EVALUATION OF THE SUITABILITY OF CASSAVA AND SWEETPOTATO FLOURS FOR PASTA PRODUCTION

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ABSTRACT
The study was carried out to establish the proportions of cassava and sweetpotato flours that would produce good quality pasta, in composite with wheat flour. Up to 50% sweetpotato and cassava flour substitutions were made. Two varieties each of cassava (Abasafitaa and Afisiafi) and sweetpotato (Faara and Sauti) were used. The following parameters were investigated on the flours: starch yield, moisture, ash, fibre, protein, amylose content, water binding capacity, swelling power, solubility, viscosity and pH. Sensory evaluation was conducted to assess the preference of the pasta products. The results showed that water binding capacity, solubility and swelling power affect the overall quality of pasta. Pasta made from sweetpotato composite flour was too brittle and crumbled easily when pressed between the fingers. Pasta made from 50% cassava (Abasafita)/ 50% hard wheat performed better and showed no significant difference from that made from100% hard wheat flour.

Keywords: *Sweetpotato, Cassava, composite flour, Pasta.*

INTRODUCTION

Cassava and sweetpotato are good and inexpensive sources of calories. There is increased focus on these crops as sources of energy and nutrients due to the rapidly growing population especially in developing countries. They are however highly perishable and even though production is increasing; utilization is still limited to their traditional uses. They are low- cost carbohydrate sources for urban consumers especially where they are available in a form, which is convenient for working urban people. Development of technologies that will process sweetpotato and cassava into value added products would promote their production and consumption and thus increase their economic value.

The use of composite flour, a combination of wheat and non-wheat flour (example: cassava and sweetpotato flour) has recently assumed great relevance in developing countries including Ghana. It represents one way of cutting down on the large amounts of wheat importation for bread making and other wheat flour based products. Even though much research has been done on the use of composite flour for bread making, not much work has been done on its use in pasta production (FAO, 1990), which, by its unique combination of properties (ease of preparation, palatability, versatility and long shelf life) has become a fast demanding food commodity. The best quality pasta is made from semolina obtained from the variety of hard wheat known

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as durum due to the presence of the protein, gluten. Sweetpotato and cassava flour lack gluten, which contributes to dough formation and plasticity, to cohesiveness during extrusion and to the drying in pasta (Antognelli, 1980). However, it is believed to have the potential when used in composite with wheat flour. Thus, the objective of this study is to determine the suitable ratios of both cassava-wheat and sweetpotato-wheat composite flour for good pasta formulation.

MATERIALS AND METHODS

Source of Raw Materials

The sweetpotato tubers were obtained from Nkawkaw, Eastern Region, Ghana. The cassava roots used were of 13 months maturity and obtained from Wenchi Agricultural Research Station, Wenchi, Brong-Ahafo Region, Ghana. Two sweetpotato varieties Faara and Sauti and two cassava varieties, Afiasiafi and Abasafitaa were used.

Flour Preparation

Sweetpotato tubers were washed, peeled and chipped into 2-3cm^3 strips. The chips were submerged in 1.5% sodium metabisulfite ($Na_2S_2O_5$) solution for 30 minutes to prevent browning. They were rinsed in water and sun dried thoroughly. The dried chips were then milled and sieved to obtain sweetpotato flour.

The cassava roots were peeled and washed. They were finely grated and the mash packed into polypropylene sacks and de-watered by pressing with a screw-press. The mash obtained was sieved and dried in the sun while stirring intermittently. The dry granules obtained after 2 days of sun drying were milled and sieved to obtain the fine flour. The flour was packaged in transparent polyethylene bags and stored at room temperature.

Starch Yield

This was determined based on the wet extraction method. Ten grams (10g) of flour was weighed into a 250ml beaker. Sufficient water was added to dissolve the starch in the flour. The solution was filtered using cheesecloth. Water was added frequently to the residue to extract all starch until no more starch remained. The extracted starch solution was allowed to settle and the supernatant decanted. The sedimented starch was then dried at 50°C in an air oven. The percentage starch yield was determined as the starch recovered after extraction from 10g flour.

Moisture, ash, crude fibre and protein contents of the flour samples were determined using the Official Methods of Analysis (AOAC, 1990).

pH

Ten grams (10g) of flour (from each variety) was dissolved in 25ml of distilled water to form a slurry. The pH of the slurry was determined using the Corning pH meter (model 240).

Water binding capacity, solubility and swelling power

The water binding capacity (WBC) was determined according to the method of Yamazaki (1953) as modified by Medcalf and Gilles (1965) and solubility and swelling power of flour determined based on a modification of the method of Leach *et al.*, (1959).

Viscosity

Two percent (2%) aqueous suspension of the flour was prepared with distilled water. The suspension was heated on a steam bath with constant stirring till the temperature of the resulting paste reached 90°C. The Brookfield digital viscometer (Model DV +LV version) was then used to determine the viscosity in centipoises seconds of the hot paste at 75°C and 36°C at a speed of 100rpm using spindle number one

Preparation of Pasta

Main ingredients used were flour (hard wheat, sweetpotato and cassava), egg and water. Different percentages of wheat, sweetpotato and cassava flour were used. Fifty percent (50%) of each non-wheat flour weighed was mixed with 100ml boiling water on a hot plate to pregelatinize for one minute while stirring. The remaining 50% of non-wheat flour, the wheat flour and one (1) egg were added to the gelatinized portion and mixed thoroughly. The mixture was then kneaded to a consistent dough and fed into a pasta machine (Master Chef Pasta Bike) to produce the required pasta shapes. The pasta was dried and stored in plastic bags.

Sensory Evaluation

Thirty (30) panelists, 5 from selected cooked rice sellers were used to carry out the sensory analysis on pasta samples. The attributes monitored included colour, appearance, firmness (hand and teeth), mouth feel and overall acceptability. Sensory evaluation was performed on both cooked and uncooked pasta samples using a 7 point hedonic scale ranging from "like very much" to "dislike very much" (Mabesa, 1986). The following formulations X, V, Y, and Z (Table 2 footnote) are the pasta samples selected from preliminary sensory evaluation from each variety for final assessment.

Statistical Analysis

A Completely Randomised Design was used to study the effects of varietal differences on the determined properties and data obtained statistically analysed using One-way Analysis of Variance (ANOVA) and Least Significance Difference (LSD). A Randomised Complete Block Design was used in the sensory evaluation study and the results analysed using two-way ANOVA without replication.

RESULTS

Starch and proximate composition of the samples are shown in table 1. Starch yield ranged from 29.70% to 79.24% (dwb). Abasafitaa had the highest yield and Sauti the lowest. Significant differences (P<0.05) existed in both cassava and sweetpotato varieties. The moisture content of the various flour samples ranged from 6.68% to 14.87% with the highest being wheat flour and the lowest being Abasafitaa flour. The ash content of the various flour samples ranged from 0.62 to 2.82% with sweetpotato varieties having the highest and wheat having the lowest values. Significant differences (P< 0.05) existed between the sweetpotato varieties but not between the cassava varieties. Crude fibre content ranged from 0.39 to 3.64%. Significant differences (P<0.05) existed in the crude fibre content between varieties with the highest and lowest values being cassava and wheat respectively. pH values varied significantly (P<0.05) among the flour samples with the range being 5.07 –5.88. Wheat and cassava (Abasafitaa) flour had the highest and lowest values respectively. Significant differences also (P<0.05) existed between the two cassava varieties. Crude protein content ranged between 0.24 – 15.08 % (dwb) with cassava and wheat having the lowest and the highest values respectively. No significant difference (P>0.05) existed between varieties of cassava or sweetpotato.

Table 1 Starch yield and proximate composition of flour samples

Varieties	Starch Yield	Moisture (%)	pH	Ash (%)	Crude Fibre (%)	Crude Protein (%)
FAARA	53.38(0.29)	10.33 (0.00)	5.15(0.00)	2.82(0.00)	2.21(0.00)	2.42 (0.01)
SAUTI	29.70(0.53)	9.8 (0.00)	5.67(0.05)	2.60(0.01)	1.89(0.00)	2.62 (0.00)
WHEAT	59.30(0.10)	14.87 (0.00)	5.88(0.00)	0.62(0.00)	0.39(0.00)	15.08 (0.03)
ABASAFITAA	79.24(0.03)	6.68 (0.01)	5.67(0.00)	1.15(0.00)	3.64(0.02)	0.24 (0.00)
AFISIAFI	68.89(0.85)	10.96 (0.00)	5.07(0.00)	1.20(0.00)	2.90(0.01)	0.42 (0.06)

Values in parenthesis are standard errors of the mean

Starch swells on heating in water and the extent of swelling depends on the type of starch. The swelling power ranged from 12.96 –27.50% with cassava varieties having the highest (Table 2), probably due to the high starch content (Table 1), and wheat the lowest. Significant difference ($P<0.05$) existed only between cassava varieties. Solubility of the flour samples ranged between 13.12 and 24.44% with sweetpotato and cassava recording the highest and the lowest values respectively (Table 2). Water binding capacity values ranged between 75.88 and 187.00%. No significant difference ($P>0.05$) existed between the varieties. Sweetpotato varieties recorded the highest values while wheat had the lowest value. Viscosity of samples varied significantly ($P<0.05$) giving a range of 37.70 – 96.67 cps and 53.27 – 166.7 cps at 75° C and 36°C respectively with cassava samples having the highest and wheat the lowest viscosity. The amylose content of flour samples varied significantly and ranged between 14.1 – 23.0 % with cassava and wheat varieties having the highest and the lowest values respectively (Table 2).

Table 2. Water binding capacity (WBC), Swelling Power, Solubility, Amylose and Viscosity of Flour Samples

Varieties	WBC (%)	Swelling Power (%)	Solubility (%)	Amylose (%)	Viscosity 75°C (cps)	Viscosity 36°C (cps)
FAARA	187.00 (0.00)	17.53 (0.02)	24.44 (0.52)	18.56 (0.29)	60.67 (0.32)	92.27 (0.21)
SAUTI	172.73 (0.00)	17.17 (0.00)	23.28 (0.11)	16.33 (0.53)	49.17 (0.46)	71.27 (0.40)
WHEAT	75.80 (0.00)	12.96 (0.00)	22.79 (0.20)	14.11 (0.10)	37.70 (0.10)	57.27 (0.21)
ABASAFITAA	117.48 (0.03)	27.53 (0.00)	19.78 (0.20)	19.11 (0.03)	96.67 (0.25)	166.70 (0.20)
AFISIAFI	112.52 (0.03)	26.51 (0.00)	13.12 (0.05)	23.00 (0.85)	91.93 (0.21)	152.50 (0.20)
X (Faara)	93.22 (0.75)	10.19 (0.15)	20.73 (0.24)	17.44 (0.96)	38.97 (0.21)	63.67 (0.40)
V (Sauti)	81.39 (0.17)	11.81 (0.38)	20.93 (0.63)	15.22 (0.96)	38.00 (0.52)	69.40 (0.60)
W (Wheat)	76.25 (0.14)	10.96 (0.27)	22.79 (0.99)	14.11 (0.96)	37.70 (0.10)	57.27 (0.21)
Y (Abasafitaa)	101.77 (0.30)	13.56 (0.30)	14.91 (0.59)	16.89 (0.96)	60.70 (0.10)	93.20 (0.40)
Z (Afisiafi)	101.57 (0.54)	10.59 (0.13)	12.06 (0.78)	14.67 (0.00)	52.43 (0.47)	77.67 (0.06)

Values in parenthesis are standard errors of the mean

Note:

Composite - The composite flour that produced the most preferred pasta in each variety

X - Faara (70% wheat, 30% Faara) V- Sauti (80% wheat, 20% Sauti)

Y - Abasafitaa (50% wheat, 50% Abasafitaa) Z- Afisiafi (70% wheat 30% Afisiafi)

Table 3: Correlation between Overall Acceptability and other Sensory Attributes of Pasta

Correlation Between	Correlation Coefficient (R)	
	Cooked Pasta	Uncooked Pasta
Overall acceptability and Colour	0.99789	0.963919
Overall acceptability and Appearance	0.983046	0.930839
Overall acceptability and Firmness By Hand	0.946976	0.155252
Overall acceptability and Firmness By Teeth	0.728478	0.758765
Overall acceptability and Mouth Feel	0.848629	-

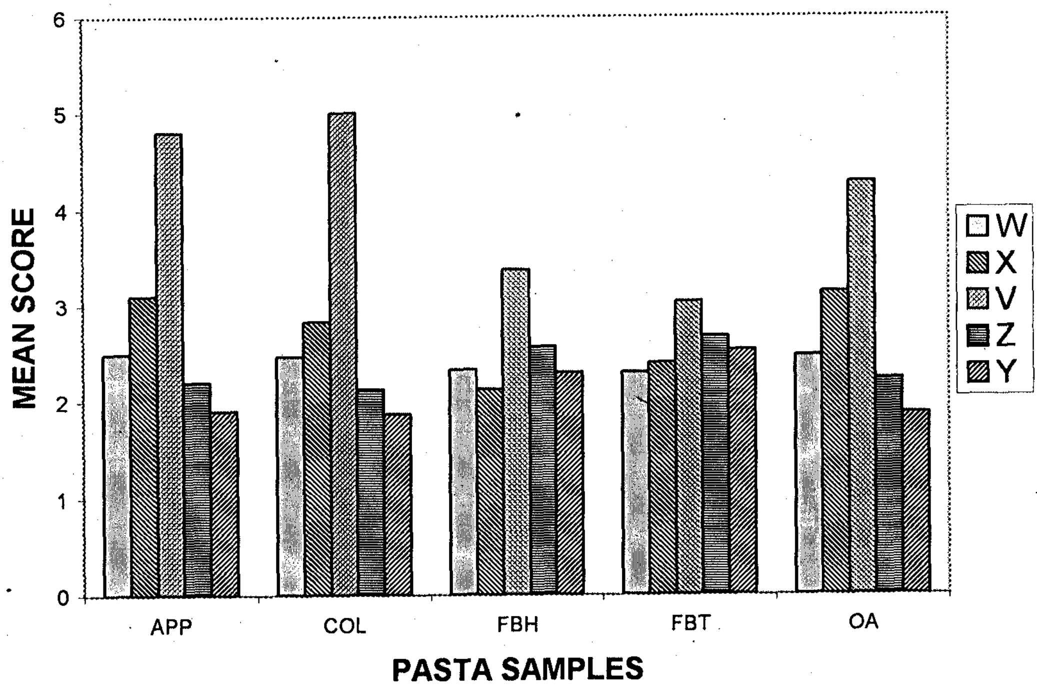

Figure 1. Mean Score for Sensory Evaluation of Uncooked Pasta Samples

KEY

X	70% Wheat	30% Sweetpotato (Faara variety)	APP	= Appearance
W	100% Wheat		COL	= Colour
Z	70% Wheat	30% Cassava (Afisiafi variety)	FBH	= Firmness by Hand
V	80% Wheat	20% Sweetpotato (Sauti variety)	FBT	= Firmness by teeth
Y	50% Wheat	50% Cassava (Abasafitaa variety)	OA	= Overall Acceptability

1.	LVM	-	Like Very Much
2.	LM	-	Like Moderately
3.	LS	-	Like Slightly
4.	NLND	-	Neither Like Nor Dislike
5.	DS	-	Dislike Slightly
6.	DM	-	Dislike Moderately
7.	DVM	-	Dislike Very Much

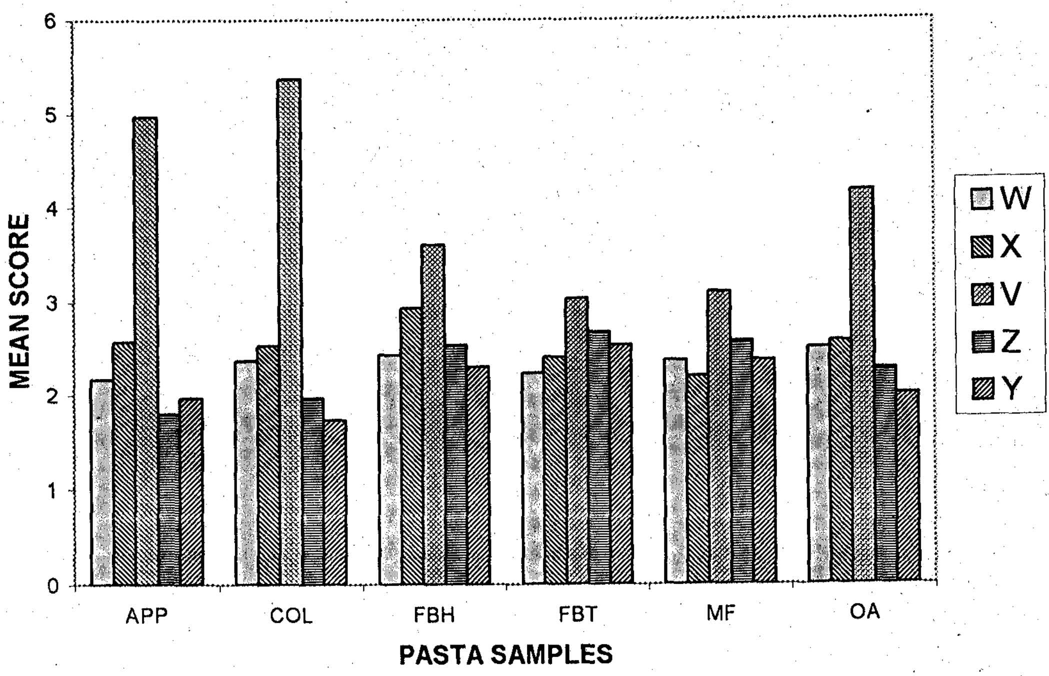

Figure 2: Mean Score for sensory evaluation of Cooked Pasta Samples

Differences in swelling power and solubility among flours could be due to differences in the varieties (Table 2). Swelling values obtained for cassava flours were within the range of those reported by Boakye (2000). Low swelling accompanied by high solubility indicates weak associative forces in the varieties (Moorthy and Ramanujam 1986). This was observed in the sweetpotato flour while cassava flour showed the inverse, suggesting that cassava flour as compared to sweetpotato flour has relatively stronger associative forces. This also confirms the variations in observed characteristics of the dough prepared from sweetpotato composite flour (had less elastic and plastic properties) relative to that of cassava composite. Solubility of all the composite flours was lower relative to their respective 100% non-wheat flours.

Sweetpotato flours had the highest water binding capacity, this is attributed to the weak associative forces between starch granules of sweetpotato flour which allows more molecular surfaces to be available for binding with water (Rickard *et al.*, 1991). Kim *et al.*, (1995) reported that higher swelling power results in high viscosity of starch paste and both are affected by the ability of starch molecules to bind water as reported by Craig *et al.*, (1989) and Swinkels (1985). Even though sweetpotato had higher water binding capacity than the cassava varieties, the cassava varieties were more viscous at both 75°C and 36°C than that of sweetpotato varieties. This may be due to the higher starch content of cassava flour relative to sweetpotato flour (Table 1). Cassava starch generally has a high paste viscosity. High viscosity is desirable for industrial uses in which a high thickening power is required. The viscosity of all the samples increased with decrease in temperature. However, the viscosity of the various composite flours also decreased substantially both at 75 °C and 36 °C. Values obtained for amylose are similar to those reported in other studies (Rickard *et al.*, 1991 and Suzuki, 1999). Suzuki (1999) reported that consistency in pasta manufacture is excellent in wheat with decreased amylose content.

Physical Characteristics of Pasta

It was observed from preliminary studies that pasta made from composite flours with high levels (>50%) of non-wheat flour crumbled easily although they maintained their shape during cooking. Among the four (4) final selected pasta samples made from sweetpotato/cassava – wheat composite flours [X - 70% wheat 30% sweetpotato (Faara variety), V - 80% wheat 20% sweetpotato (Sauti variety), Y - 50% wheat 50% cassava (Abasafitaa variety) and Z - 70% wheat 30% Cassava (Afisiafi variety)], pasta made from sweetpotato–wheat composite flours (X & V) crumbled easily between the fingers. Those made from cassava – wheat composite flour (Y & Z) crumbled only under severe pressure while pasta made from 100% wheat flour was the most firmer.

Significant differences ($P<0.05$) existed in sensory attributes. Panelists preference for colour and appearance was in the order: Abasafitaa composite (50:50), Afisiafi composite (70:30), Wheat (100%), Faara composite (70:30) and Sauti composite (80:20) for both the uncooked and the cooked pasta samples (Figures 1& 2). For firmness, significant differences existed between pasta samples but there was no significant difference ($P>0.05$) between pasta from cassava composite flour (70:30 & 50:50) and that from 100% wheat flour. For preference in terms of firmness, the most and the least preferred were pasta from 100% wheat flour and sweetpotato composite flour (80:20). No significant difference ($p<0.05$) was observed between pasta from cassava composite flour (70:30 & 50:50) and 100% wheat flour in terms of mouth feel. The response for the overall acceptability had this order of preference, pasta from Abasafitaa composite flour (50:50), Afisiafi composite flour (70:30), 100% Wheat, Faara composite flour (70:30) and Sauti composite flour (80:20). This implies that for overall acceptance, preference was higher for cassava-wheat composite flours relative to the 100% wheat flour even though 100% wheat (W) pasta was the most preferred in terms of firmness which is a very important quality measure in pasta.

Regressional analysis of the data obtained showed that overall acceptability correlated strongly with colour, appearance, firmness and mouth feel for the cooked pasta samples (Table 3). A similar trend was observed for the un-cooked pasta with the exception of firmness by hand which had a weak correlation ($r = 0.16$). This implies that overall acceptability of the pasta was influenced strongly by these sensory attributes. Thus in developing pasta from composite flour, attributes of colour, appearance, firmness and mouth feel should be taken into consideration.

CONCLUSION

Sweetpotato flours which had higher solubility and water binding capacity gave soggy and brittle pasta whereas cassava flour with higher swelling power, viscosity and amylose gave firmer pasta with higher overall acceptability. Hence tuber flour with higher solubility and water binding capacity will likely give brittle and soggy pasta in composite with wheat flour whereas those with higher swelling power, viscosity and amylose will give firmer and more acceptable pasta. The study has shown that pasta produced using 50% Abasafitaa 50% wheat composite flour was the most preferred. Thus, optimization of pasta formulation and processing conditions will promote cassava composite pasta with comparable attributes to already existing ones.

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