Effect of Heating Time and Addition of Onions on the Viscosity and Sensory Properties of *IrvingiaGabonensis* (*Ogbono*)

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ABSTRACT
This research was carried out to ascertain the effect of heating time and the addition of onions (Allium cepa) on the quality of ogbono (Irvingia gabonensis) soup. Ogbono seeds known as African Bush Mango (Irvingia gabonesis) were milled into flour. The proximate composition and functional properties of the Irvingia gabonensis flour were determined. The Irvingia gabonensis flour was used to produce six slurries by dissolving separately 30g of the Irvingia gabonensis flour in 20ml of hot palm oil (80^{o}C) and adding 440ml warm water (50^{o}C) to them. Different quantities of onion (3, 6, 9, 12, 15 and 18)g were added to the different slurries. The viscosities of the samples were determined. The samples were used to prepare ogbono soup. The soup samples were subjected to sensory evaluation. The slurries without onions were heated separately to (60, 80, 100, 120, 140,160)s, the viscosities and sensory evaluation of the samples were also determined. The fat content of the Irvingia gabonensis flour was found to be 74.25%.The viscosity results showed no significant difference ($p > 0.05$) between the samples containing different concentrations of onions, but there were significant differences ($p < 0.05$) between the samples subjected to different heating time. The sensory evaluation results showed significant difference ($p < 0.05$) in terms of overall acceptability of the soups that contained onions, though they were all accepted because their mean scores were above the average score of 4.5 on a nine point hedonic scale. There were significant differences ($p < 0.05$) in terms of draw-ability of the samples subjected to different heating time. The draw-ability decreased with increase in heating time.

Keywords*: Irvingia gabonensis, onions, viscosity, heating time, acceptability, draw-ability*

INTRODUCTION

Ogbono (*Irvingia gabonensis*)also known as African bush mangois widely used in Nigeria as a soup thickener because of its viscous properties (Akusu and Kin-Kabar, 2013). It is a small mango-like fruit sometimes called wild-mango or bush mango(Uzoma and Ahiligwo, 1999).It is commercially important indigenous fruit. The kernels of *Irvingia gabonensis* are widely marketed domestically, nationally and between countries in West Africa for their thickening properties. It is regarded as an oil seed as it contains high percentage of oil 54% (Ogungbenle, 2014) and it constitutes an important part of the natural diet in West Africa. *Irvingia gabonensis* seeds had been reported to be medicinal, aids in weight loss and improve blood sugar test in obese human volunteers (Ogunbufunm, 2014). *Irvingia gabonensis* seed oil can be pressed to produce an edible oil (solid at ambient temperature) or margarine which is used for cooking. The oil can also be processed further to produce soap, cosmetics or pharmaceuticals.

Onions (Allium cepa) is regarded as vegetable that belong to the lilly family. Onions has been found to be a medicinal food spice that contains mineral salts and is also rich in non-nutritive substances of major physiological activities such as essential oils and flavonoids. Its medicinal value include cure for common cold, heart diseases, osteoporosis and other diseases (Gazuwa, et al., 2013). Application of raw onions is said to be helpful in reducing swelling from bee strings, it is also reported that extracts from it could be used in the treatment of topical scars (Zurada et al., 2006).

The impact of a gummy texture is a desirable attributes in ogbono soup. The term “draw-soup” for ogbono reflects the ability of the mucilage to be drawn out in strings or tendrils and is a measure of the quality. Draw-soup is a special soup that is generally accepted in Nigeria.The food thickening property of *Irvingia gabonensis* is believed to be caused by mucilaginous polysaccharides, which become more viscous with cooking and it is called draw-ability (Ogunbufunm, 2014). The level of sliminess or draw-ability is a vital traditional attribute that determines the quality of the ogbono (Ladipo,1999).The use of onions in preparation of ogbono soup has been controversial due to the myth that it reduces the draw ability of the soup. Also the temperature and heating time is believed to affect the draw ability of the soup; hence the objective of the work is to ascertain the effect of these factors (heating time and onions) on the rheological properties of ogbono soup.

MATERIALS AND METHODS

The materials used for these work were *Irvingia gabonensis* seeds, onion bulbs, red oil and other soup ingredients such as salt, pepper, meat, fish, and vegetables.

Sample Preparation

Irvingia gabonensis seeds (500g) were sorted and ground into flour. The onion bulbs were peeled to remove the outer parts, washed, and chopped manually using stainless steel knife.

Proximate analysis:

Theproximate analyses of the *Irvingia gabonensis* sample were carried out using standard methods as described by AOAC (1990**)** for fat, ash, crude protein, moisture, crude fibre and carbohydrate.

Moisture Content Determination

The oven method was used. Five gram of the sample was weighed into a dried crucible. The sample was dried in a moisture extraction oven at 105^{o}C for 3hours. The dried sample was cooled in desiccators and weighed. They were dried again, cooled and reweighed. The process was repeated until a constant weight was obtained. The difference in weight before and after drying was recorded as moisture content. The experiment was done in triplicate.

$$\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where W_1 = initial weight of the empty dish

W_2 = weight of the dish+ undried sample

W_3 = weight of the dish + dried sample

Ash Content Determination

Two grams of the sample was weighed into a crucible and heated in a moisture extraction oven for 3hours at 100^{o}C before being transferred into a muffle furnace at 550^{o}C until it turned white and free of carbon. The sample was then removed from the furnace, cooled in desiccators and reweighed. The weight of the residue was then calculated as ash content. The experiment was done in triplicate.

$$\% \text{ Ash} = \frac{\text{weight of ash}}{\text{Weight of sample}} \times 100$$

Crude Protein Determination

Kjeldahl method was used. Two grams of the samples was weighed into the Kjeldahl flask followed by 0.1g of copper sulphate and 2.5g anhydrous sodium sulphate granules as catalyst. Concentrated sulphuric acid (25ml) and 10 anti-bumping glass beads were added to each flask. The samples in the flask were digested on the Kjeldahl apparatus. A light green colour was obtained after 2hours. The heating was stopped and the content (digest) in the flask changed from green to colourless. The flask was placed in the fume cupboard, covered with cotton wool; the digest was transferred into a 100ml volumetric flask and made up with distilled water. Ten millilitre portion of the digest was mixed with equal volume of 45% NaOH solution and poured into Kjeldahl distillation apparatus. The mixture was distilled and the distillate collected into 4% boric acid solution containing 3 drops of methylene blue indicator. A total of 50ml distillate was collected and titrated as well. The sample was duplicated and the average value taken. The nitrogen content was calculated and multiplied with 6.25 to obtain the crude protein content.

Determination of Fat

The fat content was determined using soxhlet extraction method. A 500ml capacity round bottom flask was filled with 300ml petroleum ether and fixed to the soxhlet extractor. Two grams of the sample was placed in a labelled thimble. The extractor thimble was sealed with cotton wool. Heat was applied to reflux the apparatus for six hours. The thimble was removed with care and the petroleum ether recovered for reuse. The flask was dried at 105^{o}C for 1 hour in an oven. The flask was cooled in desiccators and weighed. The experiment was done in triplicate.

$$\% \text{ fat} = \frac{\text{weight of fat}}{\text{Weight of sample}} \times 100$$

Determination of crude fibre

Two grams of the sample was digested in a conical flask with 200ml of 1.25% H_2SO_4 solution and boiled for 30 minutes. The solution and content were poured into Buchner funnel equipped with muslin cloth secured with an elastic band. This was allowed to filter out, and then the residue was washed with hot water to free the acid. The residue was scooped into the conical flask and digested with 200ml 0f 1.25% NaOH solution. The residues obtained were put in a clean, dried crucible and dried in the moisture extraction oven to a constant weight. The dried residues were placed in a muffle furnace until they turned into ash. They were cooled in a desiccators and weighed to enable calculation of the percentage crude fibre.

$$\% \text{ Crude fibre} = \frac{W_1 - W_2}{W_t} \times 100$$

Where; W_1 = weight of sample before incineration
W_2 = weight of sample after incineration
W_t = weight of original sample.

Determination of Carbohydrates
The carbohydrate was determined by difference and was calculated thus
Carbohydrates = 100 – (% moisture + % ash + % crude protein + % fat + % crude fibre)

Functional Properties Analysis:
Determination of water absorption capacity: One gram (1g) of the *Irvingia gabonensis* flour was weighed and mixed with 10ml distilled water for 30s in a mixer. The mixture was then allowed to stand for 1h at room temperature followed by centrifugation at 4000 rpm for 15min. The volume of supernatant was recorded. The amount of water absorbed was multiplied by its density and expressed as gram of water per gram of sample (Onwuka, 2005).

Determination of Oil Absorption Capacity: The same method was used to determine the oil absorption capacity of the sample. One gram of the sample was thoroughly mixed with 10ml of vegetable oil. The mixture was allowed to stand for 1hr and centrifuged at 4000rpm for 15 min. The amount of oil absorbed was multiplied by the density of the oil and expressed as gram of oil per gram of sample (Onwuka, 2005).

Bulk Density: The *Irvingia gabonensis* flour sample (10g) was weighed and poured into a graduated cylinder and tapped gently for 10 times on the bench to obtain a constant volume. The bulk density was measured as mass of the sample over the final volume.

Gelation and Boiling Points Determination: The flour sample (10g) was dispersed in distilled water in a 250-ml beaker and made up to 100ml flour suspension. A thermometer was clamped on a retort stand with its bulb submerged in the mixture; the mixture was stirred and heated using a heating system with a magnetic stirrer. The heating and stirring continued until the mixture began to gel and the corresponding temperature was recorded. The boiling temperature was also recorded.

Viscosity Measurement:
Heating time: One hundred and eighty grams (180g) of the *Irvingia gabonensis* flour were dissolved in 120ml of palm oil at 80^{o}C, water (240ml) was added to the mixture and stirred continuously until a homogenous mixture was obtained. The mixture was divided into six portions and subjected to different heating time (60,80, 100,120, 140,160)s. The viscosity of the samples was obtained using a Brookfield Digital viscometer model LVT one step spindle.
Addition of onions: Thirty grams (30g) of the ogbono flour were dissolved in 20ml of palm oil at 80^{o}C. Then 3g of the chopped onions and 40ml of water was added to the mixture and stirred continuously until a homogenous mixture was obtained. The viscosity of the mixture was obtained using a Brookfield Digital viscometer model LVT.The procedure was repeated for other samples with different quantities of onions (0, 6, 9, 12, 15, 18)g.

Sensory Evaluation:
The samples were used to prepare soup using the same recipe and procedure for each of them. The soup samples were subjected to sensory evaluation on draw ability, taste, mouth-feel, flavour and general acceptability using 25 semi trained panellists and 9-point hedonic scale of 9= extremely liked to 1 = extremely disliked.

Statistical Analysis: The results obtained were subjected to analysis of variance and least significant difference.

RESULTS AND DISCUSSION

The result of the proximate analysis showed that the African Bush Mango sample contained 74.3% fat, which signified that *Irvingia gabonensis* seed is an oil seed. The result was in agreement with the report of others (Ladipo, 1999: Onimawo, et al., 2003: Ogunsina et al.,2012). The value of the moisture content (6.1%) showed that the seeds had low moisture content. Low moisture content reduces microbial and enzyme activities through the lowering of water activity which results to longer shelf-life, no wonder the seeds could stay for months before going rancid. The fibre content was high. According to Ngondi *et al.*,(2005), Irvingia gabonesis seeds delay stomach emptying, leading to a gradual absorption of dietary sugar which can reduce the elevation of blood sugar level that is typical after a meal. It is also reported that the high fibre is what helps to lower low density lipoprotein (bad cholesterol) and relief from constipation. *Irvingia gabonensis* constitutes an important part of the natural diet in West Africa for controlling dietary lipids and weight gain (Ogunsina, *et al*., 2008). *Irvingia gabonensis* helps weight loss by inhibiting an enzyme called glycerol -3- phosphate dehydrogenase, and by doing this, it reduces the amount of blood sugar converted to fat.

Table 1: Chemical Composition of *Irvingia gabonensis* Seeds

Nutrients	Composition (W/W %)
Moisture	6.02± 0.2
Ash	2.05 ± 0.0
Fat	74.25 ± 0.2
Protein	5.91 ± 0.2
Carbohydrate	7.93 ± 0.3
Crude fibre	3.84 ± 0.2

Functional Properties
The result of the water absorption capacity was 5.05g/ml. The result of water absorption capacity could be due to the proportion of hydrophilic group and polar amino acids on the surface of the protein molecules or the water binding propertied of the *Irvingia gabonensis* flour. The oil absorption capacity of the sample was 2.27g/ml. The result may be due to the fact that the seeds are oil seeds. Also the hydrophobicity of proteins play a major role in oil absorption (Abdoulaye *et al.*2014). The ability to absorb water or oil is a very important property of all flours used in food preparations (Ikegwu et al., 2010).The oil absorption capacity is useful in structure interaction in food especially in flavour retention, improvement of palatability and extension of shelf life particularly in bakery or meat products (Abdoulaye *et al.*, 2014).
The *Irvingia gabonensis* sample gelation and boiling point temperatures were 82^{o}C and 60^{o}C which may be due toits high gelling capacity. The bulk density was found to be 0.47g/ml. Bulk

density is generally affected by the particle size and density of the flour and it is very important in determining the packing requirement, material handling and application in wet processing in food industry (Karuna *et al*., 1996), also it is a dispersion which can affect material flow consistency.

Table 2: Functional Properties of *Irvingia gabonensis*

Parameter	Value
Water absorption capacity	5.05g/ml
Oil absorption capacity	2.27g/ml
Gelation	82^{o}C
Bulk Density	0.47 g/ml
Boiling point	60^{o}C

Viscosity Results

The bar chart showed variation in the viscosity of the samples (Fig.1).The viscosity of the samples decreased as the heating time increased. It was reported that the viscosity of mucilaginous solutions are lower at higher temperatures and shear rates.

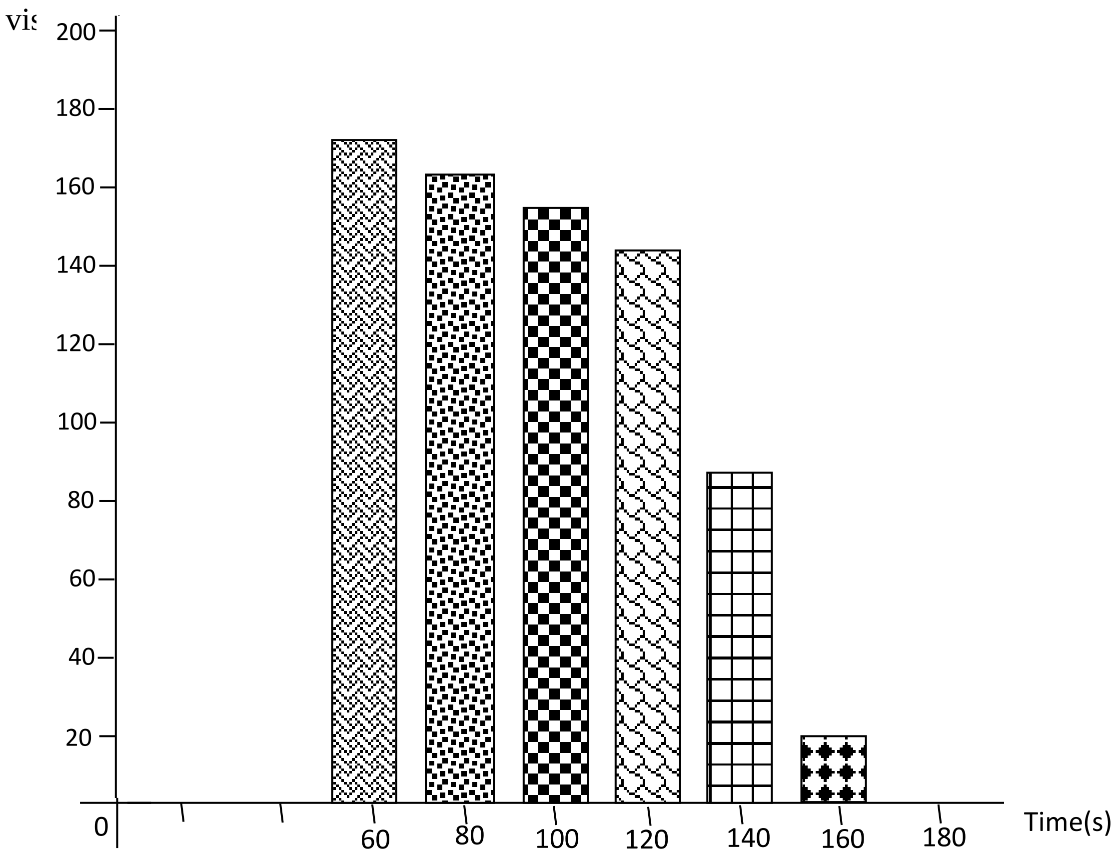

Fig 1: Bar Chart of viscosity against Heating Time of *Irvingia gabonensis* samples

The viscosity results in table 3 showed no significant differences ($p< 0.05$) between the samples containing different concentrations of onions, but there were significant differences ($p>0.05$)

between the samples subjected to different heating time. The result revealed that the concentration of onions in the samples did not affect the viscosity of the samples and therefore did not affect the draw ability of the samples.

Table 3:Result of the viscosities of the samples with different amount of onions

***Irvingia gabonensis* (g)**	3	6	9	12	15	18
Viscosity (cp)	128.0	129.7	107.0	113.7	95.7	112.0

Sensory Evaluation Result

The sensory evaluation result (Table 4)showed no significant difference (p>0.05) in terms of draw ability of samples heated from 60s to 100s, but there were significant differences (p<0.05) between samples as the heating time extends to 160s. The result of the taste showed significant differences (p<0.05) between sample A that was heated for 60s and sample E that was heated for 140s, the result may be attributed to the preference of the members of the panel. The flavour of the samples were also affected by the heating time, the result showed that heating time reduced the flavour compounds in the *Irvingia gabonensis* samples since flavour compounds are sensitive to heat. The samples were generally accepted except sample F with mean score of 4.32. The scores of other samples were above average score of 4.5 for a 9 point hedonic scale.

Table 4: Sensory scores of sample with different heating time

Samples	**A**	**B**	**C**	**D**	**E**	**F**
Drawabilty	8.04^{a}	7.96^{a}	7.16^{ab}	4.32^{b}	2.12^{c}	1.96^{d}
Taste	8.24^{a}	8.16^{a}	8.16^{a}	7.20^{ab}	6.84^{b}	7.24^{ab}
Mouth-feel	6.64^{a}	6.16^{ab}	5.92^{ab}	4.44^{b}	3.44^{c}	2.92^{d}
Flavour	8.36^{a}	8.00^{b}	8.24^{ab}	$7.6b^{c}$	7.48^{c}	6.72^{d}
General acceptability	7.88^{a}	7.84^{a}	7.96^{a}	6.32^{b}	5.32^{c}	4.32^{cd}

Mean values with same superscript in the same row are not significantly different (p<0.05)

Key

Sample A = sample heated for 60sSample B = sample heated for 80s

Sample C = sample heated for 100sSample D = sample heated for 120s

Sample E = sample heated for 140sSample F = sample heated for 160s

The sensory scores of the soup samples prepared with different quantities of onions were shown in table 5. There were significant difference (p<0.05) in terms of colour of the samples. The addition of onions must have affected the colour of the samples. In all the parameters evaluated, samples G,H and M had the best values in colour, flavour, mouth-feel and general acceptance. The results showed that sample I that contained 12g of onions had the least scores, the result suggested that other factors must have affected the scoring, since samples J,K and L contained higher amount of onions and samples G,H and M contained lesser and no onions. The samples were generally accepted since their mean scores were higher than the mean of a 9 point hedonic scale of 4.5.

Table 5: Sensory scores of sample with different quantities of onions

Samples	G	H	I	J	K	L	M
Colour	7.52^a	6.80^b	6.25^c	6.80^b	6.88^b	7.00^b	7.55^a
Flavour	7.80^a	6.60^b	4.88^c	6.76^b	6.76^b	7.24^{ab}	7.50^a
Mouth-feel	7.16^a	7.16^a	5.68^c	6.80^{ab}	6.4^{bc}	6.28^b	7.16^a
Drawability	7.04^a	7.00^a	5.88^b	6.80^a	6.96^a	6.88^a	7.05^a
General Acceptability	7.60^a	7.04^b	5.60^d	6.80^c	6.88^b	7.08^b	7.60^a

Mean values with same superscript in the same row are not significantly different ($p<0.05$)

Key

Sample G = sample with 3g of onions
Sample H = sample with 6g of onions
Sample I = sample with 9g of onions
Sample J = sample with 12g of onions
Sample K = sample with 15g of onions
Sample L = sample with 18g of onions
Sample M = sample without onions

CONCLUSION

Inclusion of onions in *Irvingia gabonensis* soup showed no significant different ($p<0.05$) in the viscosity properties of the samples, but there were significant differences ($P>0.05$) in the sensory attributes. The heating time had significant effect on the viscosity of the samples. The sensory evaluation results also revealed that heating time affected the draw ability and other parameters. The sensory evaluation result showed no significant difference ($p>0.05$) in terms of draw ability of samples heated from 60 to 100s, but there were significant differences ($p<0.05$) between samples as the heating time extends to 160s. In conclusion, onions should be included in *Irvingia gabonensis* soup preparation because of its nutritional importance.

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