The Effect of Storage Conditions on the Proximate and Rheological Properties of Soup Thickener *Brachystegia enrycoma* (Achi)

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Abstract: The effect of storage conditions on the proximate and rheological properties of 'Achi' (*Brachystegia enrycoma*), was studied for 12 weeks while analyses were carried out at 4 weekly intervals. The seed was subjected to five different storage conditions namely refrigeration, ambient, fire place (*Ngiga)*, plastic, and mud pot. The proximate composition values of 'Achi' decreased under all the storage condition after 12 weeks of storage except for moisture that increased at ambient and carbohydrates that also increased as a result of decrease in the other values. Rheological analysis showed a significant decrease ($p \leq 0.05$) for viscosity, water and oil absorption capacities, foaming and emulsifying capacities, swelling index, wettability and solubility as the storage time increased from I to 12 weeks. Also there was no significant difference ($p \geq 0.05$) in gelation, and bulk density as storage time increased from I week to 12 weeks.
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1.0 Introduction

Brachystegia enrycoma (Achi), is among the legumes found in the tropical and sub-tropical regions of the world. This food thickener is known to have originated from different areas and is commonly grown along river banks. It is known with different names in different parts of Nigeria with respect to different tribes and ethnic groups. *Brachystegia enrycoma* is called 'achi' by the Ibos; 'akolodo' by Yorubas, 'ukung' by the Efiks; and 'akpakpo' by Ijaws (Adewale and Mozie, 2010). *Brachystegia enrycoma* belongs to the family Caesalpinaceae; phylum spermatophyte and order fabacea. Other species include *Brachystegia allanii, B. leonnsis, B. lussel,* and *B. kenedy.*

Nutritionally, the importance of legumes such as *Brachystegia enrycoma* lies in high content of protein and lysine. They are usually limited in the sulfur-containing amino-acids particularly methionine. They are better source of phosphorous but only fair in their supply of iron and calcium (Okaka, *et al.*, 2006). 'Achi' contains about 10 – 32% protein, 18 – 47% CHO, 5.0% fat, 3 – 7% moisture and 6 – 8% crude fibre.

Brachystegia enrycoma (Achi) is used in preparing various soups. Achi is a favourite soup thickener in south eastern Nigeria because of its characteristic flavour which they impart in soups. Achi seed flour has good gelation properties and imparts a gummy texture when used in soup which is a desirable attribute for the eating of Gari, fufu, pounded yam etc.

As a result of increasing interest in the use of soup thickeners for food preparation and industrial purposes especially in new product development, the issue of storage condition as it affects the rheological properties of these soup thickener have become one of the optimum concern. Previous works on the rheological properties of soup thickener indicate that storage condition significantly affects its quality due to attack by pest and spoilage by micro-organisms. Therefore the need for selecting the most suitable storage cannot be overemphasized.

The objective of this research work therefore is to determine the rheological or functional properties of 'achi' stored in different storage conditions or environments.

2.0 Materials and Methods

'Achi' seeds used for this research work were purchased from a local market (Afo-oru) in Mbaise in Imo State. The chemicals used were of analytical grade and were obtained from the Department of Food Science and Technology, Federal University of Technology Owerri. The equipment and other materials were obtained from the Departments of Food Science and Technology and Crop Science and Technology, Federal University of Technology Owerri.

2.0.1 Sample Preparation

The 'Achi' seeds were sorted to remove dirts and stalks. One kilogram (1 kg) of cleaned seeds were conditioned to 25% moisture by adding 4 liters of distilled water and held for 3h at ambient temperature (28 ± 2^0C) with occasional stirring. This helps to ease

hull removal. The conditioned sample was dried at 50 – 60^0C in a Gallenkamp moisture extraction oven for 2h to a moisture content of 10%. The dried seeds were then dehulled using disc attrition mill and sieved with American Standard Sieve No 40 with 435 µm aperture. The samples were then stored for 12 weeks in five different storage conditions of refrigeration, fire place ('Ngiga'), plastic and mud pot including a control sample kept at ambient temperature. The samples were analysed every 4 weeks (monthly) for proximate composition and rheological properties.

3.0 Proximate Composition Analysis

This was carried out according to the method of AOAC (1990).

3.1 Moisture Content Determination

Two grams of each of the sample was weighed into dried weighed crucible. The samples was put into a moisture extraction oven at 105^0C and heated for 3h. The dried samples was put into desiccators, allowed to cool and reweighed. The process was reported until constant weight was obtained. The difference in weight was calculated as a percentage of the original sample

$$\text{Percentage moisture} = \frac{W_2 - W_1}{W_2 - W_3} \times \frac{100}{1}$$

Where

W_1 = Initial weight of empty dish
W_2 = Weight of dish + undried sample
W_3 = Weight of dish + dried sample

3.2 Ash Content Determination

Two grams of each of the samples was weight into crucible, heated in a moisture extraction oven for 3h at 100^0C before being transferred into a muffle furnace at 550^0C until it turned white and free of carbon. The sample was then removed from the furnace, cooled in a desiccator to a room temperature and reweighed immediately. The weight of the residual ash was then calculated as

$$\text{Percentage Ash} = \frac{\text{Ash Content}}{\text{Weight of original of sample}} \times \frac{100}{1}$$

3.3 Crude Protein Determination

The micro kjeldahl method described by A.O.A.C (1990) was used. Two grams of each of the samples was mixed with 10ml of concentrated H_2SO_4 in a heating tube. One table of selenium catalyst was added to the tube and mixture heated inside a fume cupboard. The digest was transferred into distilled water. Ten millimeter portion of the digest mixed with equal volume of 45% NaOH solution and poured into a kjeldahl distillation apparatus. The mixture was distilled and the distillate collected into 4% boric acid solution containing 3 drops of methyl red 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.

This is given as percentage Nitrogen

$$= \frac{(100 \times N \times 14 \times VF)\ T}{100 \times Va}$$

Where

N= Normality of the titrate (0.1N)
VF= Total volume of the digest= 100ml
T= Titre Value
Va= Aliquot Volume distilled

3.4 Fat Content Determination

Two grams of the sample was loosely wrapped with a filter paper and put into the thimble which was fitted to a clean round bottom flask, which has been cleaned, dried and weighed. The flask contained 120ml of petroleum ether. The sample was heated with a heating mantle and allowed to reflux for 5h. The heating was then stopped and the thimbles with the spent samples kept and later weighed. The difference in weight was received as mass of fat and is expressed in percentage of the sample.

The percentage oil content is percentage fat

$$= \frac{W_2 - W_1}{W_3} \times \frac{100}{1}$$

Where

W_1 = weight of the empty extraction flask
W_2 = weight of the flask and oil extracted
W_3 = weight of the sample

3.5 Crude Fibre Determination

Two grams (2g) sample and 1g asbestos were put into 200ml of 1.25% of H_2S0_4 and boiled for 30 minutes. The solution and content then poured into buchner funnel equipped with muslin cloth and secured with elastic band. This was allowed to filter and residue was then put into 200ml boiled NaOH and boiling continued for 30 minutes, then transferred to the buchner funnel and filtered. It was then washed twice with alcohol, the

material obtained washed thrice with petroleum ether. The residue obtained was put in a clean dry crucible and dried in the moisture extraction oven to a constant weight. The dried crucible was removed, cooled and weighed. Then, difference of weight (i.e. loss in ignition) is recorded as crucible fibre and expressed in percentage crude fibre

$$= \frac{W_1 - W_2}{W3} \times \frac{100}{1}$$

Where

W_1 = weight of sample before incineration
W_2 = weight of sample after incineration
W_t = weight of original sample

3.6 Carbohydrate Content Determination

The nitrogen free method described by A.O.A.C (1990) was used. The carbohydrate is calculated as weight by difference between 100 and the summation of other proximate parameters as

Nitrogen free Extract (NFE) percentage carbohydrate (NFE). = 100- (m + p + F + A + F_2)

Where
m = moisture
p = protein
F_1 = Fat
A = ash
F_2 = Crude fibre

4.0 Determinations of the Rheological Properties

4.1 Foaming Capacity and Stability

Foaming capacity and stability of the flour samples were studied according to the methods described by Desphande *et al* (1982). For stability, the flour sample (0.5g) was blended for 30 min in distilled water (40ml) at top speed in a blender. The whipped mixture was transferred into 100ml graduated cylinder. The blender was rinsed with 10ml distilled water and then gently added to the graduated cylinder. Foam volume in the cylinder was recorded per sample after 30 minutes standing. Triplicate measurements were taken for each sample and mean values recorded.

4.2 Emulsion Capacity

Emulsion capacity was determined according to A.O.A.C (1990). A flour sample (2g) and distilled water (100ml) were blended for 30sec at high speed of 100rpm. After complete dispersion, peanut oil was added from a burette in streams of about 5ml. blending continued until there appeared separation into two distinct layers (emulsion breakpoint). Emulsion capacity was expressed as grams of oil emulsified by 1g flour. Triplicate measurements was made *and average results taken.*

4.3 Bulk Density

Bulk density of flour samples were determined by weighing the sample (50g) into 100ml graduated cylinder, then tapping the bottom ten times against the palm of the hand and expressing the final volume as g/ml.

4.4 Wettability

The method of Onwuka (2005) was used. Into a 25ml graduated cylinder with a diameter of 1cm,1g of sample was added. A finger was placed over the open end of the cylinder which was invested and clamped at a height of 10cm from the surface of a 600ml beaker containing 500ml of distilled water. The finger was removed and the rest material allowed to be dumped. The wettability is the time required for the sample to become completely wet.

4.5 Viscosity

The method of Onwuka (2005) was adopted. Ten (10) percent of the flour was suspended in distilled water and mechanically stirred for 2h at room temperature. Oswald type Viscometer was used to measure the viscosity.

4.6 Water Absorption Capacity Determination

The method of Abbey and Ibeh (1998) was adopted for determination of water absorption capacity. Flour sample (1g) of each treatment was weighed separately (and also together with a clean, dry centrifuge tube, into which it was placed). Distilled water was mixed with the flour to make up to 10ml of dispersion. It was then centrifuged at 3500 rpm for 15 minutes. The supernatant was discarded and the tube with its contents reweighed as gram water absorbed per g of sample. The gain in mass was the water absorption capacity of the flour sample.

4.7 Oil Absorption Capacity

Two (2g) of sample was mixed with 20ml of oil in a blender at high speed for 30sec. Samples were then allowed to stand at 30^0C for 30 minutes then centrifuged at 1,000rpm for 30 minutes. The volume of supernatant in a graduated cylinder was noted. Density of water was taken to be 1g/ml and that of oil determined to be 0.93g/ml. Means of triplicate determinations were reported.

4.8 Swelling Index Determination

Three gram portions (dry basis) of each flour were transferred into clean, dry graduated (50ml) cylinders. Flour samples were gently leveled into it and the

volumes noted. Distilled water (30ml) was added to each sample; the cylinder was swirled and allowed to stand for 60 minutes while the change in volume (swelling) was recorded every 15 minutes. The swelling power of each flour sample was calculated as a multiple of the original volume as done by Ukpabi and Ndimele (1990)

4.9 Solubility Determination

The cold water extraction method, as described by Udensi and Onuora (1992), was adopted. Flour dispersion (10% w/v, db) was prepared with each of the flour samples by dispersing 1g (dry basis) of flour in 5 ml distilled water and making it up to 10ml. It was left for 60 minutes while it was stirred every 10 minutes. Then it was allowed to settle for 15 minutes after which 2ml of the supernatant were weighed in a dry Petri dish, evaporated to dryness and re-weighed. The difference in mass is the total soluble solids (Udensi and Onuora, 1992). Solubility was calculated as follows:

$$\text{Solubility} = \frac{\text{TSS (\%)}\ ((V_s M_e - M_d) \times 100}{2M_s \qquad 1}$$

Where

V_s = Total supernatant/ filtrate
M_d = Mass of empty, dry Petri dish
M_e = Mass of Petri dish plus residual solid after evaporative drying
M_s = mass of flour sample used in the preparation of the dispersion.

4.10 Gelation Capacity

The method of Onwuka (2005) was adopted in the determination of gelation capacity. A sample suspension of 2.20% (w/v) in 5ml of distilled water was prepared in test tubes. The samples were heated for 1h in a boiling water bath followed by rapid cooling under running cold tap water. The test tubes were then cooled further for 2h at 4oC. The gelation capacity is the least gelation concentration determined as the concentration when the sample from the inverted test tube will not fall or slip.

5.0 RESULTS AND DISCUSSION

5.1 The Effect of Storage Condition on the Proximate Composition of "Achi"

The mean value for protein of 'achi' as affected by storage condition is shown in Table I below. The crude protein content for the control samples before storage was 10%. This reduced to 9.40% after 12 weeks of storage under ambient conditions. The protein content of 'Achi' was reduced by the different storage conditions. 'Achi' stored under fire place (Ngiga) gave the least value after 12 weeks of storage (8.50%), while refrigeration had the highest retention of protein after 12 weeks storage. The high temperature employed in fireplace storage may have caused more protein denaturation (Pushpamma and Uma, 1979). Though the protein content of the control sample was low (10%), the storage under refrigeration conditions could be the best way of storage in order not to loose much of the protein if protein is the main requirement aimed at during this storage.

Table 1: Mean Values for the Proximate Composition of 'Achi' As Affected By Different Storage Condition

Storage Condition Time	Moisture %	Ash %	Fat %	Crude Fibre %	Crude Protein %	CHO %
Control (0h)	8.50^{a}	4.00^{a}	8.45^{a}	8.50^{a}	10.0^{a}	62.17^{c}
After 12 wks						
Refrigeration	8.00^{b}	2.00^{b}	7.80^{b}	7.50^{c}	9.50^{a}	65.20^{b}
Plastic	8.10^{a}	1.91^{b}	7.68^{b}	7.41^{c}	9.02^{bc}	65.40^{b}
Mud pot	8.02^{b}	1.89^{b}	7.60^{b}	7.60^{b}	9.05^{bc}	65.84^{b}
Fire place	7.00^{c}	1.84^{b}	7.00^{c}	7.60^{b}	8.50^{c}	68.66^{a}
Ambient	8.62^{a}	1.88^{b}	7.70^{b}	7.75^{b}	9.40^{b}	64.70^{b}
LSD	**0.404**	**0.792**	**0.292**	**0.248**	**0.578**	**1.450**

a,b,c means with the same superscript on the same column are not significantly different at ($p \geq 0.05$)

Table 1 also shows the effect of storage condition and duration on the proximate condition of 'Achi'. The original moisture content was 8.5%. There was a significant decrease ($p \leq 0.05$) in their moisture content under the different storage conditions as storage time increased up to the 12^{th} week. The result also showed that storage of Achi under fireplace (Ngiga) lost moisture rapidly compared to the other storage conditions. This could be attributed to the fact that heat or higher temperature causes loss of moisture in foods (Dengate, 1984).

On the ash content, the initial value of 4.00% continuously decreased as at the time of storage of 12 weeks. There was a significant difference ($p \leq 0.05$) between the control (stored at 0h) and all the other samples after 12 weeks. The lowest value was recorded for samples stored under fireplace (1.84%). This decrease could be attributed to destruction of the minerals present by heat as ash depicts the mineral contents in food materials.

The fat content of the control sample was 8.48%. The lowest value was recorded for those samples stored under fireplace with a value of 7.00% because fat in foods reduce rapidly under high temperatures. This shows also that 'Achi' has a high fat content more than other legumes like 'Ukpo' and 'Ofo' as that has 5% and 6% respectively as reported by Sirivongpaisal (2008). The fat content was retained more under refrigeration (7.80%) than the other storage conditions.

The recorded crude fibre content was 8.50%. This value decreased with storage with plastic storage having the lowest value of 7.41% after 12 weeks of storage. There were significant differences between the control sample and all the other samples.

The carbohydrate content of raw 'achi' was 62.17%. There was a significant increase ($p \leq 0.05$) in the carbohydrate content of Achi during storage. This increase was highest under fireplace storage of 68.66%, the slight increases in CHO value shows a reduction in the moisture content and other proximate composition parameters.

5.2 The Effect of Storage Condition on the Rheological Composition of "Achi"

The bulk density of Achi stored in different conditions ranged from 1.44 to 0.116 (g/g) as shown in Table 2 below. The highest bulk density was observed when 'Achi' was stored at refrigeration temperature for a period of 12 weeks. This was closely followed by storage in mud pot for 12 weeks. This result showed that long storage at refrigeration and mud pot conditions increased the bulk density of 'Achi' flour. This result shows an increase in low temperature storage as against high temperature storage. The results were statistically different ($p \leq 0.05$). This finding is in agreement with the work of Banigo and Mepba (2008) who reported that bulk density of legume flours decrease at high temperature and increase at low temperature.

The water absorption capacity (WAC) of Achi ranged from 2.70 – 0.70g/g as seen in Table 2. The highest was observed under refrigeration condition of 2.70g/g and 2.40g/g at the 12^{th} and 8^{th} weeks respectively. This was followed by storage under fireplace of 2.14g/g also at 12^{th} week of storage. There were significant differences ($p \leq 0.05$) between the values obtained in water absorption of the samples. Water absorption capacity refers to the water retained by protein. Protein is capable of binding large quantities of water due to their ability to form hydrogen bonds between molecules and polar group on the polypeptide chain.

The viscosity of 'Achi' was highest in the samples stored under fireplace. The longer they stored, the higher the viscosity. Also there was no significant difference ($p \geq 0.05$) between the samples stored in all the conditions. It was also observed that mud pot storage closely followed that of fireplace in the viscosity levels. This result is in agreement with the findings of Enwere (1986) that legume flours have high viscosity under high temperature, which indicates that these flours are more resistant to swelling and rupture towards shear. The factors which may influence this property include the size and shape of the starch granules, presence or absence of fat and protein and perhaps molecular size and degree of branching of starch fractions (Schoch and Maywald, 1968). As a result of high viscosity it can be incorporated in various food formulas in foods that require high thickening e.g. soups.

The solubility of legume flours according to Table 2 showed that samples stored at refrigeration conditions had the lowest solubility values of 4.93 to 7.98%. This was closely followed by the ambient condition of 5.96 – 7.98%. The highest solubility value was recorded by samples stored at fireplace which ranged from 7.98 – 8.09% within the four weeks of storage. There was no significant difference ($p \leq 0.05$) between the solubility of samples stored under plastic condition and fireplace throughout the 12 weeks storage period. There was a significant difference among the samples stored at ambient refrigeration and mud pot within the twelve weeks of storage. Low solubility of legume starches with increase at elevated temperature had been reported by winkles (1985); Henshaw and Abebowale (2004); Lawal *et al* (2004) and Yusuf *et al*, (2007). Banigo and Mepba (2008) suggested that water penetration into the granules can be achieved at elevated temperatures.

5.2.1 Gelation

The highest gelation capacity was recorded for products that were stored in plastic containers and refrigeration which ranged from 14.00% for the 1^{st} week to 20.00% for the 12^{th} week. This was closely followed by those stored at ambient conditions which had up to 18% to 19% as the highest gelation capacity. There were significant differences ($p \leq 0.05$) between the samples in all the storage conditions.

Table 2: Rheological/Functional Properties of Achi

Storage condition	Wk(s)	Bulk Density (g/g)	WAC (g/g)	OAC (g/g)	Wettability (sec)	Viscosity (Cp)	Solubility (%)	Gelation (%)	Swelling Index (g/g)	Emulsion Capacity (%)	Foaming Capacity (%)
Refrigeration	1	1.44^{d}	1.60^{d}	1.40^{a}	55.00^{a}	18.10^{a}	7.980^{a}	14.00^{d}	1.25^{a}	45.50^{a}	2.00^{a}
	4	1.73^{c}	2.10^{c}	1.22^{b}	50.00^{b}	15.90^{ab}	5.66^{ab}	18.00^{c}	1.21^{a}	40.90^{ab}	1.30^{b}
	8	1.99^{b}	2.40^{b}	1.00^{b}	45.00^{c}	14.70^{ab}	5.21^{b}	19.00^{b}	1.12^{a}	35.50^{b}	1.10^{c}
	12	2.31^{a}	2.70^{a}	0.73^{c}	40.00^{d}	11.30^{b}	4.93^{b}	20.00^{a}	1.00^{a}	31.50^{b}	1.00^{c}
Plastic	1	1.44^{b}	1.60^{a}	1.40^{a}	55.00^{a}	18.10^{a}	7.980^{a}	14.00^{d}	1.25^{a}	45.50^{a}	2.00^{a}
	4	1.55^{a}	1.40^{b}	1.32^{a}	53.00^{a}	17.20^{a}	7.50^{a}	17.00^{c}	1.21^{a}	44.20^{a}	1.90^{a}
	8	1.59^{a}	1.10^{c}	1.22^{a}	51.00^{b}	16.30^{a}	7.21^{a}	19.00^{b}	1.19^{a}	41.20^{a}	1.60^{b}
	12	1.65^{a}	0.80^{d}	1.20^{a}	49.00^{b}	14.30^{a}	7.09^{a}	20.00^{a}	1.11^{a}	39.10^{b}	1.60^{b}
Mud pot	1	1.44^{c}	1.60^{a}	1.40^{a}	55.00^{a}	18.10^{a}	7.980^{a}	14.00^{d}	1.25^{a}	45.50^{a}	2.00^{a}
	4	1.92^{b}	1.40^{b}	1.32^{a}	51.00^{b}	18.00^{a}	7.72^{a}	16.00^{c}	1.24^{a}	45.20^{a}	1.70^{b}
	8	1.99^{ab}	1.20^{c}	1.21^{a}	51.00^{b}	16.50^{a}	7.58^{a}	17.00^{b}	1.22^{a}	45.10^{a}	1.40^{c}
	12	2.10^{a}	0.90^{d}	1.11^{a}	49.00^{b}	14.40^{a}	5.89^{b}	18.00^{a}	1.22^{a}	41.20^{a}	1.20^{d}
Fireplace	1	1.44^{a}	1.60^{b}	1.40^{b}	55.00^{c}	18.10^{a}	7.980^{a}	14.00^{a}	1.25^{c}	45.50^{a}	2.00^{a}
	4	1.30^{b}	1.80^{b}	1.60^{ab}	60.00^{b}	19.20^{a}	7.99^{a}	10.00^{b}	1.90^{b}	40.20^{a}	1.50^{b}
	8	1.13^{c}	194^{b}	1.80^{a}	68.00^{a}	22.10^{a}	8.09^{a}	5.00^{c}	2.10^{b}	31.20^{b}	1.30^{c}
	12	0.116^{c}	2.14^{a}	1.00^{c}	71.00^{a}	22.10^{a}	8.09^{a}	2.00^{d}	2.70^{a}	25.50^{c}	1.10^{d}
Ambient	1	1.44^{c}	1.60^{a}	1.40^{a}	55.00^{a}	18.10^{a}	7.980^{a}	14.00^{d}	1.25^{a}	45.50^{a}	2.00^{a}
	4	1.53^{b}	1.30^{b}	1.34^{a}	54.00^{a}	17.10^{a}	9.60^{a}	17.00^{c}	1.23^{b}	46.10^{a}	1.60^{b}
	8	1.63^{b}	1.10^{bc}	1.25^{a}	52.00^{a}	16.50^{a}	6.00^{b}	18.00^{b}	1.21^{c}	47.30^{a}	1.40^{c}
	12	0.116^{c}	0.70^{c}	1.20^{a}	50.00^{b}	15.20^{a}	5.69^{b}	19.00^{a}	1.22^{c}	50.10^{a}	1.10^{d}
LSD		**0.116**	**0.297**	**0.316**	**3.939**	**6.144**	**2.704**	**0.695**	**0.430**	**6.687**	**0.105**

5.2.2 Swelling Index

The swelling index in the different storage conditions ranged from 1.25g/g to 2.70g/g. The highest value of 2.70g/g was observed amongst samples that were stored over fireplace for 12 weeks. This means that high temperature increased the values of the swelling index. There was no significant difference (p=0.05) in the swelling index of samples stored under refrigeration conditions, plastic containers and mud pot while significant increase (p≤0.05) occurred in those stored at fireplace and also there was significant decrease (p≤0.05) among those stored at ambient conditions.

The emulsion capacity of Achi stored in different conditions was affected by storage time and conditions of storage. It was observed that there was a decreasing trend in refrigeration, plastic, mud pot and fireplace storage conditions while an increasing trend was observed in ambient storage after twelve weeks. There was a significant difference (p≤0.05) during storage in refrigeration and fireplace while no significant difference (p≥0.05) occurred at storages in mud pot and ambient for the twelve weeks storage periods. The solubility of a protein is usually affected by emulsifying activity. This could be because of its hydrophilicity of hydrophobic balance, depending on the surface active agent, can form and stabilize the amino-acid composition, particularly the protein emulsion by creating electrostatic repulsion on oil surface (Moure *et al*, 2006).

On the foaming capacity of the stored 'Achi' samples it was observed that there were significant differences (p≤0.05) amongst all the storage conditions for the twelve weeks of storage. It was also noted that there was a decreasing trend in the foaming capacity among all the storage condition.

This indication shows that storage of this product under any of the conditions does not improve foaming rather the intermolecular cohesive and elastic polymers responsible for producing stable forms are lacking (Tang *et al* 2003). From this result it could be deduced that storage of this seed under any of this conditions is not advisable for products where foaming is an important requirement.

CONCLUSION

From the result of the proximate composition, it was observed that there was a decreasing trend in all the parameters except for the CHO value. This shows that storage of 'Achi' under these conditions for a long period of time decreases the quality of this food since

proximate composition is an index of quality characteristics.

On the functional/rheological properties, it could be said that storage under fireplace improved most of this properties like viscosity, wettability, swelling index and solubility. These improvements are required in various food formulations. Also decreases in properties like bulk density, water absorption capacity and gelation properties are also required in areas like packaging, transportation and storage. Also increases in some parameters and conditions of storage like emulsion shows that these products can be stored under these conditions for better utilization. Consequent to these observations, it is required that 'Achi' be grown in large quantities and stored in conducive environments depending on the final usage in order not for it to get into extinction.

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