumers. Samples with 50% cassava flour were preferred more than that with wheat flour alone when a comparative preference test was given. This supported the laboratory taste test result. Cheese crackers with 50% cassava flour received the highest scores for all the sensory qualities evaluated.

Similar results were obtained in coconut cookies. Based on chi-square test, the difference in preference was highly significant in favor of samples with 50% wheat flour + 50% cassava flour.

Snack Items. — *Polvoron* samples consisting of either 100% wheat or 100% cassava flour were equally preferred by consumers. Similar results were obtained with *gollorias* samples.

Consumers preferred doughnut samples with wheat flour over samples with 50% flour + 50% cassava flour because of the sandy taste sensation observed in the latter. The difference in preference was significant in favor of the wheat flour samples.

Children

The sensory evaluation given by 45-48 school children studying at the ViSCA Foundation Elementary

Table 9. Cost analysis of the different products.

Name of Product	Unit Cost	Yield Per Recipe	Total Cost
Yeast Bread			
Pan de sal	₱0.073	48	₱3.50
Hot rolls	0.086	48	4.13
Quick Breads			
Paborita	0.048	100	4.80
Cheese crackers	0.055	108	5.95
Coconut cookies	0.100	95	9.50
Snack Items			
Polvoron	0.104	52	5.40
Gollorias	0.060	50	3.00
Doughnut	0.417	15	6.25

School supported the results obtained from adult consumers. The products tested were found to be acceptable since the scores were concentrated in 1, "like very much" to 3, "like moderately".

Cost Analysis

Root Crop Flour.— Root crop flour, specifically cassava, has a recovery yield of 25% based on fresh weight. One kilogram of cassava flour costs ₱4.00, including the cost of labor. This is slightly lower than the retail price of wheat flour which

is ₱5.50/kg.

Product Cost. Table 9 shows the cost of the different products based on the costs of the different ingredients for each formulated and tested product.

Hot rolls cost higher than *pan de sal* since the former contain more ingredients (quantity) than the latter.

Coconut cookies which cost ₱0.10 per piece rank highest in cost among the quick breads due to the inclusion of eggs and other enriching ingredients in its recipe.

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