THE STATUS OF TROPICAL ROOT CROP PROCESSING RESEARCH AT THE UNIVERSITY OF THE WEST INDIES, TRINIDAD

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SUMMARY

A flour produced from sweet potatoes that can be used at 15 percent substitution level for wheat flour in bread can be used at higher rates for other bakery products. The flour can be made from unpeeled sweet potatoes by the use of a mild bleaching with 1 percent sodium metabisulphite. Pan-loaf and butter-bread had a high consumer acceptability, and there is little obvious advantage in trying to produce the crusty type of loaf which is incompatible with the use of sweet potato flour without the additional use of other chemical additives. Yam flour can be used for production of acceptable bread at up to 25 percent substitution for wheat flour. Canning of sweet potatoes in brine can produce a very acceptable product. Pre-cooked yam flakes are another promising product.

RESUME

Une farine de patate douce pouvant être utilisée a 15 pour cent pour substituer la farine du blé dans le pain peut être employée a des taux plus élevés pour d'autres produits de boulangerie. On peut fabriquer la farine à partir de la patate douce non épluchée décolorée légèrement avec 1 pour cent métabisulfite de sodium. Le pain beurré cuit au moule est beaucoup apprécié par les consommateurs; il n'y a pas d'intérêt apparent à produire du pain ayant une forte croûte, ce qui n'est pas faisable sans avoir recours à d'autres produits chimiques additifs lorsqu'on utilise la farine de la patate douce. La farine d'igname peut être valablement utilisée pour la fabrication du pain et substituée jusqu'à 25 pour cent à la farine du blé. La mise en boîte de la patate douce contenant d l'eau salée peut donner un produit de conserve acceptable. Des flocons d'igname précuits offrent aussi des perspectives encourageantes.

RESUMEN

Una harina de camote que puede usarse como substituto en un 15%, de la harina de trigo para pan, puede usarse en proporciones mayores en otros productos de panadería. La harina se puede hacer a partir de camote sin descascarar usando metabisulfito de sodio al 1% como blanqueador suave. El pan de barra y el de mantequilla tuvieron un alta aceptabilidad en el consumo, y habría muy pocas ventajas en tratar de producir el tipo de hogaza (con corteza dura) que es incompatible con el use de harina de camote, sin el uso de otros ingredientes químicos adicionales. La harina de ñame se puede utilizar para una producción aceptable de pan substituyendo hasta en un 25% a la harina de trigo. El enlatado de camote en salmuera puede producir un producto bastante aceptable. Las hojuelas de ñame precocinado son otro prometedor producto.

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INTRODUCTION

Research on the processing of tropical root-crops was started at the University of the West Indies, Trinidad in 1969 through participation in the Root Crop Programme of the Faculty of Agriculture, financed at that time from the Rockefeller Foundation and now through the Canada International Development Agency (CIDA). Emphasis is placed on sweet potatoes (*Ipomoea batatas*) and yams (*Dioscorea* spp.), but some preliminary work is also being done with breadfruit (*Artocarpus communis*).

The object of the research is to study the processing potentials of tropical root-crops having possibilities for commercial utilization and thus of economic and developmental benefit to the Caribbean region. Work is being done on preparation of 'composite flours' for bread and baked goods, canning, 'instant' products and breakfast foods.

COMPOSITE FLOURS RESEARCH

The object is to study the baking characteristics of composite flours made from wheat flour mixed with varying quantities of root-crop flours, using the baking methods already in existence in Trinidad and Tobago. Any major changes in the baking industry is expected to be gradual. Because of this we are searching for composite flours that have baking properties and produce products essentially similar to those obtained from wheat flour. Products in the experiments described were considered 'acceptable' only when the taste panel recorded a 100 percent acceptance. Studies have been conducted using composite flours containing sweet potato, yam and breadfruit flours.

In the first study flour derived from sweet potato cultivar 049 had good baking properties when used for dilution up to 15 percent for bread, 20 percent for cakes and 30 percent for cookies, while flour from cultivar C9 had poor baking properties. (Tables 1 and 2). In the preparation of the sweet potato flour, peeling was found to be unnecessary, while treatment with one percent sodium metabisulphite improved the colour of the flour. Addition of one percent glyceryl monostearate or monopalmitate only slightly improved the baking properties. Addition of five percent fish protein concentrate or cotton seed flour had little or no effect on the baking properties.[1]

In the subsequent study of seventeen different cultivars of sweet potato, bread-making potential varied greatly with cultivar and there seems to be an association between the higher crude protein content and better baking potential (Tables 3 and 4). After the laboratory studies, hundred pound batches of composite flour were given to local bakeries for baking trials. Bread of the pan-loaf and butter-bread types were readily produced, and proved to be highly acceptable by a consumer acceptance test. However, the preparation of 'hops' which is a crusty loaf, proved difficult at a 15 percent dilution. Addition of 0.5 percent of sodium and calcium Stearoyl–2 Lactylate, strengthened the dough and permitted the production of an acceptable 'hops'.[2]

Experiments have shown that yam composite flour produces an acceptable loaf at dilutions of up to 25 percent. The quality and storage life is better, for a loaf made with 25 percent dilution of wheat with yam flour, as compared to a loaf made with 100 percent white wheat flour (Table 5).

Bread made from breadfruit composite flour had poor baking qualities as compared with sweet-potato and yam. The highest acceptable dilution was 5 percent.

CANNING

Studies were carried out on the canning of sweet potato cultivar 049 and *D. alata* cultivars 'Lisbon', 'Coconut' and 'Oriental', Portuguese yam (*D. rotundata*), cush-cush yam (*D. trifida*) and Chinese yam (*D. esculenta*) in brine. Yams were canned as ¼ and ½ inch cubes (diced) as well as chunks. Sweet potato was canned as small whole potatoes unpeeled.

The canned yam or sweet potato cubes and chunks showed considerable starch leaching and the sweet potato samples disintegrated. Leaching was so heavy that after one month of storage the total liquor in the can became a pasty mess.

Blanching of the cubes before can-filling, and the addition of 0.1 to 0.5 percent calcium chloride gave little improvement. The canning of small (2.0 – 4.0 cm dia.) whole, unpeeled sweet potato in brine gave a good product with little or no starch leaching. The canning liquor remained relatively clear after six months of storage. The skin on the potato posed no problem as it was easily removed before serving. This canned sweet potato product had a high acceptability on a random taste-panel of 150 consumers.

INSTANT PRODUCTS

The aim here was to prepare a precooked 'instant' product from yam similar to those marketed prepared from Irish potato. Tubers were cooked, mashed into a paste and drum-dried. The main problems en-

countered with yams were high blue-values (200 to 1,200) and difficulty in scraping the product cleanly off the drum. The high blue value was an indication of large numbers of ruptured starch cells. This was solved somewhat by passing the cooked yam pieces first through a meat-mincer and then mixing to the required consistency using a 'k' beater (Hobart). This reduced the amount of free starch from broken cells to an acceptable level. To assist the scraping of the product from the drum dryer, 0.1 to 0.5 percent glyceryl monostearate was added. With these modifications an acceptable product was achieved. There was some difficulty with discoloration of the final product. It is known that the head-end of cooked yam becomes discoloured, varying from light reddish brown to brown, while the tail-end remains white to off-white. This problem was overcome by judicious blending to give an acceptable off-white product.

Experimental results have shown that pre-cooked yam flake may be produced with equal facility from a variety of yams such as Lisbon, Coconut, and Oriental (*D. alata*), Portuguese (*D. rotundata*), Cush-Cush (*D. trifida*) and Chinese (*D. esculenta*). The flakes produced from the Chinese yam had poor texture on reconstitution, and developed a bitter taste after two weeks of storage. The flakes prepared from the other species were all acceptable.

Preliminary experiments have indicated that an 'instant' sweet potato, similar to the yam product is possible to make. Research is continuing to work out the various parameters affecting the final product. The results obtained thus far are encouraging.

BREAKFAST FOOD

The object of this research is to produce breakfast foods from root crops or with a root crop base as a replacement for imported convenience breakfast foods. Experiments are being carried out on two types of products, the flake type, similar to corn flakes and an instant porridge.

Preliminary work has indicated that both types of products are possible from sweet potato. The study includes fortifying the products with soya beans and other legumes in order to increase the protein content. Table 6 gives a summary of the formulations and process conditions.

Future research on the processing potential of root crops will be expanded on the breakfast foods to include puffed and milled products. High protein pre-weaning mixes for children using locally produced legumes and root-crops is also being considered. Other root crops to be included in the programme will be the aroids, dasheen, eddoes and tannia.

REFERENCES

1. Sammy, G.M. (1970) Studies in composite flour. I. The use of sweet potato in flour in bread and pastry making. *Trop. Agric. Trin.* 12(2).

2. – – – – – (1972) The status of composite flour research at the University of the West Indies. Conference on the Production and Marketing of Composite Flour, Baking and Pasta Products, Bogota, Colombia.

TABLE 1

Effect of different proportions of sweet potato and wheat flour on characteristics of loaves baked under controlled conditions

	Cultivar								
	049						C9		
Sweet potato flour %	0	5	10	15	20	25	5	10	15
Loaf volume ml/g bread	4.6	4.2	4.3	4.3	3.7	2.8	4.0	3.8	2.7
ml/k.flour	7429	7214	7286	7357	6333	5000	7000	6428	4571
Shape:	stable	stable	stable	stable	some fall	fallen	stable	some fall	fallen
Colour: crust	pale brown	pale brown	brown	brown	brown	brown	pale brown	brown	brown
crumb	white	pale grey	pale grey	pale grey	pale grey	pale grey	pale grey	pale grey	pale grey
Texture: crust	smooth	smooth	smooth	smooth	rough few cracks	rough many cracks	smooth	rough few cracks	rough many cracks
crumb	cells even (good)	cells even (good)	cells even (good)	cells even (good)	cells un-even (very fair)	cells un-even (fair)	cells even (good)	cells un-even (very fair)	cells un-even (fair)
Taste:	good	good	good	good	fair	poor	good	fair	poor

TABLE 2

Effect of 'composite flour' with sweet potato on pastry quality

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Product	% sweet potato flour	Cultivar 049	Cultivar C9
Roti (unleavened bread)	15	good	poor
Sponge cake	20	good	poor
Raisin bread	20	good	poor
Pancakes	20	good	poor
Doughnuts	20	good	poor
Sweet cream biscuits	15	poor	poor

Good means acceptable as compared with product made from wheat flour.
Poor means unacceptable.

TABLE 3

Comparative study of flour made from different sweet potato cultivars for bread making. Loaf properties of bread from 'composite flour' with 15 percent sweet potato flour and 85 percent wheat flour

Cultivar	Volume		Shape	Colour		Texture		Taste
	ml/kg flour	ml/g bread	of loaf	crust	crumb	crust	crumb	
Wheat flour	5830	3.3	normal	brown	white	smooth	(even cells)	good
A 13/56/11	6380	3.6	normal	light brown	yellowish	smooth	good (cells even)	good
02/62	6270	3.5	normal	light brown	off-white	smooth	good (cells even)	good
08/58/9	6160	3.5	normal	brown	white	smooth	very good(cells even)	good
C9/9	6160	3.5	normal	brown	off-white	smooth	good (cells even)	good
02/59	5940	3.4	normal	brown	off-white	smooth	coarse (uneven cells)	good
Austin Canner	5940	3.4	normal	dark brown	pale yellow	smooth	good (cells even)	good
B 13/56/11	5885	3.3	normal	gold brown	gold yellow	smooth	coarse	slightly sweet
Centennial	5830	3.3	normal	dark brown	gold yellow	smooth	coarse (large uneven cells)	slight off flavour
049	5720	3.3	normal	brown	off-white	smooth	good (cells even)	good
28/59	5720	3.3	normal	brown	off white	smooth	fair (small cells, dense)	slight off flavour
A 7/63/22	5530	3.1	normal	brown	buff	smooth	coarse (few large cells)	good
A 16/15	5520	3.1	normal	brown	gold yellow	smooth	coarse (few large cells)	good
I 62	5500	3.1	normal	brown	off-white	smooth	fair (small cells, dense)	good
03/62	5060	3.0	normal	brown	greyish	rough	fair (small cells, dense)	off flavour
Sunny side	5060	3.0	some fall	brown	pale yellow	rough	coarse (soggy)	off flavour poor mouth feel
C9	4290	2.4	fallen	brown	pale grey	rough(many cracks)	coarse (uneven cells)	off flavour
A 28/7	3960	2.3	fallen	pale brown	off-white	rough(many cracks	coarse (uneven cells)	off flavour

TABLE 4

Properties of sweet potato tubers and flour made from them

Cultivar	Tuber shape	Colour		Moisture		Flour bulk Density g/ml	Crude protein %	Total sugar %	Reducing sugar %	Fat %	Fibre %	Ash %
		Skin	Flesh	Tuber	Flour							
A 13/56/11	bulbous	yellow	pale orange	68	2.7	0.472	4.1	9.5	3.0	0.56	3.72	1.40
02/62	cylindrical	reddish	white	70	3.1	0.506	4.1	7.9	2.4	0.16	2.47	1.46
08/589	bulbous	white	white	71	3.2	0.618	3.8	8.2	1.0	0.60	1.46	2.07
C9/9	cylindrical	white	white	65	2.8	0.494	3.8	6.1	1.2	0.27	2.39	2.03
02/59	bulbous	reddish	white	67	2.5	0.542	3.6	7.9	1.2	0.61	2.85	1.62
Austin Canner	bulbous	yellow	orange	69	3.4	0.508	3.6	8.2	1.5	0.81	3.41	2.19
B13/56/11	bulbous	yellow	orange	68	2.3	0.442	3.1	12.0	3.0	0.90	4.31	2.07
Centennial	cylindrical	deep orange	deep orange	72	2.1	0.498	3.3	10.4	1.3	0.39	1.66	2.15
049	bulbous	reddish	white	70	3.9	0.486	3.0	6.3	3.2	0.41	1.82	1.71
28/59	bulbous	reddish	white	68	2.2	0.564	3.0	6.9	1.4	0.46	1.04	1.29
A 7/63/22	bulbous	dark red	pale yellow	69	2.3	0.548	2.9	7.9	3.0	0.17	1.64	1.94
A 16/15	bulbous	orange	orange	66	3.2	0.466	2.6	4.7	2.7	0.54	2.32	1.70
I 62	cylindrical	reddish	white	70	2.3	0.596	2.6	6.5	3.0	0.31	2.26	1.04
03/62	bulbous	white	white	71	2.5	0.518	2.4	5.6	2.9	0.52	2.35	1.64
Sunny side	bulbous	orange	pale orange	69	3.4	0.550	2.1	9.1	1.4	0.85	2.45	1.93
C9	cylindrical	white	white	68	3.2	0.494	2.8	7.1	0.7	0.62	1.62	1.74
A 28/7	bulbous	reddish	white	66	2.6	0.504	2.6	4.5	1.0	0.53	2.62	1.17

TABLE 5

Effect on baking properties of composite flour with different proportion of yam flour (baked under home conditions')

	% of yam flour in composite flour						
	0	5	10	15	20	25	30
Loaf volume:							
ml/g	3.3	3.4	3.5	3.6	3.5	3.3	3.1
Ml/kg flour	5860	5940	6160	6380	6165	5850	5500
Shape	normal	normal	normal	normal	normal	slightly fallen	fallen
Colour							
crust	light brown	light brown	light brown	light brown	light brown	light brown	light brown
crumb	white	white	white	white	white	white	off-white
Texture							
crust	smooth	smooth	smooth	smooth	smooth	slightly rough	rough (few cracks)
crumb	good (cells even)	good (cells even)	good (ceels even)	good (cells even)	good (cells even)	very fair (cells uneven)	fair (cells uneven)
Taste	good	good	good	good	good	good	good

TABLE 6

Formulation for flake-type breakfast foods using sweet potato flour as the base

Experiment No.	11	12	13	14	16	18	19
Ingredients (% dry weight)							
Sweet potato flour	94	82	13	50	50	50	50
Rice flour	-	-	-	44	34	22	12
Wheat flour (white)	-	-	-	-	-	20	35
Corn (maize)flour	-	12	-	-	10	-	5
Skim milk powder	4	4	4	4	4	-	-
Salt	2	2	2	2	2	3	3
Soya flour (whole)	-	-	12	-	-	-	-
Water (gms)	40	40	40	40	40	40	40

Processing conditions	range:
% dough moisture	32 - 41%
% moisture after drying	13 - 16%
Roller spacing for pressing flakes(cold)(inches)	0.003
Toasting temperature ^{o}C	210
Moisture content of finished product	2 - 4