



Production of Adhesive from Cassava Starch in Owerri, Imo State, Nigeria

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ABSTRACT

In this work, the potentials of adhesives production from cassava starch were investigated. An adhesive product produced from *Manihot utilissima* was compared with a commercially available adhesive. Improvements in the properties of the cassava-based adhesive were achieved by investigating the effects of temperature and the addition of a viscosity enhancer/stabilizer (borax) on the density of the produced adhesive. The results obtained provide a wide range of insight into the production potentials of using cassava starch as a raw material in the production of large scale adhesives

Keywords: Cassava, Starch, Adhesive

1. INTRODUCTION

Cassava, a relatively unknown crop in the old world before the discovery of America is fast assuming the status of the saviour of the world, as it is second to potato as the most important starchy root crop of the tropics used for food and industrial purposes. In Nigeria, it is consumed raw or cooked, used for the manufacture of garri, starch flour and a variety of other items. The current drive towards earning foreign exchange from cassava products in Nigeria had raised more awareness on the importance of the crop.

It is estimated that the crop provides about 40% of all calories consumed in Africa. Cassava derives its importance from the fact that its starchy thick tuberous roots are valuable source of cheap calories, especially in developing countries where calories deficiency and malnutrition are wide spread. Cassava originated in north east Brazil with the likelihood of an

additional centre of origin in Central America. From its place of origin, the plant has spread to various parts of the world. Cassava is a crop of low land tropics; it does best in warm, moisture climate, where mean temperature ranges from 19-25 °C and when the rainfall is 100-150 cm per year and well distributed.

However, the secondary product (cassava starch and milk) from the product of garri (the most important food item from cassava in Nigeria) is not properly utilized in most processing industries. These products are just drained off without any thought for their utilization especially in the rural areas. It is in the light of this and the fact that this cassava is readily available; these studies were conducted to investigate the possible utilization of cassava starch as a binding material (adhesive).

1. 1. Starch

Starch is a carbohydrate consisting of a large number of glucose units joined by glycosidic bonds. This polysaccharide is produced by most green plants as an energy store. It is the most common carbohydrate in human diets and is contained in large amounts in staple foods such as potatoes, wheat, maize, rice and cassava. Pure starch is a white, tasteless and odourless powder that is insoluble in cold water or alcohol. In a recent research conducted by explained that, starch is the principal energy storage polysaccharide in photosynthetic plant. Most starches have two structurally different forms – amylose, a linear polymer having degrees of polymerization between 100 and 6,000 and a high concentration of amylopectin, a highly branched fraction. Branches in amylopectin are 12 to 15 glucose residues in length and occur at every sixth to twelfth backbone residue. Starch is the major component of flour, potatoes, rice, beans and corns. It is a mixture of two different polysaccharides.

1. 2. Adhesives

An adhesive is any substance applied to the surfaces of materials that binds them together and resists separation without deformation through a process called adhesion. Throughout most of the 8,200 year history of adhesives, natural sources have dominated the adhesive chemist's stockpile of raw material. Not until, well in the 20th century did synthetic raw material sources become important part of the adhesive formulator's bag of tricks.

1. 3. Objectives of the Work

- i. Production of adhesive from cassava starch
- ii. Comparing the adhesive produced with the commercially available adhesive; to ascertain the potential of using cassava starch in a large scale production of adhesive.
- iii. To determine the effect of temperature on the density of the produced adhesive

2. MATERIALS AND METHODS

2. 1. Reagents

All the equipment used for this study were in good working condition and the chemicals used include Hydrochloric acid (HCl), sodium tetraborate ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$), Starch ($\text{C}_6\text{H}_{10}\text{O}_5$), Formalin and Water (H_2O).

2. 2. Extraction of Starch from Cassava Tuber

Tubers of cassava (*Manihot utilissima*) were harvested from Onyema's farm, Umuguma, Owerri-west L.G.A Imo State. The cassava tubers were peeled, to remove the brownish scaly flesh. The peeled cassava were carefully washed and sent to a milling center where grinding took place. At the end of the grinding, the slurry was carefully and selectively milled to obtain a fine seepage of the cassava. Allowing the seepage to stand for 3-4 hours, separates water from the starch sediment. At the end of the separation, decanting separates water from the starch sediment. The resultant wet starch is sun dried and later sent to the oven for optimum drying. Oven dries the starch at a temperature of 45 °C for 6-10 hours.

2. 3. Production of Adhesive from Cassava Starch

5 grams of dried cassava starch from *Manihot utilissima* in 50 cm³ of 0.1M hydrochloric acid (HCl) solution was heated on a magnetic stirrer with heater to a temperature of 100 °C (for the first production). It was allowed to cool to a lower temperature of 75 °C. At this temperature, sodium tetraborate (Borax) was added in a drop wise manner with continuous stirring. The addition was continued until the product became sticky. This was repeated at various temperatures of (75, 70, 65, 60 and 55) to determine the most suitable stabilization temperature; its effect on the density of the adhesive and the best sodium tetraborate requirement. Formalin was added at the end of the production as a preservative.

3. RESULTS

Table 1. The result of the adhesives produced.

Weight of starch (g)	Vol of HCl (cm ³)	Vol of borax (g)	Stabilization temperature v	Produced volume (ml)	Heating/gelation temperature (°C)	Density (g/cm ³)	Nature
5	50	0.15	75	45	100	1.025	Watery
5	50	0.13	70	50	80-82	1.027	Sticky
5	50	0.10	65	50	80-82	1.029	Sticky
5	50	0.08	60	47	80-82	1.031	Sticky
5	50	0.07	55	49	80-82	1.035	Sticky

Table 2. The properties of the adhesive produced.

Colour	White
Solubility in water	Insoluble
Solubility in Alcohol	Insoluble
Molar mass	Variable
Molecular mass	(C ₆ H ₁₀ O ₅) _n
Nature	Sticky in nature

Table 3. Showing the comparison of the adhesive produced with the commercially available adhesive.

	Produced Adhesive	Commercial Adhesive
Binding strength	Weaker binding or adhesive strength	Stronger binding or adhesive strength
Colour	Milky white	Brownish
Durability	19-21 days	Above 19-21 days because it has been treated

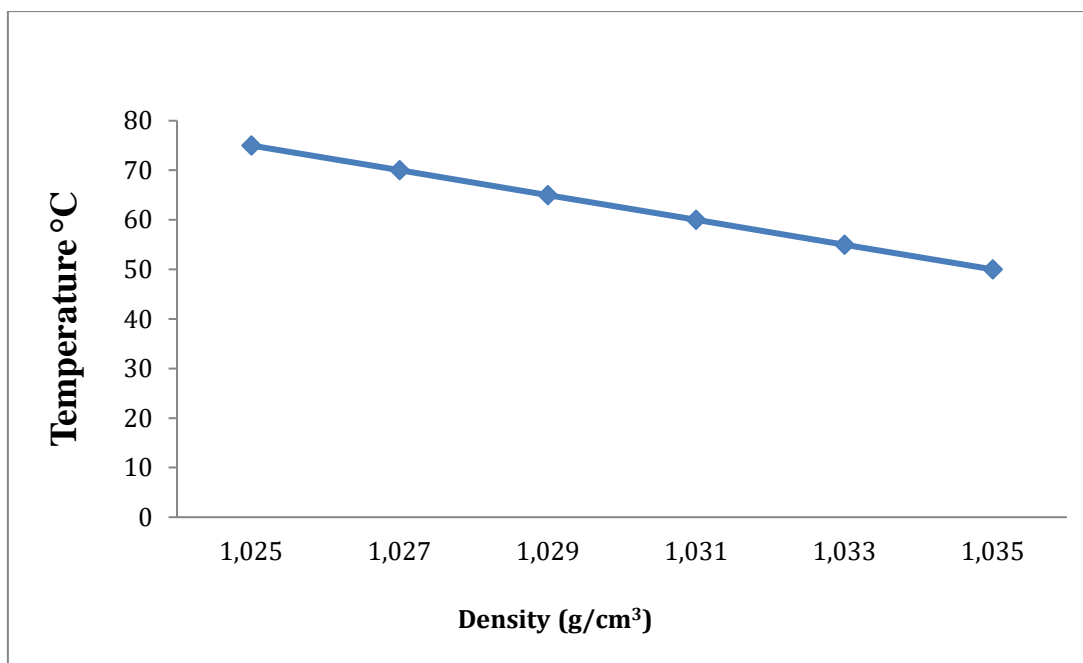


Figure 1. A graph of density against the temperature of adhesive produced).

3. 1. Tensile Strength of the Product on Different Materials

Few milliliters of the adhesives were robbed on different material surfaces such as paper, wood, plastic, glass. The cassava adhesive was found to posses' very high adhesive strength on the above materials. Based on this, the materials were stuck as follows: paper-paper, paper-glass, paper-wood. The adhesive had a very high binding property on the materials; especially on the paper-paper surfaces. However, there was a slight difference in adhesion between paper-glass surfaces. These results were obtained after 30 mins to 72 hours of drying under the sun followed by the separation of the bound materials with some amount

of force. The adhesive produced is a white/milky substance with a choking smell which is insoluble in alcohol and water. It is sticky, but has a limited binding strength on comparison with commercially available adhesive.

4. DISCUSSION AND CONCLUSION

It was discovered that adhesive produced from cassava (*Manihot utilisima*) retained a longer stability. This could be attributed to effect of higher cyanide content of *Manihot utilisima*. From the result of the experiment, the density of the produced adhesive decreased with increasing temperature.

4. 1. Observations and recommendation

For the first production, using 0.1 M HCl and 5 g of starch with 0.15 g of borax, the solution became cloudy and sticky(viscous) at the temperature of 70 °C. A little rise in temperature of about 71-75 °C, produced a colourless solution at the base of the conical flask. A somewhat liquid, less viscous mixture was noticed at 80 °C; which later assumed a partial foamy form with a milky suspension at 82 °C. Heating to a high temperature of 100 °C made the mixture assume a watery form. At this stage, allowing the mixture to cool to a lower temperature of 75 °C before the addition of 0.15 g of borax had no meaningful effect on the visual viscosity of the adhesive. It could be deduced that borax has no significant effect on cassava starch at a very high temperature of say, 100 °C. Cassava starch, which is readily available, was used to produce non-structural adhesives. Certain conditions that could give optimum production had been specified using the obtained adhesives produced from starch. Cassava starch is a good source of cheap and readily available adhesives thus saving the industries from spending foreign exchange on importation. Cassava starch adhesive is mostly preferred and used in the paper packaging industries because of its high binding strength.

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