Physicochemical, Rheological and Consumer acceptability of cassava starch salad cream

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Abstract: Cassava is popularly consumed as a staple in many regions of the developing world. Limitation to utilization of cassava roots by processors is its high perishability and bulkiness. Salad Cream is a ready made creamy-white dressing with a flowing consistency of which modified maize flour serves as the base raw material. At present there is little information on the physical, chemical, pasting and rheological properties of salad cream from cassava starch. This work was aimed to evaluate the physicochemical, rheological and consumer acceptability of cassava starch salad cream from three Nigerian low cyanide cassava varieties (96/01632, 98/0505 and TME419). Commercial salad and cassava starch salad cream were evaluated for physical (colour), chemical (titratable acidity, pH, total solids, protein, sugar, starch, fat, ash, moisture content and dry matter) and rheological (viscosity). Consumer acceptability was evaluated by ten-member panel randomly selected from male and female adults. Lightness (L*) values of cassava starch salad cream from 96/01632 (85.17), 98/0505 (84.21), TME 419 (84.38) and control (77.28), Chroma were 96/01632 (15.77), 98/0505 (16.13), TME 419 (17.59) and control (28.97). Commercial salad cream was significantly higher at $p<0.05$ in moisture (48.99%), protein (1.61%), sugar (17.59%), titratable acidity (8.63), total solids (61.92%) and ash (2.75%). However, cassava starch salad cream from TME 419 was significantly higher in fat (21.64%). The viscosity of the salad creams was non-Newtonian with cassava starch salad cream from 98/0505 having viscosity (0.43Pa.s) at 50^0C. Sensory evaluation showed increased preference for cassava starch salad cream. Acceptable and nutritious salad cream can be processed from cassava starch. [Journal of American Science 2010;6(1):65-72]. (ISSN: 1545-1003).

Keywords: cassava starch salad cream, cassava, cassava starch, sensory evaluation

Introduction

Cassava (*Manihot esculenta* Crantz) is a root crop cultivated and consumed as a staple in many regions of the developing world. The world output of cassava in 2004 was 202 million Metric tones (Ashaye *et al* 2007). Nigeria produced 38,179,000 Mt of cassava in 2004 making the country the highest producer of cassava in the world (Ashaye *et al* 2007). The potential of the crop is large because it offers the cheapest source of food calories and the highest yield per unit area. It also has multiple roles as a famine reserve, food and cash crop, industrial raw material and livestock feed (Albert *et al* 2005, Oboh and Akindahunsi 2003). There are also many agronomic (relative resistance to pests and diseases, flexibility in planting and harvesting, etc.) and social reasons (income earner for women, flexible labour requirements) why cassava has become so important (Ashaye *et. al*., 2007).

However, a major hindrance to the utilization of cassava roots by processors is its high perishability and bulkiness. This has increased the post-harvest losses of cassava to well over 8.4% (Maduagwu 1979). Once harvested, cassava roots are highly perishable and when stored, rapid physiological and microbiological deterioration occurred. Cassava thus needs to be processed into dried forms that are more shelf stable. Processing of cassava into dry form reduces the moisture content; convert it into more durable and stable product with less volume, which makes it more transportable. Processing is also necessary to improve palatability, eliminate or reduce the level of cyanide cassava (Cardoso *et al* 2005). Starch is one of such shelf-stable products from cassava.

The fresh roots of cassava contains 30% to 40% dry matter of which 85% is starch, since the roots are rich in starch, they are increasingly used as raw materials. Hence, starch is the main constituent of cassava. About 25% starch may be obtained from mature, good quality tubers. About 60% starch may be obtained from dry cassava chips and about 10% dry pulp may be obtained per

100kg of cassava roots.(Oyewole and Obieze 1995)

The Industrial uses of starch is based on its properties and suitability to different purposes; in paper and paper tapes; in textiles industry for sizing and finishing; as drilling mud in oil drilling; as dye stuff and in building, metal and chemical industries, starch pearls (sag) dextrose, glucose, spirit, alcohol. In the food industry, starch is mainly used as food, but is also readily converted chemically, physically, and biologically into many useful products, which include beverages, confectionery, pharmaceuticals, etc. Cassava starch has many remarkable characteristics, including high paste viscosity, high paste clarity, and high freeze-thaw stability, which are advantageous to many industries. .(Oyewole and Obieze 1995)

Salad Cream is a ready made creamy-white dressing with a flowing consistency for eating with salad (mixture of raw vegetables), is prepared with various ingredients of which modified maize flour serves as the base raw material. (Turgeon., 1996).

However, there is a death of information on the physical, chemical and rheological properties of salad cream from cassava starch.

Therefore the objectives of this study are

To assess the chemical and rheological properties of Cassava starch salad cream.

To determine the consumer acceptability of the Cassava starch salad cream

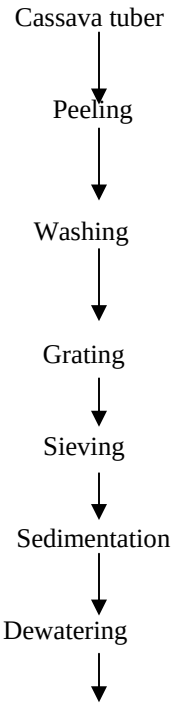
Materials and Methods

Raw materials

Three newly released low cyanide cassava varieties (96/01632, 98/0505 and TME419) from International Institute of Tropical Agriculture (IITA), Ibadan were used. The cassava varieties were planted at the research farm of IITA under rain-fed condition. No fertilizers or herbicides were applied during the course of the experiment. Hand weeding was done when necessary. Harvesting was done at 12 months after planting. The harvested cassava roots were processed into starch within 60 minutes after harvest.

Extraction of cassava starch

This was done following the traditional method of starch extraction as described by Oyewole and Obieze, (1995). 7kg of freshly harvested cassava roots were peeled, washed in water and grated with an electric motor powered mechanical grater (Fig 1). The resultant pulp was immediately sieved through a screen and suspended in 10L of water. This separates the fibrous and other coarse root material from the starch pulp. The starch pulp was allowed to settle for 4 – 6 hrs before decanting. The supernatant was decanted and the thick sediment is the wet starch. The starch was then dried using a convectional oven dryer at 60°C for 18 hrs and packed.



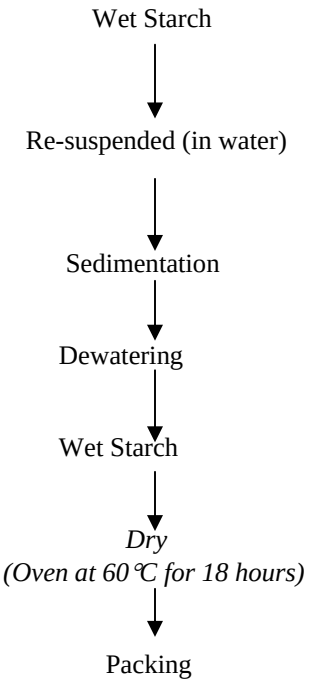
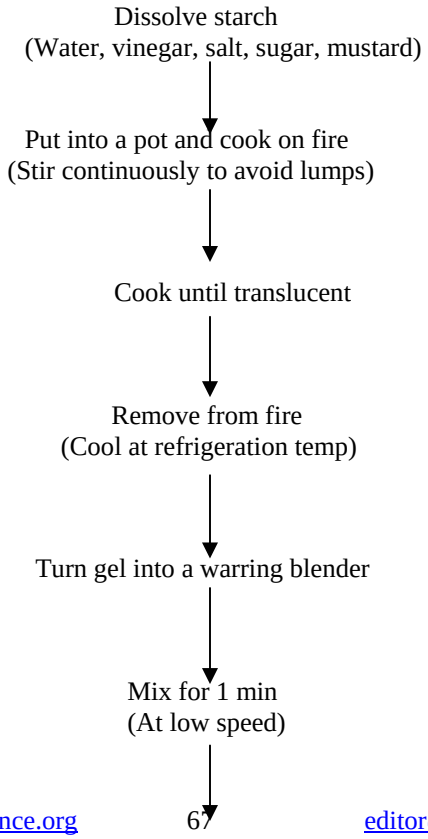


Figure 1: Flow Chart of Cassava Starch Production

Preparation of cassava starch-based salad cream

Dry cassava starch was reconstituted with water, vinegar, salt, sugar and mustard (Fig 2). It was then cooked on fire until translucent. This was then cooled and blended in a warring blender for one minute after which, egg yolk and vegetable oil were added and then blended for another five minutes. The resultant salad cream was then poured into a covered jar.



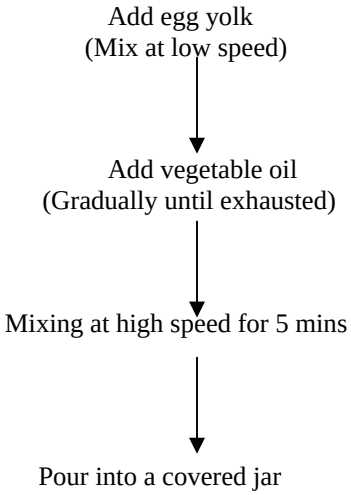


Figure 2. Preparation of Cassava starch based salad cream

Chemical analysis

pH determination:

The pH meter (model BA 350 EDT instruments) was standardized with standard buffer solution 4. 0. and 7.0. The pH was measured by inserting directly the electrodes into 10ml beaker containing the sample.

Determination of titratable acidity:

Titratable acidity was determined according to the method described by Ruck (1969). 1g of blended portion of Roselle jam sample were weighed and put into 50ml centrifuge tube respectively. 10ml of distilled water was added to each tube to dissolve each respectively and then flitted. 1ml aliquot of each solution was taken into another 50ml centrifuge tube and 10ml of distilled water added to dilute the sample because it is highly colored. 10ml of the diluent was titrated against 0.1N NaOH solution using phenolphthalein (2 drops) indicator percentage titratable acidity was calculated.

Determination of dry matter and moisture content:

Two milliliters (2mls) of each sample was measured into a previously weight crucible, dry over water for some time. The crucible plus sample taken was then transferred into the oven set at 100^0C to dry to a content weight for 24hour over night. At the end of 24hours, the crucible plus sample was removed from the oven and transfer to dessicator cooled for ten minutes and weighed.

If the weight of empty crucible is $W_{0,}$ then, the weight of crucible plus sample is W_1. Weight of crucible plus oven dried sample is W_3

$$\% \text{ Dry matter} = \frac{W_3 - W_0}{W_1 - W_0} \times \frac{100}{1}$$

$$(\% \text{ Moisture}) = \frac{W_1 - W_3}{W_1 - W_0} \times \frac{100}{1}$$

% Moisture Content = 100 - % DM

Determination of Ash

The sample (2 g) was weighed into a porcelain crucible. This was transferred into the muffle furnace set at 550°C and left for about 4 hours. About this time it had turned to white ash. The crucible and its content were cooled to about 100°C in air, then room temperature in a dessicator and weighed (AOAC, 1990).

The percentage ash was calculated from the formula below:

$$\% \text{ Ash content} = \frac{\text{Weight of ash}}{\text{Original weight of sample}} \times \frac{100}{1}$$

Determination of Crude Protein

The micro-Kjeldahl method for protein determination is employed for protein determination. This is based on three principles:

Procedure

The finely ground dried sample (0.5g) was weighed into the micro-Kjeldahl flask. To this were added 1 Kjeldahl catalyst tablet and 10ml of

conc. H_2SO_4. These were set in the appropriate hole of the digestion block heaters in a fume cupboard. The digestion was left on for 4 hours after which a clear colourless solution was left in the tube. The digest was carefully transferred into 100ml volumetric flask, thoroughly rinsing the digestion tube with distilled water and the volume of the flask made up to the mark with distilled water. 5ml portion of the digest was then pipetted to Kjeldahl apparatus and 5ml of 40% ($^{w}/_{v}$) NaOH added.

The mixture was then steam distilled and the liberated ammonia collected into a 50ml conical flask containing 10ml of 2% boric acid plus mixed indicator solution. The green colour solution was then titrated against 0.01 NHCL solution. At the end point, the green colour turns to wine colour, which indicates that, all the nitrogen trapped as ammonium borate have been removed as ammonium chloride. The percentage nitrogen was calculated by using the formula:

% N = Titre value x atomic mass of nitrogen x normality of HCL used x 4

The crude protein is determined by multiplying percentage nitrogen by a constant factor of 6.25 (AOAC, 1990).

Crude Fat Determination

The dried sample (1g) was weighed into fat free extraction thimble and plug lightly with cotton wool. The thimble was placed in the extractor and fitted up with reflux condenser and a 250ml soxhlet flask which has been previously dried in the oven, cooled in the dessicator and weighed. The soxhlet flask is then filled to ¾ of it volume with petroleum either (b.pt. 40 – 60°C) and the soxhlet flask extractor plus condenser set was placed on the heater. The heater was put on for six hours with constant running water from the tap for condensation of ether vapour. The set is constantly watched for ether leaks and the heat sources are adjusted appropriately for the ether to boil gently. The ether is left to siphon over several times at least 10 – 12 times until it is short of siphoning. It is after this is noticed that any ether content of the extractor is carefully drained into the ether stock bottle. The thimble-containing sample is then removed and dried on a clock glass on the bench top. The extractor flask with condenser is replaced and the distillation continues until the flask is practically dried. The flask which now contains the fat or oil is detached, its exterior cleaned and dried to a constant weight in the oven (AOAC, 1990). If the initial weight of dry soxhlet flask is Wo and the final weight of oven dried flask + oil/fat is W_1, percentage fat/oil is obtained by the formula:

$$\frac{W_1 - Wo}{\text{Weight of sample taken}} \times \frac{100}{1}$$

Determination of sugar

1 gm of sample was weighed into a boiling tube and 30ml of hot 80% ethanol was added into the boiling tube and shake on a shaker. The mixture was allowed to rest for 20-30mins. The mixture was then filtered through a Whatman no 41 filter paper. The process was repeated to ensure complete extraction of sugar. The extract was then evaporated until dry. 10ml of distilled water was added to dissolve the contents and transferred into a 100ml volumetric flask. The contents were washed into a beaker two or three times and made up to 100ml with distilled water.

1 ml of aliquot was pippeted into a test tube and 1 ml of distilled water was also pipetted into a test tube separately as blank. 1ml of 5% phenol was added to each tube and shake. Into the mixture 5 ml of 96% H_2SO_4 was added and shook vigorously to obtain a good mixing.. Allow the tubes to stand for 10mins for the development of golden yellow colouration. The absorbance of the golden yellow was measures against the blank at 490nm (A.O.A.C 1990)

Sugar = Absorbance of sample x Dilution factor x gradient factor/10,000 x weight of sample

Total Solids

3g of sample was weighed into a flat Petri dish, heat on steam bath for 15 minutes, exposing maximum bottom to live steam. Heat for 3 hrs in an air oven at 100^0C. Cool in desiccators, weight quickly and report % Residue as total solid.

$$\% \text{ Total solid} \quad W_2 - \frac{W_1 \times 100}{S}$$

Colour Analysis

This was determined using colour meter (Color Tec PCMTM Color Tec associates, Inc., 28 Center STREET, CLINTON, NJ 08809). The colorimeter operates on the CIE (Commission Internationale de I'Eclairage) L*, a*, b* colour scheme. Multiple measurements of several points on samples were made. The instrument was first standardized (L=87.82, a=02.97, b=-00.29) with a Business Xerox 80g/m^2 white paper with 136 CIE whiteness D65. About 3g of starch were put in a transparent polythene bag and the colour meter was placed on the sample by allowing the sensor to touch the sample. The reading was taken

directly for L*. The instrument display three-dimensional colour difference in uniform colour space (Lab) co-ordinates. Uniform colour space defines three directions, a Light to Dark direction, called L*, a Red to Green direction called a*, and a blue to yellow direction called b* (Patterson, 2002).

Rheological properties

The viscosity of different Cassava starch salad cream samples with control were measured in triplicates at controlled temperature of 50^0C using a digital rotational Brookfield viscometer (Brookfield Engineering Laboratories, Middleboro, USA, Model DV – E). There readings were taken per samples at 20, 40 and 1 min rotation at each speed (30, 60 and 100 rpm). Spindle #4 was used for all measurements. A 600 ml beaker was used for the measurement with the viscometer guard leg on. The samples were poured into the beaker to reach a level that covers the immersion groove on the spindle shaft. All viscosity measurements were carried out immediately after preparing the salad cream.(Radomir, 2009)

Sensory Evaluation

Sensory evaluation carried out comprised of eight – man panelists, ranking method was used to make simultaneous comparison of samples on the basis of a single characteristic, colour, taste, texture aroma and sheen. IFT, (1964)

Statistical Analysis

Statistical analysis of data was with the Statistical Analysis Systems (SAS) package (version 8.2 of SAS Institute Inc 1999). Significant differences ($P<0.05$) were determined by Duncan Multiple.

Results and discussion

Physicochemical properties of Cassava starch based salad cream

Table 1 depicts the physicochemical properties of cassava starch based salad cream. Commercial salad cream was significantly higher in moisture (48.99%), titratable acidity (8.63%), total solids (61.92%), protein (1.61%), sugar (17.59%) and ash (2.75%). Higher values reported in this product is not unrelated to the difference in the method of preparation. Different methods of preparation affect the compositional attributes of any food product (Ashaye *et al* 2001, Saxema *et a*l 2009 and Vilai *et al* 2001)

Table 1: **Physicochemical properties of Cassava starch based salad cream**

Variety	Moisture content %	Dry matter %	Titratable Acidity	pH	Total solids %	Protein %	Sugar %	Starch %	Fat %	Ash %
96/01632	35.73^{b}	64.28^{a}	3.84^{b}	3.14^{c}	38.85^{b}	0.37^{b}	5.85^{b}	12.25^{a}	25.94^{ab}	1.74^{c}
98/0505	35.46^{b}	64.55^{a}	3.94^{b}	3.19^{b}	38.56^{b}	0.38^{b}	6.02^{b}	10.94^{ab}	28.71^{a}	1.75^{c}
TME419	35.44^{b}	64.57^{a}	3.75^{b}	3.23^{a}	37.89^{b}	0.39^{b}	4.37^{c}	10.64^{ab}	21.64^{b}	1.78^{b}
Commercial salad cream	48.99^{a}	51.01^{b}	8.63^{a}	3.07^{d}	61.92^{a}	1.61^{a}	17.59^{a}	8.03^{b}	6.66^{c}	2.75^{a}

Means in the same column having the same letter are not significantly different from each other at $P<0.05$

It was also seen that cassava based salad creams were not significantly different from each other in dry matter, titratable acidity, total solids and protein. Cassava salad creams processed from cassava varieties (96/01632 and 98/0505) are not significantly different from each other in sugar (5.85% and 6.02%) and ash contents (1.745 and 1.75%) at $p<0.05$.

Colour of Cassava Starch salad cream and control.

Table 2 shows the colour of cassava starch salad creams. L* values of the Cassava starch salad cream from cassava varieties 96/01632, 98/0505 and TME 419 was higher than control with values 85.17, 84.21 and 84.38 respectively. Control (commercial salad cream) was 77.28. These values showed an indication of the cassava starch base salad cream tending towards white colouration more than the control.

The b* value of the control salad cream was higher (27.53) compared to other cassava starch salad creams with increased prominent yellowish colouration.

The Hue and Chroma reveals the intensity of the colour pronounced by the L* and b* values (McWatters *et al*., 2001).

Table 2: Colour of Cassava Starch salad cream and control.

Varieties	L*	A*	B*	Hue (Rad)	Chroma
96/01632	85.17	-6	14.47	-1.17	15.77
98/0505	84.21	-3.98	15.26	-1.33	16.13
TME 419	84.38	-7.43	15.84	-1.13	17.59
Control	77.28	2.14	27.53	0.45	28.97

Viscosity properties of cassava starch based salad cream

Fig 3 indicates significant difference in the viscosity of the Salad cream prepared from cassava starches of 96/01632, 98/0505, TME 419 and control at different shear rates and temperature. There is a great interaction in their behavior. All exhibit a pseudo plastic behaviour (Non Newtonian behaviour) as the shear rate increase the viscosity decreases, highest viscosity was observed at lowest shear rate exhibiting a thinning properties. (Morris, 1989).

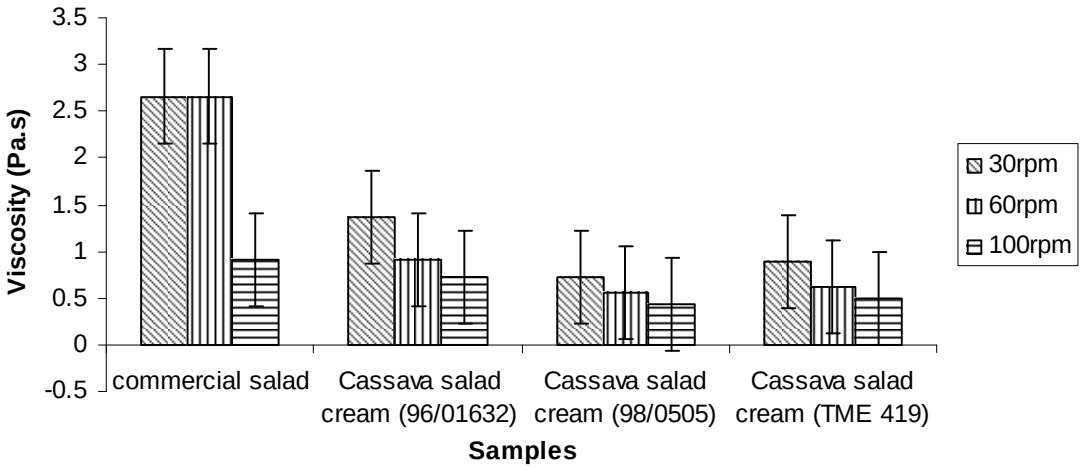


Fig 3: Viscosity of cassava starch based salad cream at 50^0C

The highest viscosity was observed with control cassava starch salad cream; this observation could be due to the modified corn flour and gums additives used in its preparation, Elder and Smith. (1969).

Sensory evaluation scores for cassava based salad cream

The sensory evaluation of cassava based salad cream was presented in table 3. The colour of commercial salad cream was (3.6) while there was no significant difference in the colour of other cassava based salad creams. The result showed increased likeness for the colour of cassava based creams. The consistency and odour of cassava salad creams from 96/01632 and 98/0505 were not significantly different. However the consistency of the commercial salad cream (Control) was highly accepted. There was no significant difference in the taste and sheen of all the salad creams.

Table 3 Sensory evaluation scores for cassava based salad cream.

Varieties	Colour	Consistency	Taste^{ns}	Odour	Sheen ^{ns}
96/01632	1.3b	1.8ab	1.9	2.0a	1.1
98/0505	1.4b	1.9ab	1.9	2.0a	1.1
TME 419	1.6b	2.0a	1.8	2.0a	1.2
Control	3.6a	1.4b	2.0	1.5b	1.3

Mean values having different superscripts within column are significantly different (P<0.05).

Conclusion.

It can be concluded that cassava based salad creams compared favourably with commercial salad in proximate composition and sensory attributes. Viscosities of the salad creams were also Non-Newtonian. Therefore, acceptable and nutritious salad cream can be processed from cassava starch.

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