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Effect of Processing Methods on Pasting Properties of Gum Extracts from Selected Soup Thickeners in South-East, Nigeria

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ABSTRACT

The work was designed to determine the effect of processing methods on pasting properties of gum extracts of selected soup thickeners common in Imo state, South-East, Nigeria. The cotyledons, flours (full-fat and de-fatted) and gum extracts from de-coated *Afziela africana* "akparata", *Mucuna. sloanei* "ukpo", *Brychestegia eurycoma* "achi" and *Detarium microcarpum* "ofor" seeds were obtained after boiling at 100°C for 10, 20, 30 min; roasting at 130°C for 10, 20, 30 min and soaking at ambient temperature for 8, 16, 24 h. The flours from each of the raw seeds served as control. The flours were de-fatted using petroleum ether and gums extracted using propan-2-ol. The pasting properties of the seed gums extracted and conventional guar were determined using a Rapio Visco Analyzer (RVA) (Madel RVA 3D +, Newport Scientific Pty LTD., Sydney, Australia 1995) with the thermocline for windows software. Analysis of variance (ANOVA) was performed on the collected data at $p<0.05$. The results were statistically analysed using Statistical Package for Social Sciences (SPSS) version 23. *D. microcarpum* gum had the same pasting temperature with guar gum (50.20°C) at the average level of pre-treatment. The mean peak time, pasting temperature, setback and final viscosity of the gums from the different legume seeds under different processing methods were all higher, while their mean peak and trough viscosities were lower than that of guar gum. Reduced setback viscosity (298 to 129) RVU and breakdown viscosity (3866 to 3182) RVU obtained from processed seeds are indications that gums from them will form more stable paste than guar gum and if added to starch-based foods will have the tendency of retarding the problem of retrogradation.

KEYWORDS: Afziela africana, Mucuna sloanei, Brychestegia eurycoma, Detarium microcarpum, Guar gum, Pasting properties.

INTRODUCTION

Thickeners according to Igwenyi and Azoro[1] are additives which when added to an aqueous mixture increase the viscosity, stability and improve the suspension of other added ingredients without substantially modifying other properties. The mechanisms of food products thickening involve: starch gelatinization, protein coagulation and emulsification. *Afzelia africana* "Akparata", *Mucuna sloanei* "Ukpo", *Brachystegia eurycoma* "Achi" and *Detarium microcarpum* "Ofor" are soup thickeners commonly used in the South-Eastern part of Nigeria and they belong to the same family *leguminosae* as well as the same sub-family *caesalpiniacea*. Flours from these seeds are used as thickeners, emulsifiers and flavouring agents in traditional soups (for eating gari, pounded yam or cocoyam and cassava fufu), due to the high level of their gum contents. The gums are extracted from the seeds and serve as natural hydrocolloids, when crushed to flour and in powdered form they have the ability to swell in water and thus are able to influence the flow and consistency of the liquid.

Hydrocolloids or gums are diverse group of long chain polymers characterized by their property of forming viscous dispersions and/or gels in water. The presence of large number of hydroxyl groups increases their affinity for binding water molecules, and so belongs to the group of hydrophilic compounds. According to Juszczac et al.[2], they produce a dispersion, which is intermediate between a true solution and a suspension, and exhibits the properties of a colloid. Considering these two properties, they are appropriately regarded as hydrophilic colloids or hydrocolloids. Hydrocolloids have a wide array of functional properties in foods including; thickening, gelling, emulsifying, stabilization and coating. The primary reason behind the use of hydrocolloids in foods is their ability to modify the rheology of food systems.[3] This includes two basic properties of food systems that is, flow behavior (viscosity) and mechanical solid property (texture) which in turns affect its sensory properties.

The world hydrocolloid market which is valued at about USD 4.4 billion per annum, with a total volume of about 260,000 tonnes in the year 2000. This reflects a remarkable demand for hydrocolloids which has influenced the price and availability.[4] Sequel to the increase in the hydrocolloid market demand, it is therefore imperative to exploit some new raw materials as potential and alternative sources of food hydrocolloids and seed gums.[5,6] Studies on the extraction of the hydrocolloids from seeds such as: *Mucuna sloanei* and *Irivingia gabonensis* and their visco-elastic properties have been reported.[7] The flours and gums from the cotyledon of these legumes have not found much use in food systems unlike the tapioca starch which is used in numerous industrial and food applications, as thickening and gelling agents.[1] This work is aimed at the determination of the colloidal property of gum extracts from selected soup thickeners.

MATERIALS AND METHOD

Material Collection

Mucuna sloanei "ukpo", *Detarium microcarpium* "ofor", *Brachysteia eurycoma* "Achi)" *Afzelia africana* "akparata", seeds were obtained from "Ekeikpa" (a local market) in Ihitte/ Uboma, Imo state, Nigeria. Petroleum ether, distilled water and propane-2-ol were purchased from a scientific laboratory in Owerri, Imo state, Nigeria and were of analytical grade. Other reagents and equipment/facilities were obtained from the department of Food Science and Technology of Federal University of Technology.

Processing of Seed Flour

The seeds of 'Ukpo', 'Achi', 'Akparata' and 'Ofor' were cleaned to remove dirt. The whole and healthy seeds were weighed separately and manually cracked with the use of a wooden hammer (Mallet). They were divided into four equal portions each; the first three portions were subjected to boiling, roasting and soaking respectively while the fourth portion was processed raw.

Processing of Flour from Boiled Seeds

The first portion of the cracked seeds was divided into three equal portions and placed in boiling distilled water in the ratio of 1/5 (w/v) for durations of 10 min, 20 min and 30 min. They were drained and allowed to cool to ambient temperature. They were de-decoated to obtain the seeds endosperms by scraping the seed coats with a stainless-steel knife and washed in surplus water (1/5 w/v) and milled using an attrition mill. The flours were dried in a moisture extraction oven (DHG- 9053 Model) at 65^{o}C to a constant weight, cooled to ambient temperature and sieved through a 500 µm mesh-sized sieve to generate fine flour. They were packaged in airtight containers and stored at ambient conditions for further analysis and application. The production flow chart is as shown in Figure 1.

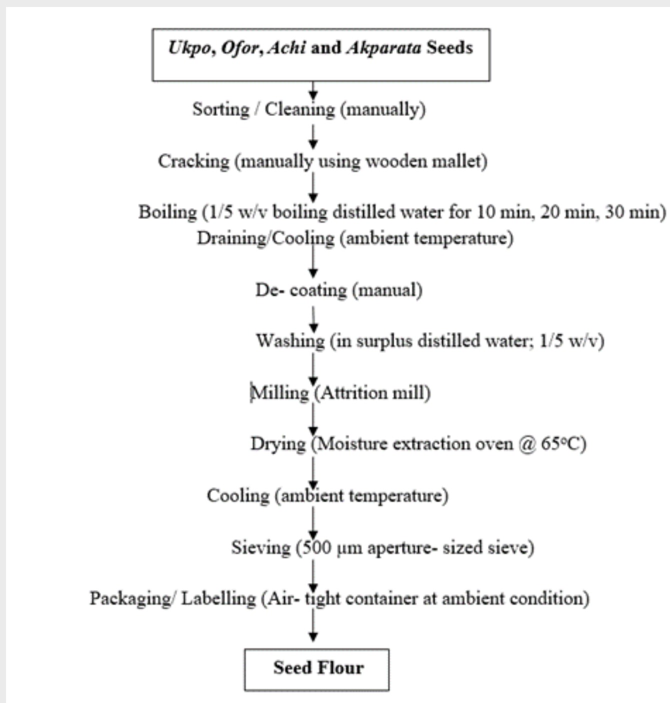

Figure 1. Flow Chart for the Preparation of Flour from Boiled Seeds (Ukpo, Ofor, Achi and Akparata)

Processing of Flour from Roasted Seeds

The second portion of the cracked seeds were divided into three equal portions, and toasted in a pre- heated locally fabricated oven at 130^{o}C for 10min, 20 min and 30 min, allowed to cool to ambient temperature. They were de-coated to obtain the seeds endosperms by scraping the seed coats with a stainless-steel knife and washed in surplus water (1/10 w/v) and milled using an attrition mill. The flour was dried in a moisture extraction oven (DHG- 9053 Model) at 65^{o}C to a constant weight, cooled to ambient temperature and sieved through a 500µm mesh-sized sieve to generate fine flour. They were packaged in airtight containers and stored at ambient conditions for further analysis and application. The production steps are as shown in Figure 2.

Processing of Flour from Soaked Seeds

The third portion of the cracked seeds were soaked in distilled water in the ratio of 1/10(w/v) at ambient temperature for 8 h, 16 h and 24 h. The soaking liquors were drained at the elapse of each soaking time, de-coated to obtain the seeds endosperms by scraping the seed coats with a stainless-steel knife and washed in surplus water (1/5 w/v) and milled using an attrition mill. The flour was dried in a moisture extraction oven (DHG- 9053 Model) at 65°C to a constant weight, cooled to ambient temperature and sieved through a 500 µm mesh-sized sieved to generate fine flour. They were packaged in airtight containers and stored at ambient conditions for further analysis and application. The processing steps are as shown in Figure 3.

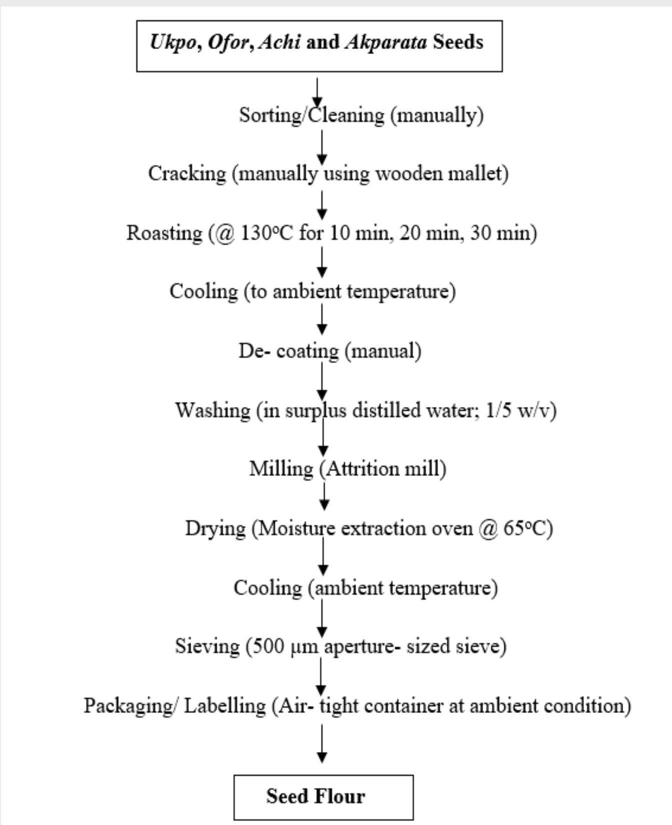

Figure 2. Flow Chart for the Preparation of Flour from Roasted Seeds (Ukpo, Ofor, Achi and Akparata)

Processing of Flour from Raw Seeds

The fourth portion of the cracked seeds was de-coated raw to obtain the seeds endosperms by scraping the seed coats with a stainless-steel knife and washed in surplus water (1/5 w/v) and milled using an attrition mill. The flour was dried in a moisture extraction oven (DHG- 9053 Model) at 65°C to a constant weight, cooled to ambient temperature and sieved through a 500 µm mesh-sized sieved to generate fine flour. They were packaged in airtight containers and stored at ambient conditions for further analysis and application. The processing steps are as shown in Figure 4.

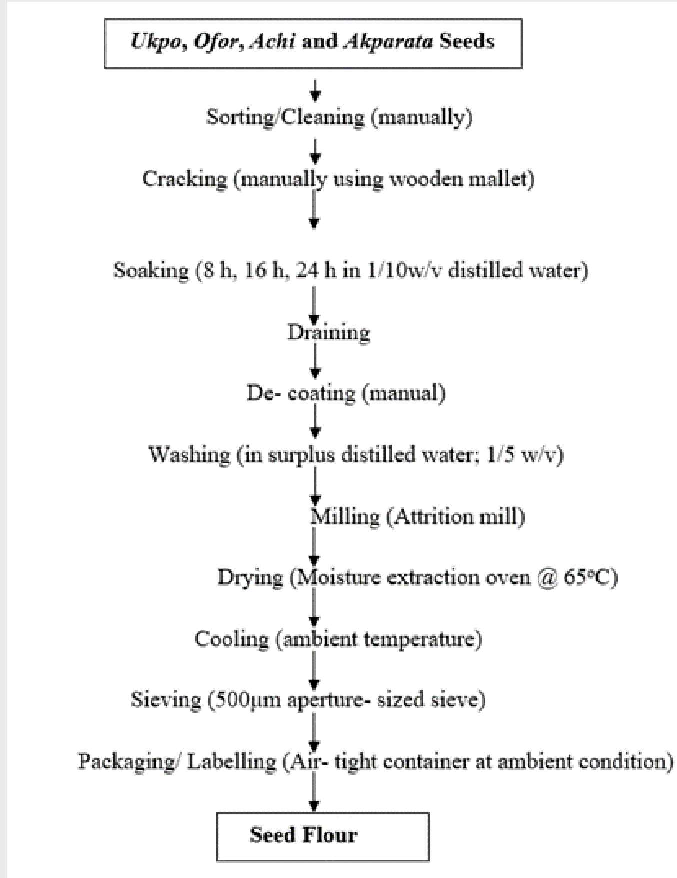

Figure 3. Flow Chart for the Preparation of Flour from Soaked Seeds Sample (Ukpo, Ofor, Achi and Akparata)

De-fatting of Seed Flours

Cold (bulk) extraction method of Abah and Egwari[8] was used for the de-fatting of the flours. The full-fat flour (200 g) was wrapped in a white cotton fabric and soaked in 400 ml of Petroleum ether in an enclosed transparent glass jar and allow for a period of 72 hours. The wrapped flour was removed and rinsed in fresh Petroleum ether and manually squeezed to express out the entrapped solvent. The de-fatted flour was spread on a stainless tray for 4 hours to allow the trapped solvent to volatilize. The flour was sieved through a 500 µm mesh sized sieve, packaged in air-tight container and stored at ambient conditions for further analysis and applications.

Seed Gum Extraction

The method of Nwokocha and Williams[9] was adopted for gum extraction from the de-fatted seed flours. Five (5) g of the flour samples were dispersed in 400 ml distilled water and hydrated continuously by means of a magnetic stirrer (FBI 15001, Fischer Scientific, UK) for 6 h. Four hundred (400) ml of Propane -2-ol was gradually (drop by drop) added to the hydrated flour solution. The precipitated gums that spool out of the solution were gently separated from the mother liquor with the use of perforated spoon. The clear liquor was decanted, while the trapped solvent was removed by filtering under suction in a Buchner funnel. The precipitates were dried in a moisture extraction oven (DHG-9053 Model) at 60°C till a flaky- dried gum (Plate 1) could be easily scrapped off the drying tray. The resultant gums were cooled in desiccators to ambient temperature pulverized using the dry section of an electric blender and stored at ambient temperature in a sealed container.

Processing of Flour from Raw Seeds

The fourth portion of the cracked seeds was de-coated raw to obtain the seeds endosperms by scraping the seed coats with a stainless-steel knife and washed in surplus water (1/5 w/v) and milled using an attrition mill. The flour was dried in a moisture extraction oven (DHG- 9053 Model) at 65°C to a constant weight, cooled to ambient temperature and sieved through a 500 µm mesh-sized sieved to generate fine flour. They were packaged in airtight containers and stored at ambient conditions for further analysis and application. The processing steps are as shown in Figure 4.

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Ukpo, Ofor, Achi and _Akparata_ Seeds
↓
Sorting/Cleaning (manually)
↓
Cracking (manually using wooden mallet)
↓
De- coating (manual)
↓
Washing (in surplus distilled water; 1/5 w/v)
↓
Milling (Attrition mill)
↓
Drying (Moisture extraction oven @ 65°C)
↓
Cooling (ambient temperature)
↓
Sieving (500 µm aperture- sized sieve)
↓
Packaging/ Labelling (Air- tight container at ambient condition)
↓
Seed Flour

Figure 4. Flow Chart for the Preparation of Flour from Raw Seeds Sample (Ukpo, Ofor, Achi and Akparata)

Plate 1. Samples of Flaky Gum Extract

Seed Gum Extraction

The method of Nwokocha and Williams[9] was adopted for gum extraction from the de-fatted seed flours. Five (5) g of the flour samples were dispersed in 400 ml distilled water and hydrated continuously by means of a magnetic stirrer (FBI 15001, Fischer Scientific, UK) for 6 h. Four hundred (400) ml of Propane -2-ol was gradually (drop by drop) added to the hydrated flour solution. The precipitated gums that spool out of the solution were gently separated from the mother liquor with the use of perforated spoon. The clear liquor was decanted, while the trapped solvent was removed by filtering under suction in a Buchner funnel. The precipitates were dried in a moisture extraction oven (DHG-9053 Model) at 60°C till a flaky- dried gum (Plate 1) could be easily scrapped off the drying tray. The resultant gums were cooled in desiccators to ambient temperature pulverized using the dry section of an electric blender and stored at ambient temperature in a sealed container.

Statistical Analysis

The data obtained were subjected to statistical analysis such as simple description mean and standard deviation, Analysis of variance (ANOVA), using General Linear Model (GLM) procedure. A comparison test (LSD) was used to separate the means where significant differences existed.

RESULTS AND DISCUSSIONS

Effect of Processing on Rheological Properties of Selected Seed Gums

Peak viscosities of Seed Gums

The Peak viscosities of the gum extracts from the various cultivars as well as with that of the guar (6096 RVU) significantly ($p \leq 0.05$) differed from each other (Table 1). *D. microcarpum* seed gums had the highest peak viscosities for all the processing methods and the results are as follows: 4444 RVU (boiled), 3939 RVU (roasted) and 3869 RVU (soaked). On the average, the peak viscosities of the gums from legume seeds showed that gums from soaked seeds had the highest (2982 RVU), while those from roasted seeds had the lowest (2831 RVU) peak viscosities. According to Sandhu and Singh[10], the differences in the peak viscosities of the gum extracts could be as a result of the variation in the amylose contents of their starch granules. These results implied that *D. microcarpum* gums if added to any food will have the ability to cause increase in the volume of such food during heat processing. This is because high level of peak viscosity is advantageous in foods were high level of gel strength and elasticity is needed. According to Osunbgbara[11]; Teferra *et al.*[12], high peak viscosity of food sample is an indication of high starch content in the food.

Results in Tables 2 showed that the peak viscosities of all the laboratory prepared legume seed gums were lower than that of commercial (guar) gum which was 6096 RVU at 50.02°C within 2.76 min of heating. The average peak viscosities of the gums from raw seeds were 2074 RVU. Though there were significant ($p \leq 0.05$) differences observed in the peak viscosities of the gum extracts at different processing durations, no particular trend was followed, but there were noticeable fluctuation with increase in processing time. For the gums from the boiled and soaked seeds, the peak viscosities increased to 2665 RVU and 3001 RVU after 10 min. of processing and beyond this level dropped to1544 RVU 1540 RVU, respectively with increase (30 min) in processing time. Generally, the average peak viscosities of the gums from legume cultivars reduced significantly (3117 - 2608) RVU as pre-treatment levels increased. Peak viscosity is the measure of the ability of food starch to swell in the presence of moisture before their breakdown.[13,14]

Table 1. Effect of Processing Methods on the Pasting Properties RVU) of Selected Legume Seed Gums

Processing Methods	Peak	Trough	Breakdown	Final	Setback	Peak Time (min.)	Pasting Temp. (°C)
Boiling							
A. Africana	2589^{b}	1857^{b}	732^{ab}	5165^{c}	3308^{c}	6.13^{a}	75.49^{b}
M. sloanei	2060^{c}	1423^{c}	637^{b}	3413^{d}	1989^{d}	6.03^{a}	79.75^{a}
D.microcarp.	4444^{a}	3619^{a}	824^{ab}	7566^{a}	3947^{b}	6.14^{a}	52.05^{c}
B. eurycoma	2661^{b}	1740^{bc}	921^{a}	6284^{b}	4544^{a}	6.15^{a}	77.35^{b}
Mean	2938	2160	778	5607	3447	6.11	71.16
Roasting							
A. Africana	2372^{c}	1715^{b}	657^{b}	4083^{d}	2367^{d}	6.15^{a}	69.17^{b}
M. sloanei	2333^{c}	1633^{b}	700^{b}	4706^{c}	3073^{c}	6.15^{a}	83.97^{a}
D.microcarp.	3939^{a}	3206^{a}	734^{ab}	7525^{a}	4320^{a}	5.82^{b}	53.45^{c}
B. *eurycoma*	2680^{b}	1768^{b}	911^{a}	5797^{b}	4029^{b}	6.13^{a}	80.91^{a}
Mean	2831	2081	750	5528	3447	6.06	71.87
Soaking							
A. Africana	2536^{c}	1782^{b}	754^{a}	5014^{b}	3232^{b}	6.15^{a}	80.29^{a}
M. sloanei	2613^{c}	1831^{b}	782^{a}	5361^{b}	3530^{b}	6.15^{a}	82.18^{a}

Processing Methods	Peak	Trough	Breakdown	Final	Setback	Peak Time (min.)	Pasting Temp. (^oC)
D.microcarp.	3869^a	3007^a	861^a	6293^a	3285^b	5.67^b	54.88^b
B. *eurycoma*	2909^b	1988^b	922^a	6313^a	4325^a	6.15^a	82.35^a
Mean	2982	2152	830	5745	3592	6.03	74.92
Guar gum	6096	3371	2726	5594	2224	2.76	50.2

Means on the same column with different superscript are significantly ($p \leq 0.05$) different from each other

Trough Viscosities of Seed Gums

Trough also known as holding strength is the difference between the Peak viscosity and breakdown viscosity when the formed gel/paste are kept at constant temperature, time and steady level of stress.[12,15] The same trend observed for peak viscosities of gum extracts in Table 1, was also followed for the trough. For all the processing methods, *D. microcarpum* gums had the highest value of trough and they are as follows: 3619 RVU, 3206 RVU and 3007 RVU for gums from boiled, roasted and soaked seeds, respectively. Results showed that gum from boiled seeds had the highest trough value (2160 RVU), while those from roasted seeds had the lowest (2081 RVU). According to Vongsawasdi *et al.*[16], the higher the trough value of flour or gum, the lower the rate of starch molecules breakdown after the peak viscosity is attained. From the results, paste, gel or any food formed from gums from processed seeds of *D. microcarpum* having the highest trough value (3740 RVU) will be more stable than the others. Unlike in peak viscosities, the average trough viscosities of the gums from legume seeds flours reduced from 2265 RVU to 1881 RVU as pre-treatment level increased. The average trough value for the gums from raw seeds was 1766 RVU, gums extracted from boiled and soaked seeds flours increased this value to 2303 RVU and 2510 RVU respectively, after 10 min processing time (Table 2).

Table 2. Effect of Processing Time on Pasting Properties (RVU) of Selected Legume Seeds Gums

Processing Time (min.)	Peak	Trough	Breakdown	Final	Setback	Peak Time (min.)	Pasting Temp (^{o}C)
0 (Raw)	2074^c	1776^{cd}	297^b	6425^a	4648^a	6.99^a	83.41^a
Boiling							
10	2665^b	2303^b	362^b	5283^{ab}	3980^b	6.97^a	75.23^b
20	2313^c	2002^{bc}	311^b	5534^b	3532^b	6.98^a	79.51^a
30	1544^d	1348^d	196^b	4199^c	2851^c	6.87^a	67.44^c
Roasting							
10	1748^d	1363^c	385^b	5911^{ab}	4548^a	6.99^a	82.45^{ab}
20	2454^b	2238^b	215^{bc}	5162^c	2924^b	6.61^b	70.85^c
30	1784^d	1655^c	129^c	4546^d	2891^b	6.97^a	72.45^{bc}
Soaking (h)							
8	3001^b	2510^b	492^b	6539^a	4029^b	6.42^b	76.51^b
16	2198^c	1848^c	350^b	5617^b	3769^b	7.00^a	77.15^b
24	1540^d	1256^d	284^b	4551^b	3295^c	7.00^a	87.34^a
Guar gum	6096^a	3371^a	2726^a	5594^c	2224^d	2.76^c	50.20^c

Means on the same column with different superscript are significantly ($p \leq 0.05$) different from each other

Breakdown Viscosities of Seed Gums

From Table 1, the highest (830 RVU) breakdown viscosity was observed in gums from soaked seeds, while those from roasted seeds had the lowest (750 RVU) value. Breakdown in its simplest definition is the difference between the peak and trough viscosity of the product under examination and it is used to measure the level of starch and gel stability.[13] From Table 2, the breakdown viscosities of the gums from the experimental seeds were very low (297 RVU) when compared to that of the guar gum (2727 RVU). For all the processing methods adopted in this research, the breakdown viscosities of the gum extracts, slightly increased at the initial level of processing time to 362 RVU (10 min), 385 RVU (10 min) and 492 RVU (24 h) for boiled, roasted and soaked seeds, respectively after which they finally reduced, though with no significant ($p > 0.05$) differences. Reduction in breakdown viscosity is an indication of reduced tendency of starch granules to rupture under applied shear stress usually experienced during processing.[17,18] Among the legume seeds, increase in pre-treatment levels, generally reduced the average breakdown viscosities of the gum extracts from 852 RVU to 726 RVU. The findings from this research are indication that gum from the processed legume seeds used for this research will give more stable paste than guar gum.

Final Viscosities of Seed gums

According to Maziya-Dixon *et al.*[19], final viscosity also known as cool-paste viscosity is a pasting property that measures the ability of starch to form a viscous paste during cooking which in turns changes to viscous gel during cooling. Increase in final viscosity is an indication of increase rate of retro-gradation.[20] Comparing the final viscosities of gums from different legume seeds, *D. microcarpum* gum had the highest value for boiled (7566 RVU) and roasted (7525 RVU) seeds, while *B. eurycoma* gum had the highest (6313 RVU) value for the soaked seeds and these values varied significantly ($p \leq 0.05$) from each other. With the exception of gums from soaked seeds, the final viscosities of gums from *M. sloanei* had the lowest final viscosities when compared to the other legume seeds cultivars (Table 1). This implies that gums from boiled seeds of *M. sloanei* will be better applied in processing of foods such as baked products where retro-gradation have been a problem. As shown in Table 2, the mean final viscosities of gums from soaked legume seeds (5745 RVU) were higher than that of the guar gum (5594 RVU) and gums from boiled (5607 RVU) and roasted (5528 RVU) seeds. The differences in the final viscosities could be attributed to the effect of cooling on viscosity and the re-association of starch granules in the gums.[21]

From Tables 2, the average final viscosity of the gum extracted from raw seeds was 6425 RVU and with the exception of the gum from the soaked seeds, the final viscosities of the gum extracts from the seeds reduced with increase in processing time and they were as follows: 4199 RVU and 4546 RVU for boiled and roasted after 30 min., respectively. According to Flores-Farias *et al.*[22], high final viscosity is a function of the nature of the arrangement of the amylose chains in the starch.[23] These results indicate that any gel, paste or food formed from gums from processed seeds will be more stable than those from raw seeds and guar gum.

Setback Viscosities of Seed Gums

Setback value is read from the pasting curve after the cooling of the paste and it is all about re - association, retro-gradation and re - ordering of starch molecules.[24] According to Sanni *et al.*[25], the lower the setback viscosities, the lower the rate of retro-gradation during cooling and staling of the products made from the starch. From Table 1 gums from soaked seeds generally had the highest (3592 RVU) average setback viscosities when compared with those from the other processing methods (boiling and roasting) which were at the same level (3447 RVU). Also, gums from boiled *B. eurycoma* had the highest setback viscosity (4544 RVU), while the gum from boiled *M. sloanei* seeds had the lowest (1989 RVU). Sanni *et al.*[26] reported that the lower the setback viscosity during the cooking of paste, the greater the level of resistance to retro-gradation. By implication, if not for the discoloration challenges, gums from boiled *M. sloanei* when compared to the other laboratory extracted gums will help to increase the shelf stability of food products such as baked products and pastas which have the problem of retro-gradation.

The setback viscosities of the laboratory extracted gums for both the raw (4648 RVU) and processed seeds were higher than that of the guar gum (2224 RVU). Generally, increase in all the processing time (Table 2) as well as pre-treatment significantly reduced the setback viscosities of the gums of the processed seeds. On the average as pre-treatment levels increased, the setback viscosities of legume seeds gums reduced from 3886 RVU to 3182 RVU. From the results, it implies that gums from processed legumes will compare favourably with guar gum in increasing the shelf life of baked products since they would reduce the rate of staling. These results are in support of the afore-discussed on the effect of increase in processing levels of seeds on the reduction in breakdown viscosities of extracted gums. High setback viscosity is associated with increased level of syneresis during cooling of gum pastes or products made with its incorporation.[27] According to Marquezi *et al.*[28], higher the amylose content of starch, the higher the rate of retro-gradation. However, the amylopectin content, size and shape of starch granules, the starch source and intermediate materials also affect the retro-gradation tendencies.[18]

Peak Time of Seed Gums

Table 1 showed that there was no significant ($p > 0.05$) difference observed in peak time of gums from the boiled legume seeds. They were in the range of 6.03 min to 6.15 min for *M. sloanei* and *B. eurycoma* gums respectively. With the exception of gums from roasted and soaked *D. microcarpum* seed, the peak time for the gums from the various legume seeds were not significantly ($p > 0.05$) different from each other. The gums from soaked seeds recorded the longest (6.11 min), while those from soaked seeds had the shortest (6.03 min). Results also showed a slight increase from 6.03 min to 6.12 min on the average pasting time of the different legume seeds gums as pre-treatment levels increased. According to Ajatta *et al.*[18], reduction in starch content of food materials results to increase in peak time. This means that the different processing methods adopted in this research did not significantly affect the starch contents of the various legume gums.

As was observed in Table 2, the peak time of the gum extracted from the laboratory prepared seeds were significantly ($p \leq 0.05$) different and higher than that of the guar gum (2.76 min). This implied that more energy will be spent in order to attain the peak viscosities of the laboratory extracted gums than for the guar gum (Figure 5 and 6). According to Adebowale *et al.*[29], the time at which peak viscosity occurred in minutes is termed peak time and increase in this pasting property implies high energy requirement for cooking of starchy foods.

Pasting Temperature of Seed Gums

The pasting temperature according to Adebowale *et al.*[30] is a pasting property which measures the minimal temperature required to cook a given sample. It is also, the temperature at the onset of the rise in the viscosity of the sample.[31] From Table 1, the pasting temperatures of the seed gums from the various legume seeds varied significantly ($p \leq 0.05$) from each other and were in the following ranges: 52.05 ^{o}C to 79.75 ^{o}C (boiled) and 53.45 ^{o}C to 82.35 ^{o}C (soaked) with *D. microcarpum* having the lowest value for all the processing methods adopted in this research. This implies that the starch from *D. microcarpum* gum will have the tendency of forming gel with reduced power consumption, cost and time than the gums from the other legume seeds.[23] Moreover, gums from soaked legume seeds had the highest (74.92°C) pasting temperature, while those from boiled seeds had the lowest (71.16°C). The average pasting temperatures (Figure 5) of the laboratory extracted gums were all higher than that of the guar gum (50.20°C) (Figure 6) and were in the following ranges: 75.23°C to 67.44°C, 82.45°C to 72.45°C and 76.51°C to 87.34°C for boiled, roasted and soaked seeds respectively (Table 2). From the results, with the exception of soaking methods, increase in all the processing time used in this work reduced the pasting temperatures of the gums extracted. Average pasting temperatures of the seed gums reduced significantly from 73.56 °C to 72.17 °C as pre-treatment levels increased. The reduction could be associated with the effect of heat treatments such as boiling and roasting used in this research.[32-34]

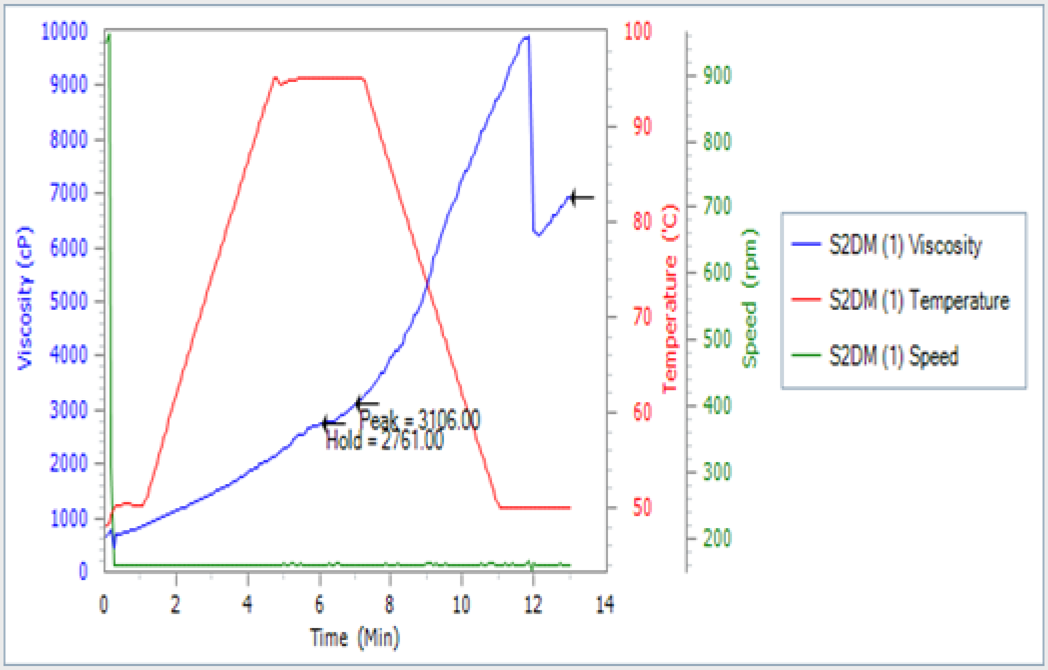

Figure 5. Amylograph for Gums from 15 min Soaked Seeds

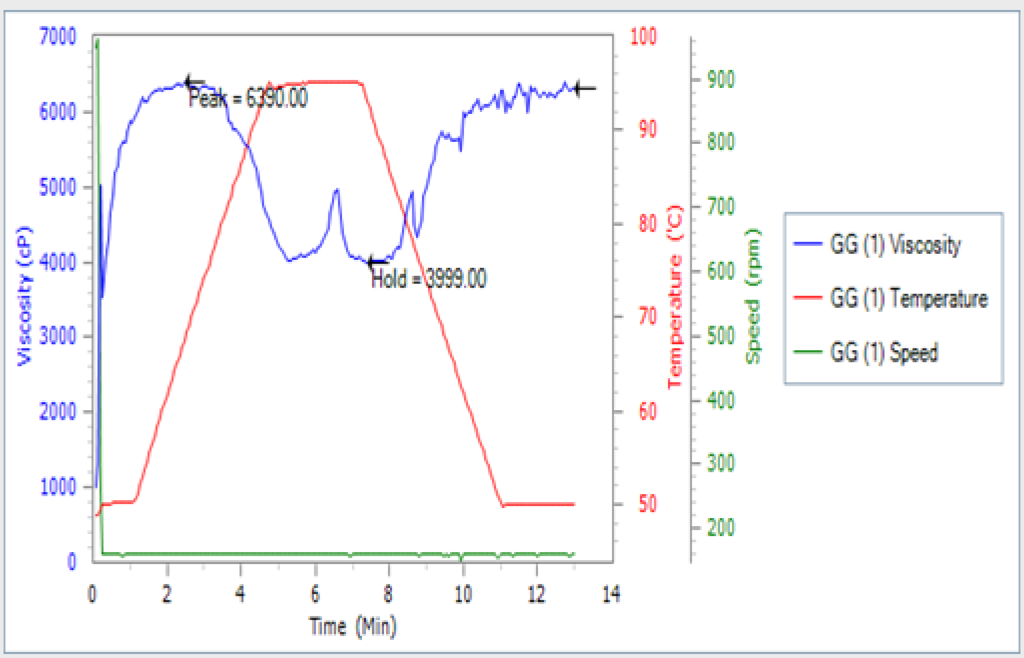

Figure 6. Amylograph for Guar Gums

CONCLUSION

Reduced setback viscosity (298 to 129) RVU and breakdown viscosity (3866 to 3182) RVU obtained from processed seeds are indications that gums from them will form more stable paste than guar gum and if added to starch-based foods will have the tendency of retarding the problem of retrogradation.

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CONFLICT OF INTEREST

The author declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

1. Igwenyi IO, Azoro BN. Proximate and phytochemical composition of flour from indigenous seeds used as soup thickeners in Ebonyi State, Nigeria. *J Environ Sci Toxicol Food Technol.* 2014;8(6):35-40.
2. Juszczak L, Witczak M, Fortuna T, Babachowicz A. Effect of some hydrocolloids on the rheological properties of rye starch. *Int J Food Sci Technol.* 2004;10(2):125-131.
3. Myhan R, Białobrzewski I, Markowski M. An approach to modeling the rheological properties of food materials. *J Food Eng.* 2012;111(2):351-359.
4. Williams PA, Phillips GO. Introduction to food hydrocolloids. In: Phillips GO, Williams PA, eds. *Handbook of Hydrocolloids.* Cambridge, UK: Woodhead Publishing Ltd; 2000:1-19.
5. Joshi H, Kapoor VP. *Cassia grandis* Linn. f. seed galactomannan: Structural and crystallographical studies. *Carbohydr Res.* 2003;338:1907-1912.
6. Azero EG, Andrade CT. Testing procedures for galactomannan purification. *Polym Test.* 2002;21:551-556.
7. Onweluzo JC, Obanu ZA, Okwandu MC. Potentials of gum from *Detarium microcarpum* and *Mucuna flagellipes* seeds as raw beef burger stabilizers. *Plant Foods Hum Nutr.* 2004;59(4):137-141.
8. Abah SE, Egwari LO. Methods of extraction and antimicrobial susceptibility testing of plant extracts. *Afr J Basic Appl Sci.* 2011;3(5):205-209.
9. Nwokocha LM, Williams PA. Isolation and rheological characterization of *Mucuna flagellipes* seed gum. *Food Hydrocoll.* 2009;23:1394-1397.
10. Sandhu KS, Singh N. Some properties of corn starches II: Physico-chemical, gelatinization, retrogradation, pasting and textural properties. *Food Chem.* 2007;101:1499-1507.
11. Osungbaro TO. Physical and nutritive properties of fermented cereal foods. *Afr J Food Sci.* 2009;3(2):23-27.
12. Teferra FT, Abadi G, Abrehet FG, Carol JH. Pasting characteristics of starches in flours of chickpea (*Cicer arietinum* L.) and faba bean (*Vicia faba* L.) as affected by sorting and dehulling practices. *Afr J Food Sci.* 2015;9(12):555-559.
13. Akanbi TO, Nazamid S, Adebowale AA. Functional and pasting properties of tropical breadfruit (*Artocarpus altilis*) starch from Ile-Ife, Osun State, Nigeria. *Int Food Res J.* 2009;16:151-157.
14. Peace PD, Adekunle OA. Effect of some processing methods on anti-nutritional, functional and pasting characteristics of *Detarium microcarpum* seed flours. *Ann Food Sci Technol.* 2017;19(1):69-78.
15. Ikegwu OJ, Okechukwu PE, Ekumankana EO. Physico-chemical and pasting characteristics of flour and starch from achi (*Brachystegia eurycoma*) seeds. *J Food Technol.* 2010;8(2):58-66.
16. Vongsawasdi P, Noppharat M, Hiranyaprateep N, Tirapong N. Relationships between rheological properties of rice flour and quality of vermicelli. *Asian J Food Ag-Ind.* 2009;2(2):102-109.
17. Abiodun OA, Akinoso R, Oluoti OJ. Changes in the functional and pasting properties of trifoliate yam flour during storage. *J Appl Sci Environ Manage.* 2014;18(2):337-340.
18. Ajatta MA, Akinola SA, Osundahunsi OF. Proximate, functional and pasting properties of flours made from wheat, breadfruit and cassava starch. *Appl Trop Agric.* 2016;21(3):158-165.
19. Maziya-Dixon B, Dixon AGO, Adebowale AA. Targeting different end uses of cassava: Genotypic variations for cyanogenic potentials and pasting properties. *Int J Food Sci Technol.* 2007;42(8):969-976.
20. Shimelis AE, Meaza M, Rakshit S. Physico-chemical properties, pasting behaviour and functional characteristics of flours and starches from improved bean (*Phaseolus vulgaris* L.) varieties grown in East Africa. *CIGR Ejournal.* 2006;8:1-18.
21. Akissoe N, Akissoes C, Hounhouigan J, Nago M. Prediction of the sensory texture of a yam thick paste (amala) using instrumental and physicochemical parameters. *J Texture Stud.* 2006;37(4):393-402.
22. Flores-Farias F, Martinez-Bustos F, Salinas-Moreno YK, Chang JS, Hernandez R, Rios E. Physicochemical and rheological characteristics of commercial nixtamalized Mexican corn flours for tortillas. *J Sci Food Agric.* 2002;80:657-664.
23. Katekhong W, Charoenrein S. Effect of rice storage on pasting properties, swelling and granular morphology of rice flour. *Asian J Food Agro-Ind.* 2012;5(4):315-321.
24. Malomo O, Ogunmoyela OAB, Adekoyeni OO, Jimoh O, Oluwajoba SO, Sobanwa MO. Rheological and functional properties of soy-poundo yam flour. *Int J Food Sci Nutr Eng.* 2012;2(6):101-107.
25. Sanni LO, Ikuomola DP, Sanni SA. Effect of length of fermentation and varieties on the qualities of sweet potato gari. In: Akoroda MO, ed. *Proceedings of the 8th Triennial Symposium of the International Society for Tropical Root Crops–Africa Branch (ISTRC-AB); November 12-16, 2001; Ibadan, Nigeria.* Ibadan,

Nigeria: International Institute of Tropical Agriculture; 2001:208-211.

26. Sanni LO, Kosoko SB, Adebowale AA, Adeoye JJ. The influence of palm oil and chemical modification on the pasting and sensory properties of fufu flour. *Int J Food Sci Technol.* 2004;7(2):229-237.
27. Appiah F, Oduro I, Ellis WO. Pasting properties of *Treculia africana* seed flour in Ghana and the production of a breakfast meal. *Agric Biol J N Am.* 2011;2(2):325-329.
28. Marquezi M, Gervin VM, Watanabe LB, Bassinello PZ, Amante ER. Physical and chemical properties of starch and flour from different common bean (*Phaseolus vulgaris* L.) cultivars. *Braz J Food Technol.* 2016;19:1-8.
29. Adebowale PDKO, Afolabi TA, Olu-Owolabi BI. Hydrothermal treatments of finger millet (*Eleusine coracana*) starch. *Food Hydrocoll.* 2005;19:974-983.
30. Adebowale AA, Sanni LO, Onitilo MO. Chemical composition and pasting properties of tapioca grits from different cassava varieties and roasting methods. *Afr J Food Sci.* 2008;2:77-82.
31. Rincon AM, Padilla FC. Physicochemical properties of breadfruit (*Artocarpus altilis*) starch from Margarita Island, Venezuela. *Arch Latinoam Nutr.* 2004;54(4):449-456.
32. International Institute of Tropical Agriculture. *Operation Manual for the Series 3 Rapid Visco Analyzer Using Thermocline for Windows.* Newport Scientific Pty Ltd; 2001.
33. Padalino L, Mastromatteo M, Lecce L, Spinelli S, Conte A, Del Nobile MA. Optimization and characterization of gluten-free spaghetti enriched with chickpea flour. *Int J Food Sci Nutr.* 2014;49:1544-1556.
34. Peters DP, Olapade AA. Effect of some processing methods on nutritional, functional and pasting characteristics of *Detarium microcarpum* seed flours. *Ann Food Sci Technol.* 2017;19(1):69-78.