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GEL CONSISTENCY, VISCOSITY AND AMYLOSE CONTENT OF CASSAVA FLOUR

(Consistance en colloïde, viscosité et contenu en amylose de la farine de manioc)

Aurea M. ALMAZAN
International Institute of Tropical Agriculture
PMB 5320, Oyo Road, Ibadan, Nigeria

SUMMARY

Qualities of processed products from cassava tubers and flour depend on the varieties or lines used. Rapid screening methods for these qualities are being developed based on their correlations with some chemical and physical properties of the flour. Paste viscosity values obtained from the Brabender viscograph and amylose content were correlated to gel consistency. Maximum paste viscosity and setback viscosity correlate negatively with gel consistency while amylograph consistency correlates positively with gel consistency. A simple method of determining gel consistency and its application in screening cassava lines are described.

RESUME

Les qualités des produits de la transformation des tubercules de manioc et la farine dépendent des variétés et des clones utilisés. Des méthodes rapides de sélection pour ces qualités sont décrites avec pour base leurs corrélations avec quelques propriétés chimiques et physiques de la farine. Les valeurs de la viscosité de la pâte obtenues au viscographe de Brabender et le contenu en amylose ont été corrélés à la consistance en colloïde. La viscosité maximum de la pâte et la viscosité de tassement sont en corrélation négative avec la consistance en colloïde tandis que la viscosité au viscographe est en corrélation positive avec la consistance en colloïde. Une méthode simple de détermination de la consistance en colloïde et son application pour la sélection de clones de manioc sont décrites.

INTRODUCTION

Few investigations on the viscosity, gel consistency and amylose content of cassava flour and starch have been made. RASPER (1969) determined the viscosity changes and gel consistency of starches from different major starch crops in Ghana. However, gel consistency of the cassava starch was too low to be measured by the FIRA jelly tester. He was not able to evaluate the values for cassava.

In a study correlating chemical and rheological properties and quality of cassava tuber and gari, OLORUNDA et al., (1981) noted that cultivars with high amylose content also had high starch maximum paste viscosity. The number of clones used was five, too small to establish any relationship. CIACO and D'APPOLONIA (1977) obtained amylose content and maximum paste viscosity of cassava, yam, arrowroot and wheat starches and related the latter parameter to bread quality.

In the Root and Tuber Improvement Program of IITA, chemical and physical properties, specially rheological properties, of the flours and starches from different cassava clones are being determined and correlated to certain qualities of the tuberous root and its processed products. Rapid screening methods are being developed based on these correlations. This paper presents results from studies on viscosity, amylose content and gel consistency of cassava flour and their correlations.

MATERIALS AND METHODS

Preparation of Cassava Flour

Flours were prepared from 31 IITA clones (Table 1). Tubers from 12-month-old plants were washed, peeled, re-washed, cut into thin chips, dried to less than 10 per cent moisture at 55°C and ground in a Wiley mill (0.5 mm sieve).

Viscograph of Cassava Flour

The viscosity of cassava flour paste was measured with a Brabender viscograph. Fifty grams flour were suspended in 450 ml distilled water, then poured into the measuring vessel. Change in viscosity at 75 rpm was continuously recorded using a 700 cmg measuring box. Temperature was increased from 25°C-95°C at 1.5°C/min, kept at 95°C for 20 min., lowered to 50°C at the same rate, then maintained at 50°C for 20 min. Values read from the viscograph were maximum viscosity, viscosity at 95°C, and viscosity at 50°C.

Gel Consitency Determination

Gel consistency is defined as the length of gelatinized cassava flour paste in a test tube after cooling to room temperature. This definition and the method for its determination are essentially those used for milled rice (CAPAMPANG et al., 1973). Flour (0.15 g) was weighed into lipless 13 mm x 100 mm test tubes, wet with 0.1 ml 0.025 per cent thymol blue in 95 per cent EtOH and suspended in either 2.0 ml distilled water or 2.0 ml 0.2 N KOH using a Vortex-Genie mixer. The tubes were immediately covered with marbles and placed in boiling water. After 5 min., these were removed from the bath, re-mixed and cooled for 15 min. in ice-water. These were laid flat on graphing paper mounted on a table. Gel length in mm was read after 30 min.

Amylose Assay

The procedure of JULIANO (1971) based on WILLIAMS et al., (1958) for amylose assay was modified. Flour (100 mg) was weighed into a 100 ml volumetric flask, wet with 1.0 ml 95 per cent EtOH, then suspended in 9 ml 1 N NaOH. After standing overnight, the suspension was placed in boiling water bath for 30 min., cooled then diluted to 100 ml with water. To a 2-ml aliquot in a test tube, the following were added successively, mixing after each addition : 1.0 ml 0.1 N HCl, 0.4 Ml 0.2 per cent I in 2 per cent KI, 8.0 ml H O, 0.5 ml 0.1 N HCl, and 8.0 ml H O. After 20 min., the absorbance was read at 590 nm. Blank and standard solutions of potato amylose (0.1-0.4 mg/ml) were treated similarly.

RESULTS AND DISCUSSION

A characteristic viscograph of cassava flour is shown in Figure 1. Paste viscosity started increasing at the pasting temperature which ranged from 63 to 72°C. At this temperature, appreciable granule swelling had occurred and viscosity was sufficient to be recorded by the viscograph (LEACH, 1965 ; MYERS and KNAUSS, 1965). Viscosity rapidly rose to a peak value due to swollen starch granule resistance. At this time, a dynamic situation prevailed where some granule resistance. At this time, a dynamic situation prevailed where some granules were still swelling while others were disintegrating under the influence of heating and stirring. Maximum viscosity was obtained when the increase in structural viscosity caused by swollen starch aggregates was balanced by the decrease in viscosity due to disintegration and solubilization of the starch. The temperature at maximum viscosity for cassava flours ranged from 72 to 93°C. Disintegration and solubilization of the granules predominated as temperature was increases to 95°C, then maintained at 95°C for 20 min.,

TABLE 1 : IITA CASSAVA CLONES USED IN PREPARING FLOURS

TMS 518	TMS 30572	TMS 63397
TMS 1525	TMS 42055	TMS 84261
TMS 8010	TMS 50395	TMS 91142
TMS 8034	TMS 53101	TMS 91934
TMS 8042	TMS 53101	TMS 4(2)0156
TMS 30001	TMS 58308	TMS 4(2)0267
TMS 30040	TMS 60142	TMS 4(2)0378
TMS 30474	TMS 60447	TMS 4(2)0780
TMS 30555	TMS 60506	TMS 4(2)1425
	TMS 61677	

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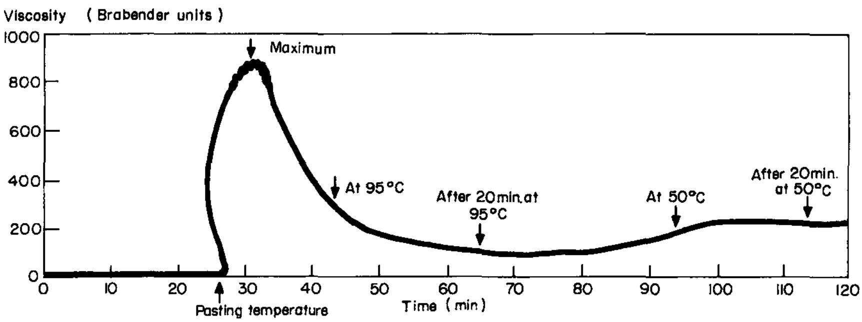

Fig. 1: Viscograph of cassava flour

resulting in decrease viscosity. When the paste was cooled to 50°C, the swollen granule fragments, and the colloidally and molecularly dispersed starch molecules tend to associate or retrogade resulting in increased viscosity, and continued up to 20 min. when the trial ended.

The gel consistency test developed for milled rice (CAGAMPANG et al., 1973) used gel length as an index of cold pasted consistency. Together with amylose content, it is used to determine cooled rice texture in screening for eating quality preferences in the rice breeding program (PEREZ, 1979). Rice gels in 0.2 N KOH were generally more stable to liquid phase separation than gels in water. In this study, both water and 0.2 N KOH were used as solvents. Figures 2 and 3 show the gel lengths of flour from several cassava clones in KOH and in water. Gels in 0.2 N KOH were blue, those in water were yellow-orange. The flour suspension in H O was pH 6.

The distribution of amylose content in the 31 cassava clones is shown in Figure 4. Values ranged from 13 to 25 per cent with most the values in a narrow range of 15-25 per cent.

Correlation coefficients among amylose content, gel lengths in KOH and in water, maximum paste viscosity, setback viscosity and amylograph consistency were determined. Setback viscosity is the difference between maximum viscosity and viscosity at 50°C. Amylograph consistency is viscosity on cooling to 50°C minus viscosity at 95°C. Both measure the tendency of the gelatinized starch to retrogade on cooling.

Amylose concentration did not correlate with gel lengths and the viscosity parameters. No correlation was found between gel length in 0.2 N KOH and any of the viscosity values. However, gel length in water was either highly significantly or significantly correlated with maximum and setback viscosities and amylograph consistency.

Maximum paste viscosity was negatively correlated with gel length in water (r= -0.6911**) as shown in Figure 5. Gel consistency of cassava flour can, therefore, be used as an index of its maximum paste viscosity. It can be used to screen cassava clones for high maximum paste viscosity. Such clones are suitable for cassava breads with pentosan (ALMAZAN, 1985).

Gel length in water was also negatively correlated with setback viscosity (r=-0.5501**) (Fig. 6). Clones with lower gel length have a greater tendency to retrogade on cooling. A positive correlation between gel length and amylograph consistency (r=0.45007*) was obtained (Fig. 7). This also showed that clones with lower gel consistency tend to retrogade more on cooling. With rice, lower gel consistency tend to retrogade more on cooling. With rice, lower gel consistency samples have a harder cooked texture (PEREZ and

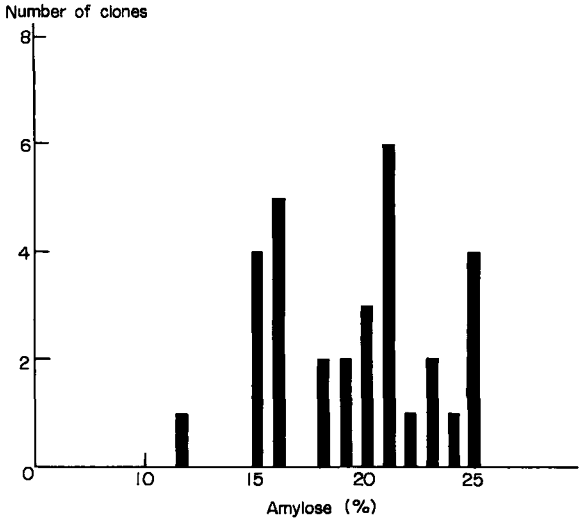

Fig.2 :Amylase concentration of cassava flours (n=31)

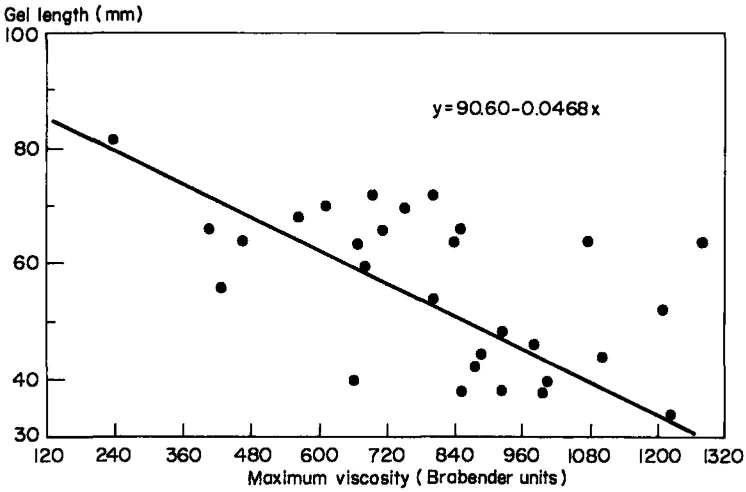

Figure 3

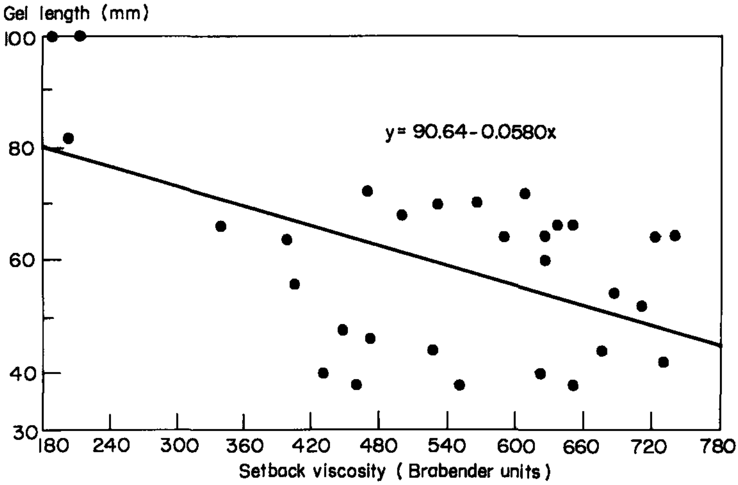

Figure 4

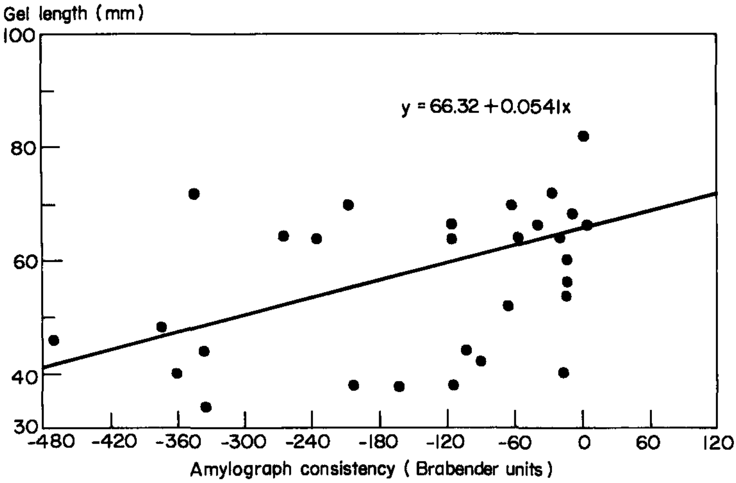

Figure 5

JULIANO, 1979). Whether such a relationship is true between gel consistency of cassava flour and texture of some processed cassava products such as fufu will be investigated.

Gel consistency of cassava flour can, therefore, be used as a tool in assessing same flour qualities of cassava clones particularly those dependent on rheological properties of the starch because it is correlated with maximum paste viscosity, setback viscosity and amylograph consistency.

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