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Determination of Physicochemical Properties of Cassava Mosaic Disease (Cmd) Resistant Varieties and Their Potentials for the Manufacture of Noodles

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Abstract
The physicochemical properties of twenty Cassava Mosaic Disease resistant varieties and their potentials for the manufacture of noodles were investigated. The cassava varieties were processed into High Quality Cassava (HQCF) and two varieties with good noodle qualities were selected and fortified with soybean. The moisture, starch, sugar, amylose and amylopectin content differed slightly for different varieties. The peak viscosity was in the range of 165.25-453.33 for all the varieties. The trough period was in the range of 32-156 for the varieties. Variety 4(2) 1425 had the highest solubility while 95/0166 was least soluble. TME419 had the highest swelling power while 96/109A had the least. TME419 had the highest dispersibility of 75.10% while 99/6012 had the least (60.95%). Water absorption capacity was highest in 92B/00068 and least in TME419. Varieties M98/0068 and 94/0026 showed the best qualities for noodle preparation. There was no significant ($p > 0.05$) difference between the moisture content of the fortified noodles from the two varieties and their control (indomie). However, the protein, ash, fat, pH, and colour of the noodles differed significantly ($p < 0.05$) from the control. Sensory evaluation of the fortified noodles from the two varieties showed they were acceptable. However, they differed significantly in terms of taste, colour, texture and general acceptability. The physico-chemical properties of the high quality flours from the cassava mosaic disease resistant varieties has revealed that they can be very useful as food and also industrially for the production of noodles. Potentials of twenty Cassava Mosaic Disease resistant varieties for the manufacture of noodles were investigated in this research. The cassava varieties were processed into High Quality Cassava Flour (HQCF) and the physicochemical and rheological properties of the flours were determined. From the basic data, two cassava varieties were identified and used to formulate noodles. The quality characteristics of formulated noodles were compared with that of a commercial sample (Indomie noodles). The moisture, starch, sugar, amylose and amylopectin content of the cassava flours differed slightly for different varieties. The peak viscosity was in the range of 165.25-453.33 for all the varieties. The trough period was in the range of 32-156 for the varieties. Variety 4(2) 1425 had the

highest solubility while 95/0166 was least soluble. TME419 had the highest swelling power while 96/109A had the least. TME419 had the highest dispersibility of 75.10% while 99/6012 had the least (60.95%). Water absorption capacity was highest in 92B/00068 and least in TME419. Varieties M98/0068 and 94/0026 showed the best qualities for noodle preparation. The protein, ash, fat, pH, and colour of the noodles differed significantly ($p < 0.05$) from the control. Sensory evaluation of the fortified noodles from the two varieties showed they were acceptable. However, they differed significantly ($p < 0.05$) from the unfortified noodles in terms of taste, colour, texture and general acceptability.

1. Introduction

Cassava is one of the widely cultivated crop that serves as staple food for more than 800 million people in Africa [1]. Nigeria is the highest producer of cassava with about 54 million tonnes per annum [2]. Despite this, Nigeria is not yet among the major exporters of cassava in the international market primarily due to subsistence production methods and limited value addition chains. Of the 248 million tonnes of cassava produced worldwide in 2012, 58% was produced in Africa [3]. As a result of the increasing uses of cassava and its products, a lot of initiatives have been put in place to ensure its production in commercial quantities.

Cassava (*Manihot esculenta Crantz*) belongs to the family of Euphorbiaceae [4]. It is a tropical plant with woody shrubs and has been reported to originate from North east Brazil and Central America [5]. It is a carbohydrate rich food [6]. Cassava serves mainly as food in the form of garri, fufu/akpu, lafun and so on in Nigeria. High Quality Cassava Flour (HQCF) another product from cassava is used widely in bakery for the production of diverse confectionaries and biscuits. Starch produced from cassava is also used by pharmaceuticals as adhesives and seasonings. Cassava master plan [7], reported that Nigeria is still importing products like starch, flour and sweeteners which can be made from cassava. This is largely due to limited research on value addition methods for development of cassava products for industrial use.

A number of policies have been put in place by Nigerian government to ensure increase production and utilization of cassava and its products. The IITA from 2003-2010 has also worked hard to develop improved varieties of cassava that are resistant to cassava mosaic disease (CMD). This research therefore aimed to evaluate the physico-chemical properties of flours from these CMD resistant varieties and their potentials for industrial use in the manufacture of noodles.

2. Experimental

2.1. Materials

Twenty cassava mosaic disease (CMD) resistant varieties were harvested from the Onne IITA sub-station cassava farm plot, Rivers state, Nigeria and processed into high-quality starch (HQCF).

2.2. Preparation of Flour Samples

The cassava varieties were weighed, pealed and washed. The pealed roots were chipped using a 274kW diesel engine powered chipping machine (IITA OE 1029 Model). The chipped samples were oven dried (Galenkamp Plus Oven Model) at 60°C for 24h. The samples were finally milled and sieved using C1 Lotec Mill (unit 1093). The products were properly labelled and sealed using an impulse sealing machine (Mode No. ME-300H) set at 5°C. Flour samples from the different varieties were used for physicochemical analysis. Two varieties having good noodle qualities were selected. The cassava noodles were fortified for noodle preparation using soybean (boiled and dehulled), salt, and egg.

2.3. Determination of Moisture Content

The moisture content of the cassava flour was determined by the gravimetric method by AOAC [8]. Two (2) grams of the flour was weighed into a clean dried pre-weighed moisture can. It was allowed to dry in the oven for 6h at 100°C until a constant weight was obtained.

The moisture was calculated as follows:

$$\% \text{ Moisture} = (W_3 - W_2) / W_1 \times 100 \quad (1)$$

Where
W_1=weight of sample used
W_2=weight of can + sample before drying
W_3=weight of can + sample after drying

2.4. Determination of Carbohydrate

2.4.1. Starch and Sugar Content Determination

The calorimetric method of determination of sugars and related substances was employed. One millimetre (1 ml) of 95% ethanol, 2 ml of distilled water and 10 ml of hot ethanol was added to 0.02g sample, vortexed and centrifuged for 10 min at 2000rpm. The supernatant was decanted and 9 ml of distilled water was added. Quantities of (0.8 ml) distilled water, 0.5 ml phenol and 25 ml H_2SO_4 were added to the extract. Absorbance was read at 420 nm for sugar determination. While For the determination of starch, $HCLO_4$ was added to sediment for hydrolysis. The sample was allowed to stand for one hour, and vortexed. An aliquot of 0.95 ml of distilled water, 0.5 ml phenol and 2.5 ml H_2SO_4 were added to 0.05 ml of extract and absorbance of sample read at 420 nm.

Calculation: The sugar and starch contents were calculated on percentage curve = 0.0055 basis.

$$\% \text{ sugar} = \frac{(A - I) \times D.F \times V \times 100}{B \times W \times 10} \quad (2)$$

$$\% \text{ starch } = \frac{(A - I) \times D.F \times V \times 0.9 \times 100}{B \times W \times 10} \quad (3)$$

Where:

A = Absorbance of sample

I = Intercept of standard curve

D. F = Dilution factor based on aliquot taken for assay, 5 ml = sugar, 20 ml = starch.

V = Total extract vol.; 20 ml = sugar, 25 ml = starch.

B = Slope of the standard curve = 0.0055

W = Weight of sample.

2.4.2. Determination of Amylose and Amylopectin

The rapid calorimetric procedure for estimating the amylose content of starch and flour according to the method described by Juliano [9] and Hoover and Ratnayake [10] was employed. A quantity of 0.1g (100 mg) of the samples (flours and starches) was weighed into a 100 ml volumetric flask and 1 ml of 99.7 to 100% (v/v) ethanol and 9 ml of 1 N-sodium hydroxide (NaOH) was carefully added and the mouth of the flask was covered with paraffin or foil and the content was mixed well. The samples were heated for 10 min in a boiling water bath to gelatinize the starch (the timing was started when boiling began). The samples were then removed from the water bath and allowed to cool very well. It was then filled up to the mark with distilled water and shaken well. About 5 ml of the mixture was then pipetted into another 100 ml volumetric flask. Acetic acid (1 N, 1.0 ml) and 2 ml of iodine solution were added, and top to mark with distilled water. Absorbance (A) was then read using spectrophotometer at 620 nm wavelength. The blank contained 1 ml of ethanol, 9 ml of sodium hydroxide, and then boiled and top up to the mark with distilled water. 5 ml was then pipetted into a 100 ml volumetric flask. Approximately, 1 ml of 1 N acetic acid and 2 ml of iodine solution were added and then filled up to the mark, this was used to standardize the spectrophotometer at 620 nm.

The amylase content was calculated as:

$$\% \text{ amylose} = \text{absorbance} \times 3.06 \times 20 \quad (4)$$

$$\% \text{ amylopectin} = 100 - \% \text{ amylose} \quad (5)$$

2.5. Determination of Rheological Properties

The rheological properties of cassava flours processed from CMD resistant varieties were determined using a Rapid Visco Analyser (RVA Newport scientific super 3D+, Australia). Parameters analysed were peak time, trough, breakdown, final viscosity, set back, and pasting temperature. A quantity of (3g) of each flour sample (on 100% dry matter basis) was weighed into a canister. Twenty-five millimetres (25 ml) of distilled water was added and stirred. The paddle was placed into canister and the canister inserted into the instrument. The measurement cycle was initiated by depressing the motor tower of the instrument when the computer indicated "press down the tower. The experiment runs with the PC attached, takes the reading and draws the graph. The cycle terminates at the end of at least 12 min.

Calculation of dried sample weight:

Since at 100% dry matter (DM) required of sample weight is 3.0g

$$\text{RVA weight} = 100 \times 3\text{g} \quad (6)$$

Volume of water = 25.0 ml – Y.

2.6. Functional Properties of Flour

2.6.1. Determination of Swelling Power and Solubility

One gram (1.0g) of sample was weighed into 100 ml conical flask. Fifteen (15) ml distilled water was added and stirred for 15 min on a shaker (Gallenkamp flask shaker) at low speed. The mixture was transferred into a water bath (Precision Sc. Co model 83) for 40 min at 80-85°C with constant stirring. A quantity of (7.5) ml distilled water was added to the sample and transferred into a pre-weighed centrifuge tube for 20 min. The supernatant was decanted into a pre-weighed can and dried to constant weight and weighed, for the determination of solubility. The sediment in the centrifuge tube was also weighed for the determination of swelling power. The swelling power and solubility were given as follows:

$$\text{Swelling Power} = \frac{\text{Weight of sediment}}{\text{Sample weight} - \text{weight of soluble solids}} \quad (7)$$

$$\%\text{Solubility index} = \frac{\text{weight of soluble solids x 100}}{\text{Weight of sample}} \quad (8)$$

2.6.2. Determination of Dispersibility

A quantity of ten gram (10g) of sample was weighed into 100 ml measuring cylinder and distilled water to reach water added to reach volume of 100 ml. The set up was stirred vigorously and allowed to settle for 3 h. The volume of settled particles was recorded and subtracted from 100. The difference was reported as % dispersibility.

$$\% \text{ Dispersibility} = 100/\text{reading} \quad (9)$$

2.6.3. Determination of Water Absorption Capacity

Fifteen (15) ml distilled water was added to 1g of sample in a pre-weighed centrifuge tube. The tube and mixture was agitated on stural Sc. (U.K Merlin 503) centrifuge. The clear supernatant was discarded and the centrifuge was weighed with the sediment. The amount of water bound by flour was determined by difference and expressed as weight of water bound by 100g dry flour.

$$\text{WAC} = (\text{Sediment} - \text{sample weight}) \times 100 \quad (10)$$

2.7. Formulation and Preparatory of Noodles from Soybean and Cassava Flour

Varieties having good noodle quality were selected. The varieties, 94/0026 and M98/0068 were chosen based on the following criteria: high amylose content, high breakdown value, low swelling power, and low setback values. The cassava noodles were fortified for noodle preparation using soybean (boiled and dehulled), salt, and egg. Noodles (Indomie brand) were used as control samples. Experimental samples contained the following ingredients: 180g cassava flour, 20g soybean flour, 100 ml water, 1 teaspoon of salt, 1 egg, 45g cassava flour (for pregelling). All dry ingredients (135 gram of cassava flour, 20g soybean and salt) were mixed and passed through a 20 µm (mesh size) sieve for uniform mixing. A quarter of the flour was pre-gelled with hot water and hand-kneaded into the dry ingredients to form the noodle dough, the egg was finally added to the mixture to improve binding quality of the dough. The dough was rested for 15 min, remixed and pressed into a hand-operated extruder. The extruded noodles were boiled for 4 mins, decanted and oven dried at 45^0C for 12h. Similar processing method was used to produce noodles from five cassava varieties that were not fortified with soybean flour. Samples were allowed to cool, packaged and properly labelled for further analysis.

2.8. Proximate Analysis of Noodles

According to the method described by AOAC (1990) moisture, fat, ash, crude, protein contents of processed noodles and control samples were determined.

2.9. Sensory Evaluation

A 50-member, untrained panel consisting of staff of IITA Onne substation evaluated samples of the cooked noodles. Panelists used a 9-point hedonic scale to evaluate colour, taste, texture and overall acceptability. Evaluation was conducted over a period of 3 days, with three sessions per day: mid-morning and mid-afternoon. Panellists evaluated five samples/session using a conventional 1-9 hedonic scale from (1) dislike extremely to like extremely (9).

2.10. Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and principal component (PCA) using SAS version 8e software (SAS Institute Inc., Cary, NC, USA) at $P<0.05$. Means were separated using standard error. Values are written as mean ± standard error (SE) of duplicate determinations.

3. Results and Discussion

Table 1. *Moisture content/carbohydrate composition of twenty cmd resistant cassava varieties.*

Variety	%Moisture content	%Starch	%Sugar	%Amylose	%Amylopectin
92B/00068	9.61b	52.23fgh	4.47bcdefghij	17.04ghijk	82.96bcd
30572	6.57dec	94.96a	4.06efghijklmno	22.71ab	77.29ghj
99/2123	5.89defghi	69.73cdef	4.39bcdefghij	20.23bcde	79.77defghi
97/2205	6.33def	73.67abcd	6.23cb	19.95cdel	80.05ghij
95/0166	11.46b	86.82abcd	1.76ar	19.58defg	80.42cdefgh
92/0057	6.07defg	36.8i	2.09opqr	19.65defg	80.35fghij
94/0039	6.13defg	78.55abcd	5.54bcdef	22.67a	77.33k
92/0326	5.99defgh	45.35ghi	10.84a	17.35fghijk	82.65bcde
M98/0068	6.18defg	84.94abcd	5.85bcde	20.78abcd	79.22jk
91/02324	5.82defghi	5.37abcde	6.33b	15.02k	86.04a
4(2) 1425	5.55efghi	87.69abcd	4.31cdefghijk	17.75efghijk	82.25bcdefg
98/2226	5.27efghi	84.25abcd	6.12bc	15.64jk	84.36a
92/0325	5.90defghi	93.05ab	3.84fghijklmnop	19.58defg	84.36a
97/4763	6.55def	89.15abc	4.35cdijk	18.21defghi	81.79bcdefgh
99/6012	6.12defgh	88.01abcd	4.82bcdefgh	16.03ijk	83.79ab
97/0211	5.99defgh	87.84abcd	6.05bcd	18.70defgh	81.30fghij
M98/0028	3.69i	83.69abcd	5.83bcde	19.37defgh	80.63efghij
96/1089A	4.27fghi	84.74abcd	4.65cdefghi	17.56efghijk	82.44bcdef
TME419	3.83ghf	85.42abcd	4.36cdefghif	22.83ab	77.17ghi

Table 1 presents the moisture content and carbohydrate composition of twenty CMD resistant cassava varieties. The highest moisture content value was obtained from variety 9213/00068 as 9.61%, while the lowest was variety 94/0162 (3.51%). Our result is in line with the recommendation of Codex Alimentarius Commission that the moisture contents of edible cassava flour should not exceed 13%. Also, lower initial moisture content of products have been distributed to better storage stability of the product [11]. The highest starch content value was obtained from variety 30572 (94.96%) while the lowest was 94/0162 (31.74%). The result obtained showed that 75% 0f the cassava varieties had starch contents that corresponds with the findings of Moorthy *et al.* [12] who reported starch values between 71% - 90%. The result is also in agreement with the report of [13] that the standard specification for cassava flour in Nigeria is a minimum of 65%. The highest sugar content value was observed for variety 92/0326 (10.83%). Variety 95/0166 (1.76%) had the lowest sugar content. The result is in contrast to the findings of Moorthy *et al.* [12] who reported sugar contents ranging from 2.0 to 3.5%. The highest amylose content was 22.83% for variety TME419. The lowest was 15.02% for variety 91/02324. Amylose content is an important determinant of the functional property of flour and starches. Low amylase starch increases relative crystallinity as a result of reduced amorphous region within starch granule [14]. High amylose content of flour increases pasting temperature [15] and flours of high amylose content are good for noodle production [16].

The amylopectin content ranged from 77.1 - 86.04%. The result is in agreement with the findings of Shittu *et al.* [17] who reported that high amylopectin levels of the different cassava flours is associated with high expansion.

The results of the rheological properties of flour from the twenty cassava varieties as presented on Table 2. Peak viscosity tells of the extent a starch can swell before its physical breakdown [17] and in this study, it ranged from165.25-454.33 RVU. Trough period is a reflection of the minimum viscosity and the ability of the material to withstand breakdown during cooling. The trough periods in this study ranged from 101.8-26.0 RVU. Rate of starch breakdown depends on the nature of the material, temperature, degree of mixing and shear applied to the mixture. Final viscosity is used to characterize starch – based products, as it indicates the ability to form viscous paste or gel after cooking and cooling [11]. Set back has been correlated with the texture of various products. The lower the setback during cooling of pasta, the greater the retrogradation. Ninety percent of the values obtained in this research is in agreement with previously reported ranges by Sanni *et al.* [18]. Peak time is the time taken to attain peak viscosity in minutes [16] and it ranged from 3.36- 3.83 minutes in this study. The pasting temperature was in the range of 63.98- 64.97°C. High pasting temperature indicates high WAC, gelatinization tendency and lower swelling property as a result of high degree of association between starch and its granules [19].

Table 2. *Rheological Properties of Flour from twenty (20) Cassava Varieties.*

Variety	Peak viscosity (RVU)	Trough (RVU)	Break down (RVU)	Final viscosity (RVU)	Setback (RVU)	peak time (RVU)	Pasting Temperature (O C)
92B/00068	321.79±22..92	117.21±2.88	160.5±60.75	179.9±8.42	62.67±5.54	3.67±9.06	64.92±0.88
30572	305.17±38.30	99.38±10.08	169.2±25.28	151.8±15.3	52.42±5.18	3.57±0.02	64.97±0.03
99/2123	280.63±24.11	105.88±3.47	167.9±29.41	175.8±12.1	69.92±8.61	3.64±0.02	64.25±0.14
97 /2205	165.25±1.53	1.13±0.06	101.8±0.59	14.6±0.35	13.46±0.30	3.38±0.02	64.18±0.25
95/0166	331.59±1.89	147.92±0.59	183.2±2.00	202.0±2.77	54.04±2.18	3.83±0.25	64.43±0.60
92/0057	251.21±16.09	66.46±1.00	135.2±10.13	90.1±1.41	23.63±0.42	3.51±0.02	64.35±0.57
94/0039	275.04±8.90	60.13±0.29	167.5±2.94	76.6±3.01	16.42±3.30	3.51±0.02	64.48±0.60
94/0162	264.79±3.83	24.63±1.00	146.5±16.32	43.7±1.53	19.05±0.53	3.41±0.02	63.98±0.04
92/0326	315.17±12.49	146.67±8.72	190.0±26.05	231.3±12.8	75.54±8.78	3.68±0.37	64.70±0.07
M98/0068	454.33±115.3	146.0±17.79	208.6±0.23	219.2±29.9	73.17±12.14	3.50±0.11	64.45±0.28
91/02324	317.79±7.13	78.17±1.18	177.5±13.85	136.9±40.8	30.46±0.41	3.39±0.04	64.50±0.07
4(2) 1425	265.49±6.84	-3.05±0.53	154.3±3.24	0.96±0.18	4.00±0.35	3.41±0.02	64.53±0.04
98/2226	365.75±10.61	148.00±1.77	206.8±12.84	227.0±4.54	79.04±2.77	3.70±0.02	64.48±0.04
92/0325	315.42±13.08	68.50±11.43	170.4±10.42	87.8±5.71	19.29±5.71	3.43±0.05	64.55±0.00
97/4763	430.34±24.63	129.67±5.07	260.0±12.32	186.2±5.36	56.54±0.30	3.50±0.07	64.50±0.00
99/6012	347.50±25.70	147.92±22.63	175.1±1.70	216.5±7.67	68.59±14.97	3.50±0.07	64.50±0.00
97/0211	261.71±1.47	8.92±17.44	144.3±10.96	20.9±28.4	11.96±10.9	3.36±0.05	64.70±0.28
M98/0028	271.21±8.43	53.62±1.18	175.1±1.24	77.8±3.48	24.13±2.30	3.60±0.03	64.53±0.04
96/1089A	254.84±20.27	1.67±2.12	199.9±37.36	3.71±1.94	2.05±0.18	3.65±0.10	64.38±0.11
TME419	429.11±36.10	139.33±7.42	229.9±20.44	203.7±11.0	64.33±3.54	3.57±0.02	64.65±0.35

The result of the functional properties of cassava flour is depicted on Table 3. The result showed that flour from variety 4(2) 1425 had the highest solubility while 95/0166 had the least. Our result is in contrast to that of previous reports by Baafi and Sapo – kantanka [20] who reported solubility ranges between 5.33 – 14.17%. The values obtained for swelling power were higher than the previously reported. This could be as a result of high fibre content of the flours Moorthy *et al.* [12]. The result of dispersibility and WAC of the flours revealed that the flours could be easily dispersed in aqueous solution. The higher the dispersibility of flour, the better it reconstitutes in water Kulkarmi *et al.* [21].

Table 3. *Functional Properties of Flour from twenty (20) Cassava Varieties.*

Variety	Solubility%	Swelling power (g/g)	Dispersibility (%)	WAC (%)	colour
92B/00068	26.85±15.67	13.92±2.94	62.90±1.56	2.66±0.13	87.05±0.28
30372	30.34±13.15	13.93±1.94	74.15±1.20	2.00±0.03	88.13±0.27
99/2123	11.44±3.63	13.18±2.12	71.75± 1.77	1.90±0.38	87.89±0.66
97/2205	71.73±2.02	10.47±0.99	71.15±0.21	2.13±0.05	86.28±0.67
95/0166	7.07± 1.86	15.33± 0.18	71.95±0.07	2.27±0.39	88.28±0.36
92/0057	8.09± 3.28	15.43± 1.34	73.90±0.14	1.88±0.11	87.58±0.23
94/0039	52.53± 11.39	9.37± 1.55	66.50±0.71	2.60±0.00	86.25±2.19
94/0162	62.56±4.36	11.15±0.05	63.60±0.57	2.32±0.14	87.17±1.06
92/0326	35.52±39.41	13.58±4.44	67.60±0.85	2.26±0.06	85.85±0.65
M98/0068	8.90±2.10	15.71±0.35	69.50±0.71	2.00±0.13	88.79±0.06
91/02324	15.58±13.16	14.83±5.95	69.10±0.14	1.18±1.06	85.98±1.20
4(2) 1425	69.86±8.18	7.69±2.28	72.75±0.35	1.54±0.03	89.28±0.18
98/2226	41.69±22.62	12.67±1.89	65.65±0.49	2.20±0.09	87.33±0.09
92/0325	26.00±17.87	15.83±0.88	69.00±0.14	1.85±0.02	86.95±0.20
97/4763	19.80±5.78	13.61±1.33	66.80±0.28	1.84±0.13	88.21±0.01
99/6012	45.95±35.75	17.13±2.42	60.95±0.07	2.35±0.04	88.40±0.12

Variety	Solubility%	Swelling power (g/g)	Dispersibility (%)	WAC (%)	colour
97/0211	39.60±1.45	6.27±0.32	66.60±0.57	2.16±0.01	87.22±0.12
M98/0028	58.52±0.20	11.16±0.24	68.90±0.14	1.83±0.11	88.20±0.83
96/1089A	54.08±6.62	5.16±0.58	73.35±0.21	1.67±0.14	89.06±0.16
TME419	9.33±1.22	15.76±0.81	75.10±0.14	1.60±0.02	89.32±0.11

The result of sensory evaluation of noodles prepared from plain cassava flour/cassava – soybean flour is as presented in Table 4 From the fisher test, the taste of control (Indomie noodles) was most preferred than other cassava flour fortified with soybean. Values for the control were 8.7 for taste and 8.6 each for colour, texture and general acceptability. In terms of colour, the control had the greatest degree of likeness followed by M98/0068 (unfortified). The texture of the control sample was rated higher than the samples. Piyachomkwan *et al*. [22] reported that high quality noodles should not be too hard, soft or sticky. The result obtained for general acceptability revealed that noodle from the fortified cassava varieties was generally acceptable.

Table 4. *Sensory evaluation.*

SAMPLE	TASTE	COLOUR	TEXTURE	G/ACCEPT
M/980068	6.1fe	7.0dc	6.5dc	6.8c
M/980068*	7.2b	7.1c	7.7b	7.9b
94/0026	6.8cb	6.2fe	6.8cd	6.8c
94/0026*	6.5de	6.5de	6.5de	6.5c

Mean value followed by different superscript within the same column are significantly different (P<0.05)
• = unfortified noodle sample
I = dislike extremely, 9 = like extremely

The result of quality attributes of noodles is as shown on table 5. Noodles from M98/0068 (unfortified) had the highest moisture content. All the noodles from the test samples had higher moisture content than the control (Indomie noodle). Low moisture content indicates better shelf stability. The protein content of the noodles from the fortified noodles was higher than the unfortified. This could be due to improvement of protein quality of the noodles from the legume soybean Jayazena *et al*. [23]. The fat content of the noodles were significantly (P<0.05) lower than the control. The ash content of the noodles were significantly (P<0.05) lower than the control except for 94/0026 (fortified). The result is similar to previously reported ash content range of between 2.8 – 5.0%. The pH of the control noodle was significantly (P < 0.05) higher than other noodle samples. pH range of 6 – 6.5 have been reported to prevent swelling, resulting in low viscosity that is good for high quality noodles. All the noodles were significantly (P<0.05) different in colour compared to control except 94/0026P (unfortified). This agrees with the findings of Jayazena *et al*. [23] that 20% substitution of cassava with Australian sweet lupin flour gave a non- significant effect on the colour of the noodle. Cassava starch possess unique properties (in both modified and unmodified forms) that make cassava flour suitable for noodle manufacture [24. 25]

Table 5. *Quality Attributes of Noodles from Plain Cassava Flour/Cassava-Soybean Flour Samples.*

SAMPLE	MC	PROTEIN	FAT	ASH	pH	COLOUR (L*VALUES)
M98/0068	6.4bc	6.1e	4.0bcd	3.0d	6.3f	52.3ba
M98/0068P	11.7a	5.7f	2.1bcd	3.0d	6.6d	53.6a
94/0026	7.1bc	7.5d	3.5bcd	3.3c	6.4g	55.7a
94/0026P	9.5ba	3.8g	1.4bcd	2.6f	6.5e	45.8bc

Mean values followed by different superscript within the same column are significantly different (P<0.05)
P = unfortified noodles sample; mc = moisture content
L * = Lightness of colour, Values increase as colour become brighter.

4. Conclusion

The physico-chemical properties of the HQCF flour from some of the CMD resistant varieties has revealed that they can be very useful industrially for the production of noodles Variety M/980068 can effectively be used for commercial noodle production. Fortification with soybean did not improve sensory properties of noodles.

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