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FUNDAMENTAL STUDIES OF THE CHARACTERISTIC PROPERTIES OF DIFFERENT CASSAVA FLOUR FOR ADHESIVE FORMULATION

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ABSTRACT

Flour from different varieties of cassava, a natural root tuber, grown at different locations in Ghana were analysed for their viscosity, pH and amylose contents.

The results showed a wide variation in the viscosities, ranging from 6400 to 24000cp. The pH varied from 6.75 to 10.2 while the percentage amylose varied from 10 to 20.

It has also been shown that sun drying had greater effect on the chemical and physical properties of the flour as compared with oven drying which had better properties. There was little change in the viscosity with storage for about three months.

INTRODUCTION

Cassava (*Mannihot esculenta,* Cranz) belongs to the family Euphobiaceae. It is cultivated throughout the tropical world for its tuberous roots from which cassava flour, breads, tapioca, laundry starch, alcohol and even an alcoholic beverage are derived. The genus has approximately 150 species. As the reserve food in plants, starch is a carbohydrate consisting of anyhydroglucose units linked together primarily thru alpha D (1- 4) glucosidic bond. It is chemically similar to cellulose. Thus starch, which is a polymeric polydroxyl compound, can be modified to produce adhesives with excellent affinity to polar substrates like wood and paper. This bonding is the result of both mechanical interlocking and interaction of secondary bond forces such as Van der Waals and hydrogen bonding. The abundance of hydroxyl groups imparts hydrophilic properties to starch. Cassava starch can therefore be used to act both as adhesive for wood and paper materials and as extender in adhesive mixtures for plywood production.

Extenders are non-volatile, paste forming ingredients normally containing starch or protein in natural or degraded state (Noller, 1963). They are added to reduce cost and improve the properties of the resins. In addition to the two advantages listed above, they improve the spreading and setting behaviour of resins and hold water at the glue line. They may reduce shrinkage stresses set up during the curing of the resin. The safe limit has been set at 25-30% of the whole adhesive mixture. The amount to be added differs considerably, depending on the density, particle geometry and more importantly on the chemical and physical composition of the extender and the adherents. Some of these extenders are wheat flour, tapioca, starch and the like. In Ghana, wheat flour is the preferred material. But it has been suggested that cassava flour could be tried in place of wheat flour.

Its use as extender is therefore to be compared with wheat flour, which has been the traditional material for this purpose. Table 1 gives the chemical composition of wheat flour, cassava flour and other starch containing materials. It shows that the chemical composition of wheat flour is not very different from that of cassava flour. The major difference is the amounts of protein, which is about 10% in wheat flour and only 0.6% in cassava flour. This is significant for Adams et al (1969) stated that wheat flour is a better material as an extender than the tuber starch because of the presences of protein in the wheat flour.

Table 1: Comparison of Chemical composition of cassava with those of other materials.

Material	Moisture %	Protein %	Ash %	Fibre %	Fat %	Starch %
Cassava	65	0.8-1.0	0.3-0.5	0.8	0.2-0.5	32
Cassava flour	15	0.5-0.7	0.3	0.5	0.2	85
Potato	17	2.1	1.0	0.7	0.1	20
Potato flour	15	-	0.3	0.4	0.3	82
Husked Rice	15	8.0	1.5	0.7-1.0	2.5	73
Wheat	9-18	8-15	1.5-2.0	2.0-2.5	1.5-2.0	65
Wheat Flour	14	8-13	0.3-0.6	0.1	0.8-1.5	68

The other significant properties, which show differences between cassava flour and wheat flour, are the % fat and % starch. Percentage fat is lower in cassava while % starch is higher in cassava. Thus in order to use cassava flour as extender its physical and chemical properties need be studied.
However, the physical and chemical properties of cassava, like most natural materials, would be influenced by genetic and site factors. Thus in this activity, various cassava varieties were analysed for their physical and chemical composition. It is also known that the method used in processing agricultural material do have effect on the composition of the final product. Processing procedures like: drying, mechanical treatment before drying, sieving and also the storage time, do have effect on the composition.

Mechanical treatment reduce the particle size and in so doing eliminate some minerals in the material. This would show up as differences in the ash content and also in the pH of the material.

The method of drying of the material has effect on the chemical composition, more especially if it is sun-dried against oven-dried. Lastly agricultural materials are biodegradable. Thus when stored over long periods undergo changes in their physical and chemical properties as a result of biological agents acting on the starch.

Thus the following physical and chemical properties: viscosity, pH and amylose and amylopectin ratios, of cassava flour were analysed with respect to the following:

i. The variety
ii. Site
iii. Drying procedure
iv. Time of storage.

Experimental Procedures

a. Raw material; the cassava flour and the starch for these studies were collected from Food Research Institute and from Ministry of Agriculture, Brong Ahafo Region.
b. Moisture content; this was determined by the oven-dried method at 70^{o}C. The m.c. was calculated from the difference in weight between the wet weight and the dried weight over the wet weight times 100.
c. Viscosity; this was measured with LVT2000 Viscometer. Fifty (50) grams of flour was stirred with 500mls of water and warmed to 60^{o}C for 10minutes. This solution was allowed to cool to 40^{o}C and the viscosity was measured with Spindle III at a shear rate of 1.5.
d. The pH; the solution from the viscosity measurement was used to determined the pH with a Hanna pH 210 meter.
e. Amylose:Amylopectin; Twenty grams of cassava flour was dissolved in water for 5minutes. This solution was saturated with normal butanol, which precipitated the A-fraction, known as amylose. Addition of methanol to the mother liquor precipitated the B-fraction, which is known as amylopectin.
f. Drying procedure; Oven-dried at 70oC for 48 hours and the sun-dried in the sunshine for a total of 96 hours at 8 hours per day.

Results and Discussion

Figures 1and 2 show the results of the physico-chemical properties studied. It shows a wide variation in the pH and viscosities. These differences could be attributed to the variety and the growing area. The viscosities ranged from as low as 6,400cp for Bosomensua from the Volta Region to 24,000cp for three varieties: Gblemoduade, Yebeshie and IITA. Based on our formulation studies, the ideal viscosity for cassava flour to be used in adhesive studies should be around 15000 ± 1000. This therefore means that Abasafitaa and Akosua Tumtum both from Brong Ahafo Region appear to be the best material for adhesive production. The Bosomensua from the Volta Region is a poor variety for adhesive work while the remainder could be used at a cost. It therefore becomes imperative to select the right variety for adhesive production. The pH values show variation between 6.75 to 10.20, but most of the varieties had neutral pH. Two varieties; Afisiafi (BA) and IITA had alkaline values while all the others were around neutral 7.00 ± 0.30. These could be attributed to the soils of the growing area.

Table 2 shows the ratio of amylose: amylopectin. This showed variation from 1:8 for Yebeshie (Pokoase) to 1:3.6 for Abasafitaa (BA). While the normal ratio reported is 1:79.

Fig 1 Variety of Cassva Flour Vrs Viscosity

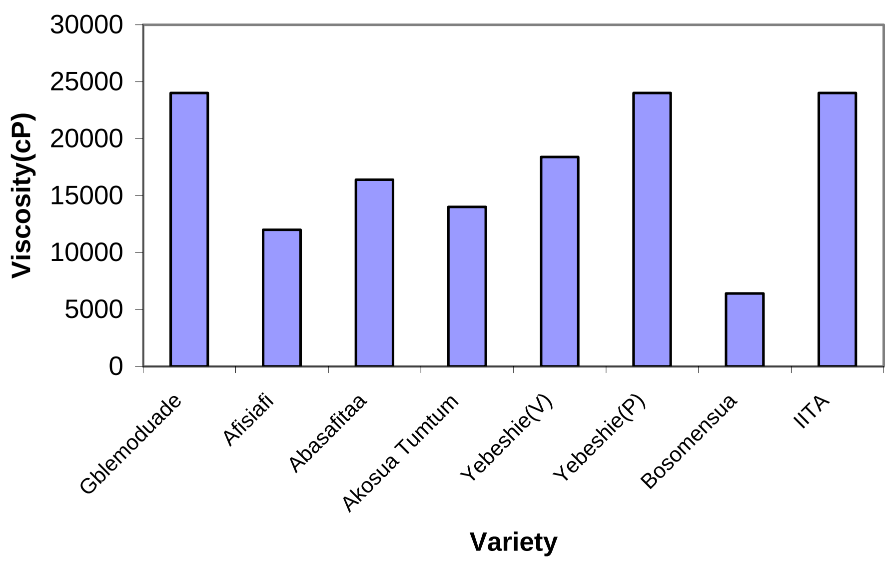


Fig 2 Variety of Cassva Flour Vrs pH

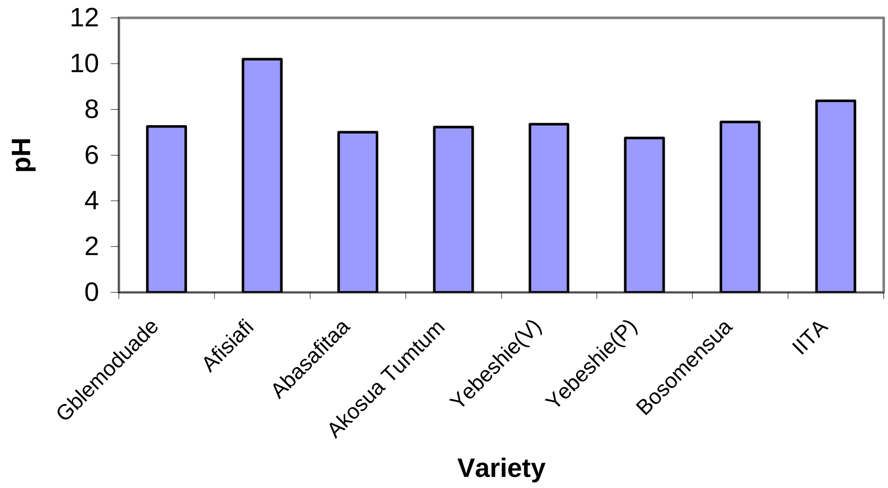


Table 2: Physical and Chemical Properties of Some Cassava Flour

Variety

Viscosity (cP)
Amylose %
Amylopectin %
pH of solution

GBLEMODUADE (ASH)

AFISIAFI (BA)

ABASAFITAA (BA)

AKOSUA TUMTUM (BA)

YEBESHIE (VR)

YEBESHIE (POKOASE)

BOSOMENSUA (VR)

IITA

24,000

12,000

16,400

14,000

18,400

24,000

6,400

24,000

10

20

20

10

10

20

20

10

85

80

72.5

80

80

75

75

88

7.25

10.20

7.00

7.23

7.35

6.75

7.45

8.37

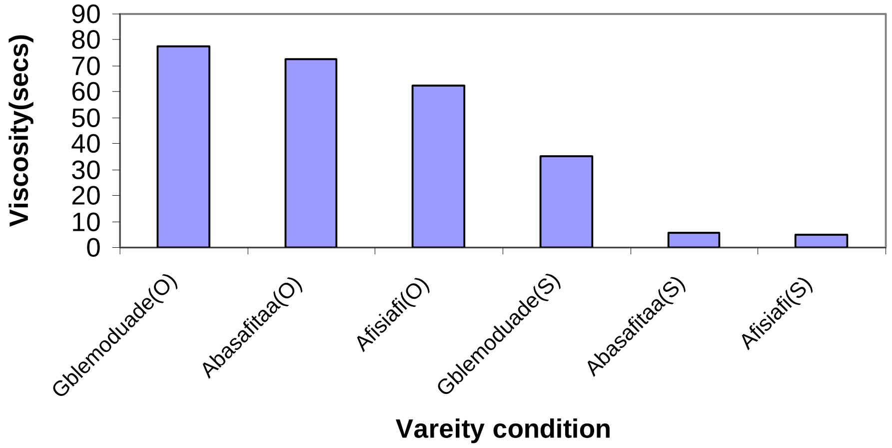
Figures 3 and 4 show the effect of processing on some physical properties of three cassava varieties. They show clearly that with sun drying, there is an increase in pH with a large decrease in viscosity. Table 3 shows a large increase in the percentage amylose of the oven-dried material over the sun-dried material. This shows that during the sun drying process, there is an increased hydrolysis of the B-fraction to the A- fraction and this probably would account for the decreasing viscosities. The low viscosities of the sun-dried material could be due to the longer drying period and the surrounding atmosphere, which might contain some microorganisms capable of hydrolysing starch and thereby reducing the viscosities and the B-fraction. The implications here are that while the oven-dried material appears to give better material, the cost of processing is high as compared to the sun-dried. Thus the selection of the variety and the method of processing should be adhered to in order to get a stable product for the adhesive mixture.

Table 3: Physical and Chemical Properties of three Varieties of Cassava at two Processing Operations.

Sample	PH	Amylose %	Viscosity (sec)
Gblemoduade (O)	7.14	41.3	77.50
Abasafitaa(O)	7.21	40.0	72.50
Afisiafi(O)	7.84	51.3	62.50
Gblemoduade (S)	10.33	37.5	35.00
Abasafitaa (S)	9.10	39.4	5.50
Afisiafi (S)	9.39	39.4	5.00

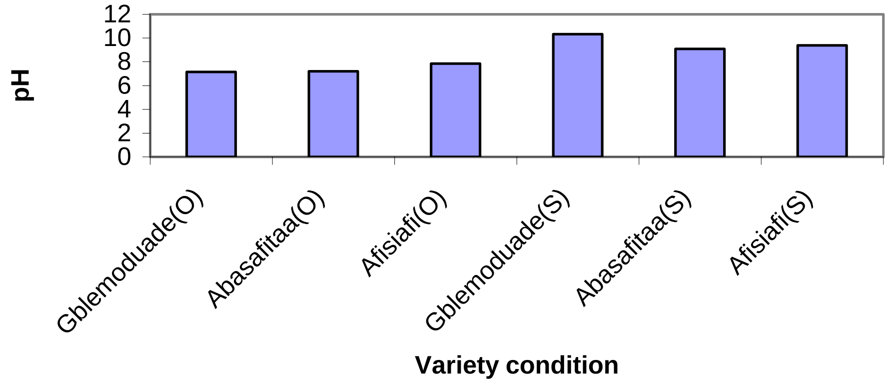
"O" Oven-dried
"S" Sun-dried

Fig. 3 Processing Operation of three variaties of Cassva Flour Vrs Viscosity



'O' Oven-dried 'S' Sun-dried

Fig. 4 Processing Operation of three of variaties of Cassava Flour Variety Vrs pH



'O' Oven-dried
'S' Sun-dried

Storage Time:

As seen in table 4, there was very little change in the viscosities of the material stored in plastic bags and at room conditions, for a period of three months.

Table 4: Viscosity (cp) of two varieties of cassava flour changes with number of days.

Number of Days	Abasafitaa	Gblemoduade
0	16400	24000
14	16000	23500
28	16100	23800
42	16400	24000
56	16100	24500
70	16100	24000
84	15800	24000

CONCLUSIONS

That the physical and the chemical properties of cassava: viscosity, pH and amylose contents are varied as a result of place of cultivation and variety.

That the method of drying, i.e. sun drying and oven drying, has effect on the properties of cassava flour with the oven drying showing better properties than the sun drying.

It has also been shown that three (3) months of storage of cassava flour under normal room conditions did not affect the viscosity of the flour.

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