

Effect of Potassium Carbonate (K_2CO_3) on the Viscosity and Related Physico – Chemical Properties of *Genger (Bombax costatum)* Powder during Storage

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ABSTARCT

Effect of storage and concentration of potassium carbonate (K_2CO_3) on the viscosity and related physico – chemical properties of *genger (Bombax costatum)* powder was determined. *Genger* powder was stored for a period of four (4) months (May-August) at $30^\circ C \pm 5^\circ C$ under varying concentrations of K_2CO_3 : 0%, 5%, 10% and 15% in two containers (plastic, giving samples A – D and metal tins, giving samples A₁ – D₁). Thereafter, the moisture and crude fat contents, water absorption capacity, least gelation concentration, effect of K_2CO_3 concentration on gel strength and viscosity of the stored powders were determined, using standard methods of analysis, with fresh powder (analyzed before storage) as control. Moisture content decreased significantly ($p < 0.05$) from 8.37% to 3.04% and 2.00% in samples D and D₁ respectively, while crude fat content increased significantly ($p < 0.05$) from 2.50% to 7.50% and 10.05% in the same samples. Water absorption capacity also increased significantly ($p < 0.05$) from 6.4g/g to 6.40g/g in the fresh sample to 7.30g/g and 8.30g/g in samples D and D₁ respectively. Gelation capacity increased considerably, with 15% K_2CO_3 giving very strong gels at 1.50% concentration. The overall viscosity increased significantly ($p < 0.05$) with increase in concentration of (K_2CO_3) from 64.00FN to 110.00FN after storage. Generally, samples stored in metal tin gave better results than those in the plastic container.

Key words: (*Bombax costatum*), Calyx, Potassium carbonate, Potash, Natural gums, Edible gums, Storage, Viscosity.

INTRODUCTION

Natural gums are polysaccharides of natural origin, capable of causing a large viscosity increase in solution, even at small concentrations¹. In the food industry they are used as thickening agents, gelling agents, emulsifying agents, and stabilizers. In other industries, they are also used as adhesives, binding agents, crystal inhibitors, clarifying agents, encapsulating agents, flocculating agents, swelling agents and foam stabilizers². Most often these gums are found in the woody elements of plants or in seed coatings and are edible in different forms³.

There are many types of edible gums, such as Gum Arabic, Gum Tragacanth, which are complex mixture of glycoproteins and

polysaccharides and are used in confectionery to gel or to set liquids to various degrees of viscosity⁴. Edible gums like xanthan gum and gelatin are used to thicken and or hold emulsions together in a food system such as a sauce. Many other types of edible gums have similar or slightly different uses in processed foods. For example, gums can help to hold moisture into injected meats. Many of these gums are used along with starches⁵.

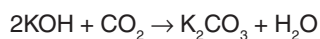
In many cultures in the developing countries (especially Africa), there exists a number of traditional foods, which are swallowed without mastication. Such foods include the popular pounded yam, *akpu*, *amala* and other types of food prepared and molded from tubers and roots such as yam and cassava as well as cereals like maize, sorghum and millet. Such foods are usually

swallowed with the aid of viscous slippery soups and stews (edible gums), generally referred to 'draw soups', which aid peristalsis. Examples of such soups include: okra, *ewedu*, *okoho*, *ager* and *ive* which are consumed in different parts of Nigeria. One of the very popular 'draw soups' in Tiv land is *genger*, a soup (edible gum) prepared from the calyx of the flowers of the plant *Bombax costatum*⁶, the flowers of which when fully developed, consist of red petals fused into a round calyx, which is attached to the stalk of the plant.

Genger soup, which is a delicacy in the Tiv speaking area of central Nigeria, has high viscosity or gelling capacity from November to February/March (dry season) depending on how soon the rains come. During this period, it can be produced from either the fresh or dried calyx, the latter of which can be stored for future use, when the plant stops producing flowers. However, as soon as the rains start, the soup from the dried calyx powdered *genger* loses its gelling properties and viscosity⁶. This has been attributed to high moisture content⁷ as a result of absorption of moisture from the atmosphere. When this happens, *genger* becomes inedible and is therefore wasted.

Oral communication (Hannah, A. D. Nyakuma, 2010) indicates that storage of *genger* powder inside dark coloured polyethylene bags in air – tight containers with addition of *kaunwa* or potash (Potassium carbonate) helps to maintain its gelling capacity, even during the rainy season.

Potassium carbonate (K₂CO₃) also known as potash or pearl ash is a white salt, soluble in water (insoluble in ethanol), which forms a strongly alkaline solution. It can be made as the product of potassium hydroxide's absorbent reaction with carbon dioxide. It is deliquescent, often appearing as a damp or wet solid. Potassium carbonate is used in the production of soap, glass and china⁸. Today, potassium carbonate is prepared commercially by the use of potassium chloride. The resulting potassium hydroxide is then carbonated using carbon dioxide to form potassium carbonate, which is often used to produce other potassium compounds⁹.



Potassium carbonate is used in reactions to maintain anhydrous conditions without reacting with the reactants and product formed. It may also be used to dry some ketones, alcohols, and amines prior to distillation⁸. In the laboratory, it may be used as a mild drying agent where other drying agents, such as calcium chloride and magnesium sulfate, may be incompatible. It is not suitable for acidic compounds, but can be useful for drying an organic phase if one has a small amount of acidic impurity⁹.

The objective of this work, therefore, was to determine the changes in the viscosity and related physico – chemical properties of *genger* (*Bombax costatum*) soup prepared from dried calyx powder stored with varying quantities of potassium carbonate (K₂CO₃).

MATERIALS AND METHODS

Source of raw materials

Fresh flowers of *Bombax costatum* (December, 2010 harvest) were collected from a tree in the University of Agriculture, while potash (Potassium carbonate), low density polyethylene bags and air tight plastic containers were purchased from a local chemical shop in Makurdi. Empty metal tins were collected from a residential home in Makurdi.

Sample preparation

The fresh calyxes were removed from the flowers, washed clean with tap water and sun dried to a moisture content of about 10.0%. The dried calyxes were then milled into powder using an attrition mill (Asiko All) and analyzed immediately. Thereafter, two sets of four samples of the powder (100g each) were blended with varying quantities of potassium carbonate (0.0g, 5.0g, 10.0g and 15.0g) to give 0.0% (control) 5.0%, 10.0% and 15.0% respectively. The samples were then stored inside dark – coloured low density polyethylene bags at ambient conditions (30 – 35°C) for four months (May - August). While one set was stored in an air tight plastic container (samples A, B, C, D), the other set was stored in an air tight metal tin (samples A₁, B₁, C₁, D₁), from where samples were taken for analysis.

Analyses

Physico – chemical analysis

Moisture and crude fat contents were determined by the method of AOAC¹⁰. While Least Gelation Concentration (LGC) was determined by the method described by Onweluzo *et al.*,¹¹, Water Absorption Capacity (WAC) was determined using the method described by Okezie and Bello¹². The viscosity of the samples was determined using the Falling Number method as described by Sultan¹³. In this method, twenty grams (20g) of *genger* sample was suspended in distilled water in a 250ml measuring cylinder, immersed in a boiling water bath and stirred for exactly 60 seconds. A plunger (7g mass) was then allowed to fall freely through the suspension in a fixed distance and the falling time (FT) was recorded. Falling time (FT) is the time in seconds for the plunger to fall through the fixed distance.

FN = FT + 60 (Where: FN = Falling number, 60 = a constant).

Statistical analysis

Data obtained was analyzed statistically using analysis of variance (ANOVA) at 5% probability level as described by Steele and Torrie¹⁴. Where significant difference existed, Tukey's Test was used to separate the means as described by Ihekoronye and Ngoddy¹⁵.

RESULTS AND DISCUSSIONS

Chemical properties

Results of the chemical properties determined are presented in Table 1. There was a decrease in moisture content of the *genger* powder with storage and increase in quantity of potassium carbonate (K_2CO_3) from 8.30% in the fresh sample to 3.00% and 2.00% in samples D and D₁ (with 15% K_2CO_3). Among the samples themselves, moisture content decreased from 7.00% to 3.00% in sample A to D (samples stored in plastic) and from 6.00% to 2.00% in A₁ to D₁ (samples stored in metal tin). This could be as a result of absorption of moisture from the *genger* powder by potassium carbonate (K_2CO_3).

Leonard *et al.*,⁹ postulated that potassium carbonate could be used in reactions to maintain

anhydrous conditions without reacting with the reactants and product formed.

There was a significant difference between the samples themselves at ($p < 0.05$) but no significant difference ($p > 0.05$) between the storage containers. Moisture content affects the viscosity of fluids. The higher the moisture content, the lower the viscosity and lower the moisture content, the higher the viscosity. This is ascribed to decrease in polymer concentration⁷.

The crude fat content of the *genger* samples increased significantly ($p < 0.05$) with storage from 2.50% in the fresh sample to 7.50% and 10.05% in samples D and D₁ respectively. This could be as a result of concentration effect occasioned by the reduction in the moisture content of the samples. There was also a significant ($p < 0.05$) increase in the fat content of the samples themselves, with values ranging from 2.50% to

Table 1: Some chemical properties of fresh and stored 'genger' (*Bombax costatum*) powder

Sample	Moisture (%)	Crude fat (%)
Fresh	8.37 ± 0.20 ^a	2.50 ± 0.06 ^f
A	7.00 ± 0.15 ^b	2.50 ± 0.10 ^f
A ₁	6.20 ± 0.30 ^c	3.52 ± 0.08 ^e
B	6.00 ± 0.25 ^c	5.00 ± 0.56 ^d
B ₁	4.35 ± 0.10 ^d	7.50 ± 0.12 ^c
C	4.52 ± 0.22 ^d	5.50 ± 0.05
C ₁	3.10 ± 0.24 ^e	8.65 ± 0.20 ^b
D	3.04 ± 0.20 ^e	7.75 ± 0.10 ^c
D ₁	2.00 ± 0.16 ^f	10.05 ± 0.20 ^a
LSD	0.35	0.25

Values are means ± standard deviation of triplicate determinations.

Means with different superscripts within the column are significantly different ($p < 0.05$)

Legend:

Fresh = Genger powder analyzed before storage

A, B, C, D = 'Genger' stored with 0.0%, 5.0%, 10.0%, 15.0% K_2CO_3 respectively in plastic container

A₁, B₁, C₁, D₁ = 'Genger' stored with 0.0%, 5.0%, 10.0%, 15.0% K_2CO_3 respectively in Metal tin

LSD = Least Significant Difference

7.50% for samples A to D and 3.50% to 10.05% for samples A₁ to D₁. This could be attributed to the drying action of the potassium carbonate. Fat is a necessary component of living tissues and essential in human nutrition. Because it can be stored and be mobilized, it is the prime reserve material for the body¹⁶.

Physical properties

Table 2 presents the results of some physical properties of fresh and stored *genger* samples. The water absorption capacity (WAC) increased with storage from 6.40g/g in the fresh sample to 7.30g/g and 8.30g/g in samples D and D₁ respectively. There was also an increase in WAC with increase in potassium carbonate (K₂CO₃) with values ranging from 6.80g/g to 7.30g/g for samples A – D and 6.92g/g to 8.30g/g for samples A₁ – D₁.

This is expected because as the samples become drier as a result of storage with K₂CO₃,

there is a greater tendency to absorb water. There was however, no significant difference ($p > 0.05$) in water absorption capacity between the samples themselves and the packaging materials. Water absorption capacity represents the ability of a product to associate with water under conditions where water is limiting. In food processing, a high water absorption capacity results in a product with excellent body, smooth, fine texture and chewiness capacity especially in ice cream¹⁷.

The viscosity of the *genger* samples increased significantly ($p < 0.05$) with storage and increase in concentration of potassium carbonate (K₂CO₃). While the viscosity increased from 64.00FN in fresh *genger* sample to 72.00FN and 110FN in D and D₁ respectively, it increased from 64.00FN to 72.00FN in samples A – D and from 69.00FN to 110.00FN in samples A₁ – D₁, thus showing a better viscosity in samples stored in metal tin. This could be as a result of the decrease in moisture caused by storage with K₂CO₃. Wang *et al.*,⁷ reported that the viscosity of

Table 2: Some physical properties of fresh and stored 'genger' (*Bombax costatum*) powder

Sample	Water Absorption Capacity (g/g)	Least Gelation Concentration (%)	Viscosity (FN)
Fresh	6.40 ± 0.30 ^e	1.00 – 1.50	64.00 ± 0.52 ^g
A	6.80 ± 0.40 ^d	1.00 – 1.50	64.00 ± 0.45 ^g
A ₁	6.92 ± 0.42 ^c	1.00 – 1.50	69.00 ± 0.42 ^e
B	6.86 ± 0.35 ^d	1.00 – 1.50	67.00 ± 0.40 ^f
B ₁	7.06 ± 0.24 ^c	1.00 – 1.50	70.00 ± 0.50 ^d
C	7.04 ± 0.20 ^c	1.00 – 1.50	69.00 ± 0.32 ^e
C ₁	7.82 ± 0.22 ^b	1.00	71.00 ± 0.30 ^c
D	7.30 ± 0.30 ^c	1.00 – 1.50	72.00 ± 0.25 ^b
D ₁	8.30 ± 0.20 ^a	1.00	110.00 ± 0.20 ^a
LSD	0.40	-	0.85

Values are means ± standard deviation of triplicate determinations.

Means with different superscripts within the column are significantly different ($p < 0.05$)

Legend:

Fresh = 'Genger' powder analyzed before storage

A, B, C, D = 'Genger' stored with 0.0%, 5.0%, 10.0%, 15.0% K₂CO₃ respectively in plastic container

A₁, B₁, C₁, D₁ = 'Genger' stored with 0.0%, 5.0%, 10.0%, 15.0% K₂CO₃ respectively in Metal tin

LSD = Least Significant Difference

fluids increases with decrease in moisture and decreases with increase in moisture. Viscosity or internal friction or resistance to flow is the key factor in distinguishing between the different types of fluid systems and is an important factor in the organoleptic acceptability of food products¹⁹.

Table 3 shows the effects of storage and potassium carbonate (K_2CO_3) on the gelation concentration of *genger* powder. In all the samples the least gelation concentration (LGC) fell between 1.0 and 1.5% of sample. Table 3 shows the effects of storage and potassium carbonate (K_2CO_3) concentration on the gel strength of the *genger* samples.

Table 3: Gel strength of fresh and stored 'Genger' (*Bombax costatum*) powder

Sample	1.0% Solution	1.5% Solution
Fresh	-	-
A	-	-
A ₁	+	+
B	+	+
B ₁	+	++
C	+	++
C ₁	++	++
D	++	+++
D ₁	++	+++

Legend:

Fresh = 'Genger' powder analyzed before storage

A, B, C, D = 'Genger' stored with 0.0%, 5.0%, 10.0%, 15.0% K_2CO_3 respectively in plastic container

A₁, B₁, C₁, D₁ = 'Genger' stored with 0.0%, 5.0%, 10.0%, 15.0% K_2CO_3 respectively in metal tin

- = very weak gel

+ = weak gel

++ = strong gel

+++ = very strong gel

The gel strength generally increased with storage and K_2CO_3 concentration. While the samples with 15.0% K_2CO_3 (D and D₁) formed stronger gels with 1.50g samples, D₁ gave the highest gel strength, thus indicating that storage in metal tin was better. Least gelation concentration is useful in predicting the texture of a food product¹⁸.

Effect of storage container

It can be observed from the results that in all the parameters measured, the samples stored in the metal tin returned better results than those in the plastic container. This could be because of the better protective barrier (better sealing) offered by the metal tin, thus preventing any leakage of moisture into the medium.

The results obtained from this study show that while the moisture content and gelation concentration of *genger* (*Bombax costatum*) powder decreased with storage and increase in potassium carbonate (K_2CO_3) concentration, the viscosity, crude fat, water absorption capacity and gel strength all increased significantly ($p < 0.05$). These changes were all more pronounced in the samples stored in the metal tin as compared to those in the plastic container. This implies that storage with potassium carbonate can be effectively used to preserve the viscosity of *genger* for use throughout the year, thus preventing wastage. Though the optimum concentration of potassium carbonate to be used is yet to be determined, it is clear that metal tins are better than plastic containers for storage.

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