The Effects of Steeping with Chemicals (Trona and Alum) on the Functional Properties and Proximate Composition of Asparagus Bean (*Vigna sesquipedalis)*

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Abstract: Asparagus bean (*Vigna sesquipedalis*) was steeped in alum and trona of different concentrations for 24h and 48h, changing the steep solution at 6h intervals. The steeped beans were dehulled, dried and milled into flour. Proximate composition and functional properties of the bean flour were determined for each sample. The result obtained from the proximate analysis showed that samples steeped in trona had an increase in the ash, fibre and carbohydrate contents and a decrease in the moisture, protein and fat content of the beans as concentration and time increased. This was also applicable to samples steeped in alum, but with slight variations. Both alum and trona effected an increase in wettability and water absorption capacities of the flour samples and a decrease in the oil absorption capacities. Opposite effect was observed in the case of bulk density, swelling index, gelling point temperature, foam capacity, boiling point temperature, pH and viscosity. The result from this study are indicative that good manipulation of the steeping time, steeping solution and steeping solution concentration can be used to modify the functionality of Asparagus bean and as such could be used in different food formulations, like ice cream, sausages. [Nature and Science 2010;8(9):111-120]. (ISSN: 1545-0740).

Key words: functional properties, steeping, dehulling.

1. Introduction

Asparagus bean (*Vigna sesquipedalis*) also known as long-podded cowpea, snake bean or yard-long bean, is an annual crop that belongs to the leguminous family and sub-family of papilonaceae (Ihekoronye and Ngoddy, 1985). In the Igbo speaking part of Nigeria, it is commonly known as "Akidi oji". Asparagus bean is a climbing plant closely related to cowpea or black eye pea, with each pod containing several edible seeds (Wikipedia, 2005). "Akidi oji" (a black vigna specie at full maturity) is grown mostly in the eastern part of Nigeria e.g. Ebonyi state, Enugu state, Abia state etc.

The chemical composition of Asparagus bean is similar to that of most edible legumes. It contains about 23% protein, 62% carbohydrate and minute amount of other nutrients (Nnayelugo *et al.,1995);* they are good sources of vitamins A and C, folate, magnesium, manganese, riboflavin, phosphorous and potassium (Wikipedia, 2005). Thus the major nutrient is protein and carbohydrate of which its variability in protein is influenced by genotype as well as environmental factors (Bliss, 1975).

Asparagus beans are consumed in different forms mostly in the eastern part of Nigeria and the country at large. Various types of products are traditionally produced from it through soaking, dehulling, grinding, boiling, steaming, frying or by combination of any two or more of these methods. The tender, crisp pods are eaten both fresh and when cut into short sectors for cooking purposes. Wikipedia (2005), found that they are best if picked for vegetable use before they reach full maturity, though the matured seed can be utilized as cooked beans or converted into paste or flour for subsequent use in "Akara" (by frying) or moin-moin (by steaming) (Uzuegbu and Eke, 2000).

Many authors have stressed the important role beans play in the diets of many populations in countries where protein is deficient. This has promoted research on various species and aspects of bean utilization. William (1974) studied the various qualities that determine consumer preference and identified the following in descending order of priority: - ability to swell when cooked, good bonding properties and desirable sensory properties such as flavor and texture. As a result of economic recession, the majority of Nigerians now derive protein mainly from bean species, because the country is faced with acute shortage of animal protein, which is often beyond the reach of an average Nigerian (Henshaw and Sanni, 1995). The choice of beans by Nigerian women is guided predominantly by the cooking time, swelling capacity, taste and colour (Hussain *et al.,* 1984).

The matured seed of Asparagus bean has been found to have limitations such as long cooking time,

reduced swelling ability, and production of black coloured liquid during cooking. Also dehulling of the dry and soaked seeds is of great difficulty to the traditional man. This has seriously affected its use for food products that requires dehulling e.g. Moin-moin. Other problems associated with Asparagus bean is flatulence and beany off flavour. These have affected the consumption rate and acceptability of "Akidi oji" for subsequent processes. For these reasons, it is necessary to determine its major components such as lipids, moisture, protein etc, with respect to the characteristics that govern their behaviors during processing, storage and preparation, as they affect the qualities and acceptability of this bean.

Therefore, the main objective of this research work is to investigate the effect of steeping Asparagus bean in different chemicals (Trona and Alum), on the proximate composition and functional properties of the beans.

It is hoped that this will help to expose the functionality of Asparagus bean and hence its increased utilization in food formulations and processing.

2. Materials and Methods

2.1 Collection of Materials

Asparagus bean seed used was obtained from a local market in Enugu state. The chemicals and equipment/facilities were obtained from Ekeonunwa market, in Owerri, Imo State; processing laboratory of Food Science and Technology, and crop Science and Technology Federal University of Technology Owerri and they are of high grade standard.

2.2 Production of Bean Flour

Dry seeds of Asparagus bean (150g) each were sorted, washed and steeped in required solutions for 24h and 48h. After 24h half of each sample was collected for further processing, the steep solution being changed at 6h intervals.

The steep solutions were prepared using alum and trona powder on dry matter basis (dmb), with the solution variation based on concentration difference, ranging from 0%, 0.25%, 0.5%.....2.0%. At the end of each steeping time, the samples were dehulled manually, dried and milled separately into flour.

After which they were stored in air tight containers at room temperature, ready for use in analysis.

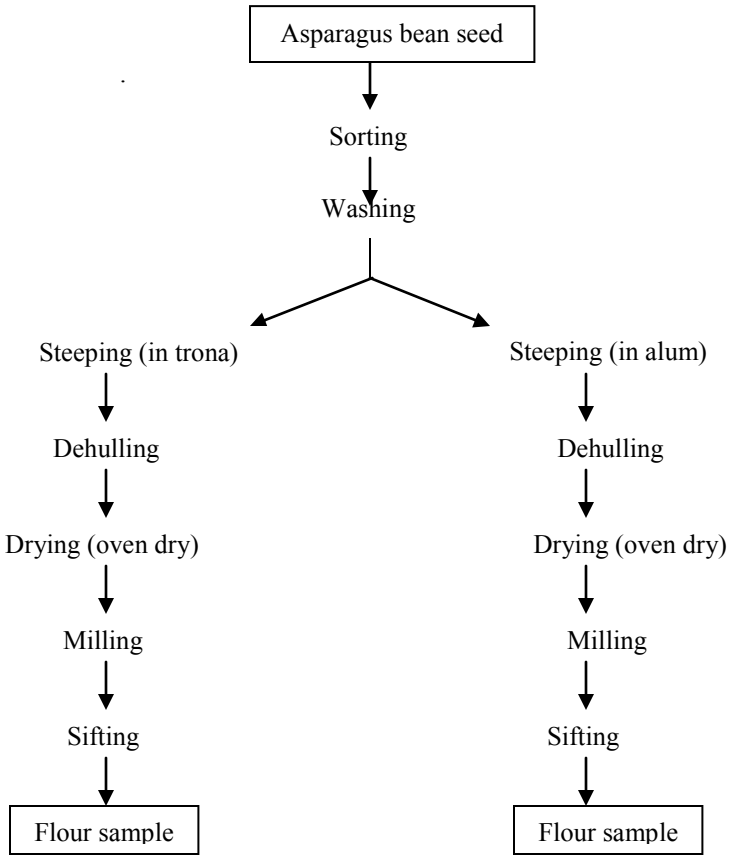

Figure1:- Flow diagram for the production of Asparagus bean flour.

3. Analyses of Flour Samples

All samples were subjected to analysis, to determine the proximate composition and functional properties as affected by processing conditions.

3.1 Proximate Analysis

The standard AOAC (1990) methods were used to determine proximate composition of the flour samples.

3.1.1 Determination of Crude Fibre

Using the digestion method, flour sample (2g) of each treatment was digested in a conical flask with 200ml of 1.25% H_2S0_4 solution under reflux for 30min boiling. The digest was allowed to cool before filtration, using Buchner funnel equipped with muslin cloth, secured with elastic band thrice. Then residue was washed thrice with hot distilled water, scooped into a conical flask and digested with 200ml of 1.25% NaOH solution under reflux for 30min boiling. After which the cool digest was filtered and with the help of distilled water washed thrice.

Finally the residue was transferred into a clean dry, weighed porcelain dish and dried in the oven at 85^{o}C to constant weight. This immediately placed in a muffle furnace at 550^{o}C for 4h, withdrawn, cooled in dessicator and weighed. The difference in weight was calculated and reported as crude fibre.

3.1.2 Determination of Moisture Content

The oven method was used each sample (2g) of flour was weighed into a dried metallic crucible of known mass. They were placed into the oven at 105^{o}C for 3h, withdrawn into a dessicator to cool and weighed. They were again reheated /dried, cooled, reweighed and reheated. This process was repeated until relatively constant mass was realized. The difference in the masses before and after drying was recorded as moisture content.

3.1.3 Determination of Ash Content

After moisture determination, the dried flour was transferred into a muffle furnace for 4h at 550^{o}C. After which it was cooled in a dessicator, weighed and recorded. The weight of incinerate calculated as ash content.

3.1.3 Determination of Crude Protein

Flour samples (0.1g) each, was weighted into a dried 50ml digestion flask. A pinch of $CaSO_4$ and Na_2SO_4 mixed in the ratio 1:10 respectively was added and 20ml of conc. H_2SO_4 also added for digestion. The flask was placed in a kjedahl heating digester slanted at about 45% and digested for 30min or until the black aqueous solution turns light green. It was cooled to room temperature and transferred quantitatively to a 100ml volumetric flask. The digestion flask was then rinsed into the digester and its volume made up to 100ml mark with distilled water. The same procedure was carried out for a blank in the absence of test sample.

The diluted digest (10ml) was pipetted into a distillation flask. Then 10ml of 2% Boric acid received in a 50ml beaker and two drops of mixed indicator added to give a brown colouration. The tip of the delivery tube was sure to extend above the surface of the boric acid solution. Then 10ml of 40% NaOH, was poured into the distillation flask and distillation unit switched on. Distillation continued until the boric acid solution colour changed from brown to blue. The resultant solution was titrated over 0:1NHCl until an observable colour change from blue to pale pink / peach noticed. Titre value was noted and recorded then the protein content calculated as

$$\% \text{ protein} = \frac{(T-B) \times NHCl \times 0.00014 \times \text{made volume} \times 100 \times 6.25}{\text{Aliquot} \times \text{weight of sample used.}}$$

Where, T = Titre value of the sample.

B = Blank title value

NHCl = Normality of HCl used.

$$\text{Aliquot} = \frac{\text{volume of diluted digest used}}{\text{Volume it was made up to}} \times \frac{10}{100} = 0.1$$

The same procedure was carried out for each sample

3.1.3 Determination of Crude Fat

Each test flour (2g) was wrapped in a filter paper, weighted and noted. Gradually it was lowered into the thimble, fitted to a flask containing a solvent (hexane). The round bottom flask in the soxhlet extraction unit was slowly heated for 3h. The filter paper with spent (de-fatted) flour were removed from the extractor and the reflected solvent distilled oil was recovered. The filter paper and spent flour were dried at 85^{o}C, cooled and weighed. The difference in mass was calculated as crude fat.

3.1.3 Determination of Carbohydrate

This component was determined by difference**.** This approach was adopted on the premise that vitamins and minerals occurred in minute (negligible) quantities. The percentage value of moisture, ash, fat, fibre and protein contents were summed up and subtracted from 100% to obtain the value of carbohydrate content in each test flour.

3.2 Analysis of the Functional Properties

3.2.1 Determination of Bulk Density

Method as described by Onwuka (2005) was adopted. A graduated cylinder (10ml) was weighed dry and gently filled with the test flour. The bottom of the cylinder then gently tapped on a laboratory bench several times. This continued until no further diminution of the test flour in the cylinder after filling

to 10ml mark, was observed. Weight of cylinder plus flour was measured and recorded.

Bulk density (g/ml) = weight of sample (g) / Volume of sample (ml)

3.2.2 Determination of pH

A 10% ($^{M}/_{V,}$ dmb) flour suspension for each sample was prepared and allowed to settle at room temperature ($30^{o}C \pm 2^{o}C$) for 15min.The pH meter switched on and allowed for 15min to stabilize. The electrodes were standardized chemically, using buffer solution of pH 7, 4 and 9 respectively; the electrode was then inserted into the test suspension and the pH value read and recorded as described by Onwuka (2005).

3.2.3 Determination of Water Absorption Capacity

The method of Sosulski (1962) as described by Abbey and Ibeh (1988) was adopted. Test flour (1g) of each treatment was weighed out into a dry, clean centrifugal tube and both weight noted. 10ml of distilled water was poured into the tube and properly mixed with the flour to make a suspension. It was then centrifuged at speed of 3500 rpm for 15min. After which, supernatant was discarded then the tube and its content re-weighed and noted. The gain in weight is the water absorption capacity of the test sample.

3.2.4 Determination of Oil Absorption Capacity

The method of Sosulski (1962) as described by Abbey and Ibeh (1988) was adopted. One gram (dmb) of each flour sample was weighed into a dry, clean centrifuge tube and both weight noted. 10ml of Gino Vegetable oil was poured into the tube and properly mixed with the flour. The suspension was centrifuged at 3500rpm speed for 15min then, the supernatant was discarded and the tube with its content re-weighed. The gain in mass is the oil absorption capacity of the sample.

3.2.5 Determination of Swelling Index

A portion (3g) of each flour sample was weighed into a clean, dry, graduated (50ml) cylinder. The flour sample gently leveled in the cylinder and the volume noted. 30ml of distilled water was added to each sample. The swirled cylinder was allowed to stand for 60min, while the change in volume recorded every 15min. The swelling power index of each flour sample was calculated as a multiple of the original volume as done by Ukpabi and Ndimele (1990).

3.2.6 Determination of Viscosity

Adopting Onwuka (2005) method, 10% ($^{m}/_{v}$ dmb) flour suspension for each sample was prepared at room temperature. Meanwhile the viscometer was switched on and allowed to stabilize for 15min. The suspension was continually stirred prior to insertion of the spindle pin. The spindle pin was inserted and its dial value read and recorded. The Brookfield dail viscometer was used, with spindle number two.

Viscosity = dial value x multiple factor.

3.2.7 Determination of Wettability

This as described by Onwuka (2005) was adopted. One gram each flour sample was placed in a clean, dry, measuring cylinder (10ml). Placing a finger over the open end, the cylinder was inverted and clamped at a height of 10cm from the surface of a 600ml beaker containing 500ml of distilled water. The flour in the cylinder was gradually spread on the surface of the water on moderate speed. The time taken for the sample to be completely wet is noted as wettability.

3.2.8 Determination of Gelling and Boiling Points

The method of Narayana and Rao (1982) was adopted.

The flour sample (10g) was dispersed in distilled water, in a 250ml beaker and made up to 100ml. A thermometer was clamped on a retort stand with its bulb submerged in the suspension. With a magnetic stirrer the suspension was continuously stirred and heated. This continued until the suspension began to gel and the corresponding temperature recorded. The temperature as soon as boiling commenced was also noted and recorded.

3.2.9 Determination of Foam Capacity

The method as described by Onwuka (2005) was adopted in the determination of foam capacity. Test flour (2g) each was mixed in 100ml distilled water and its volume noted. The suspension was blended with a warming blender at 1600rpm for 5min. It was then poured into a 250ml measuring cylinder, its volume noted and recorded.

Using Abbey and Ibeh (1988) formula, foam capacity expressed percentage increase in volume is as follows

Foam capacity =

$$\frac{\text{Volume after whipping} - \text{volume before whipping}}{\text{Volume before whipping}} \times \frac{100}{1}$$

3.2.10 Determination of Emulsion Capacity

The procedure of Beuchat *et al.,* (1975) as described by Eke (2002) was adopted. Flour sample (2g) each and 75ml of distilled water were blended for 30s using a magnetic stirrer. After complete dispersion deodorized vegetable oil (Gino oil) was added continuously through a burette until emulsion breakpoint, separation into 2 layers was reached. The emulsion capacity was expressed as ml of oil emulsified per g of flour.

Results: The results of the proximate and functional properties of the flour samples are shown in tables 1, 2 and 3 below

Table 1: Mean-ANOVA table on the proximate composition of flour from asparagus bean

Steeping time	Steeping conc.	Trona						Alum					
		Protein	Fat	Ash	Fibre	MC	CHO	Protein	Fat	Ash	Fibre	MC	CHO
24h	0.00%	22.84 [a]	2.10 [a]	3.08 [a]	2.48 [a]	8.30 [a]	61.80 [a]	22.84 [a]	2.10 [a]	3.08 [a]	2.48 [a]	8.30 [a]	61.80 [a]
	0.25%	21.70 [a]	1.99 [a]	3.85 [a]	3.34 [a]	8.58 [a]	60.48 [a]	22.78 [a]	1.99 [a]	3.81 [a]	2.54 [a]	8.25 [a]	60.56 [a]
	0.50%	21.62 [a]	1.95 [a]	3.87 [a]	3.37 [a]	8.56 [a]	60.63 [a]	22.77 [a]	1.98 [a]	3.82 [a]	2.67 [a]	8.25 [a]	60.65 [a]
	0.75%	21.55 [a]	1.85 [a]	3.89 [a]	3.39 [a]	8.23 [a]	61.08 [a]	22.64 [a]	1.98 [a]	3.83 [a]	2.77 [a]	8.15 [a]	60.61 [a]
	1.00%	21.41 [a]	1.77 [a]	3.90 [a]	3.42 [a]	8.11 [a]	62.11 [a]	22.09 [a]	1.97 [a]	3.85 [a]	2.83 [a]	8.13 [a]	61.13 [a]
	1.25%	21.05 [a]	1.75 [a]	3.91 [a]	3.45 [a]	7.24 [b]	62.60 [b]	22.04 [a]	1.92 [a]	3.86 [a]	2.85 [a]	8.13 [a]	61.20 [a]
	1.50%	20.97 [b]	1.71 [a]	3.94 [a]	3.48 [a]	6.97 [b]	62.93 [b]	21.91 [a]	1.81 [a]	3.90 [a]	2.88 [a]	7.50 [b]	62.00 [a]
	1.75%	20.88 [b]	1.70 [a]	3.97 [a]	3.49 [a]	6.81 [b]	63.16 [b]	21.74 [a]	1.74 [a]	3.95 [a]	2.90 [a]	7.41 [b]	62.26
	2.00%	20.85 [b]	1.69 [a]	3.98 [a]	3.50 [a]	6.72 [b]	63.25 [b]	21.69 [a]	1.73 [a]	3.97 [a]	3.01 [a]	6.14 [c]	63.26 [b]
	LSD	**1.88**	**ND**	**ND**	**ND**	**0.729**	**2.011**	**ND**	**ND**	**ND**	**ND**	**0.336**	**1.73**
48h	0.00%	22.75 [a]	2.01 [a]	3.10 [a]	2.51 [a]	9.52 [a]	60.11 [a]	22.75 [a]	2.01 [a]	3.10 [a]	2.51 [a]	9.52 [a]	60.11 [a]
	0.25%	21.61 [b]	1.97 [a]	3.82 [b]	3.35 [a]	9.01 [b]	60.09 [a]	22.73 [a]	1.98 [a]	3.84 [b]	2.50 [a]	9.11 [b]	59.84 [a]
	0.50%	21.58 [b]	1.94 [a]	3.84 [b]	3.39 [a]	8.88 [a]	60.37 [a]	22.71 [a]	1.91 [a]	3.91 [b]	2.64 [a]	8.94 [b]	60.89 [a]
	0.75%	21.49 [b]	1.86 [a]	3.89 [b]	3.42 [a]	8.54 [c]	59.80 [a]	22.61 [a]	1.88 [a]	3.91 [b]	2.78 [a]	8.32 [c]	60.50 [a]
	1.00%	21.38 [b]	1.76 [a]	3.91 [b]	3.46 [a]	8.41 [c]	61.07 [b]	22.00 [a]	1.87 [a]	3.92 [b]	2.81 [a]	8.21 [c]	61.18 [a]
	1.25%	21.00 [b]	1.73 [a]	3.92 [b]	3.47 [a]	7.92 [d]	62.06 [b]	21.91 [a]	1.82 [a]	3.93 [b]	2.84 [a]	8.00 [d]	61.50
	1.50%	20.15 [b]	1.69 [a]	3.95 [b]	3.48 [a]	7.84 [d]	62.89 [b]	21.79 [a]	1.77 [b]	3.95 [b]	2.88 [a]	7.43 [e]	62.18 [b]
	1.75%	20.13 [b]	1.68 [b]	3.98 [b]	3.52 [a]	7.41 [e]	63.28 [c]	21.71 [b]	1.75 [b]	3.96 [b]	2.90 [a]	7.21 [e]	62.47 [b]
	2.00%	20.13 [b]	1.60 [b]	3.99 [b]	3.54 [a]	6.88 [f]	63.82 [c]	21.68 [b]	1.74 [b]	3.99 [b]	2.91 [a]	7.04 [f]	62.64 [b]
	LSD	**1.890**	**0.321**	**0.518**	**ND**	**0.320**	**1.720**	**1.011**	**0.241**	**0.384**	**ND**	**0.237**	**2.123**

a-f mean followed by the same superscripts are not significantly different at P = 0.05
LSD – least significant difference; ND – No difference in their mean at P = 0.05

Table 2: Mean-ANOVA Table on the Functional Properties of Flour From Asparagus Bean of Samples Steeped in Trona

Steeping time	Steeping conc.	Trona										
		BD (g/ml)	SI	GPT (^{0}C)	FC (%)	Wettability (s)	BPT (^{0}C)	pH	WAC	OAC	Viscosity (mpas)	EM
24h	0.00%	0.63 [a]	1.42 [a]	81 [a]	17.82 [a]	189 [a]	95 [a]	6.99 [a]	1.25 [a]	2.56 [a]	14.0 [a]	3.42 [a]
	0.25%	0.65 [a]	1.35 [a]	80 [a]	17.11 [a]	276 [b]	92 [a]	7.02 [a]	2.26 [b]	2.31 [a]	12.5 [a]	3.46 [a]
	0.50%	0.65 [a]	1.35 [a]	78 [a]	18.19 [a]	351 [c]	91 [a]	7.04 [a]	2.36 [b]	2.23 [a]	13.0 [a]	3.49 [a]
	0.75%	0.66 [a]	1.38 [a]	76 [a]	18.76 [a]	371 [c]	89 [a]	7.15 [a]	2.39 [b]	2.09 [a]	14.5 [a]	3.51 [a]
	1.00%	0.67 [a]	1.39 [a]	75 [a]	19.70 [a]	384 [c]	88 [a]	7.28 [a]	2.41 [b]	1.93 [a]	14.5 [a]	3.51 [a]
	1.25%	0.68 [a]	1.42 [a]	74 [b]	20.14 [a]	388 [c]	85 [a]	7.39 [a]	3.71 [c]	1.83 [a]	15.0 [a]	3.56 [a]
	1.50%	0.68 [a]	1.44 [a]	73 [b]	20.52 [a]	390 [c]	83 [a]	7.45 [a]	3.81 [c]	1.71 [a]	16.5 [a]	3.67 [a]
	1.75%	0.69 [a]	1.47 [a]	71 [b]	21.98 [a]	393 [c]	82 [b]	7.66 [a]	3.88 [c]	1.73 [a]	17.0 [a]	3.70 [a]
	2.00%	0.70 [a]	1.49 [a]	70 [b]	22.23 [b]	393 [c]	80 [b]	7.76 [a]	3.92 [c]	1.70 [a]	18.5 [b]	3.73 [a]
	LSD	ND	ND	6.18	4.38	69.31	7.13	ND	1.06	ND	3.12	ND
48h	0.00%	0.66 [a]	1.40 [a]	80 [a]	19.61 [a]	131 [a]	96 [a]	6.88 [a]	1.48 [a]	1.66 [a]	10.0 [a]	3.40 [a]
	0.25%	0.56 [a]	1.40 [a]	78 [a]	17.65 [a]	153 [a]	96 [a]	6.84 [a]	2.76 [b]	1.47 [b]	12.0 [a]	3.48 [a]
	0.50%	0.57 [a]	1.42 [a]	78 [a]	19.62 [a]	167 [a]	95 [a]	7.11 [a]	2.96 [b]	1.50 [b]	14.0 [b]	3.49 [a]
	0.75%	0.60 [a]	1.43 [a]	76 [a]	19.69 [a]	206 [a]	93 [a]	7.32 [a]	3.14 [b]	1.54 [a]	16.5 [b]	3.53 [a]
	1.00%	0.62 [a]	1.48 [a]	75 [a]	21.57 [a]	295 [b]	92 [a]	7.42 [a]	3.34 [b]	1.58 [a]	17.0 [b]	3.57 [a]
	1.25%	0.62 [a]	1.51 [a]	74 [a]	23.53 [b]	340 [b]	91 [a]	7.48 [a]	3.40 [b]	1.60 [a]	17.0 [b]	365 [b]
	1.50%	0.62 [a]	1.53 [a]	74 [a]	23.52 [b]	350 [b]	91 [a]	7.49 [a]	3.44 [b]	1.63 [a]	17.5 [b]	3.72 [b]
	1.75%	0.66 [a]	1.57 [a]	73 [a]	25.49 [b]	383 [c]	90 [a]	7.50 [a]	3.54 [b]	1.81 [a]	18.0 [b]	3.79 [b]
	2.00%	0.68 [a]	1.58 [a]	72 [a]	25.49 [b]	388 [c]	88 [b]	7.61 [b]	3.63 [b]	1.84 [a]	19.5 [b]	3.82 [b]
	LSD	ND	ND	ND	4.99	56.52	8.21	0.68	1.11	0.31	4.81	0.25

a-c mean followed by the same superscripts are not significantly different at P = 0.05

LSD – least significant difference; ND – No difference in their mean at P = 0.05; BD – Bulk density;
SI – Swelling index; GPT – Gelling point temperature; FC – Foam capacity; BPT – Boiling point temperature
WAC – Water absorption capacity; OAC – Oil absorption capacity; EM – Emulsion capacity

Table 3: Mean-Anova Table on the Functional Properties of Flour From Asparagus Bean of Samples Steeped in Alum

Steeping time	Steeping conc.	BD (g/ml)	SI	GPT (^{0}C)	FC (%)	Wettability (s)	BPT (^{0}C)	pH	WAC	OAC	Viscosity (mpas)	EM
						Alum						
24h	0.00%	0.63^a	1.42^a	81^a	17.82^a	189^a	95^a	6.99^a	1.25^a	2.56^a	14.0^a	3.42^a
	0.25%	0.66^a	1.49^a	74^b	17.78^a	115^b	88^b	6.54^a	2.92^b	2.11^a	13.0^a	2.42^a
	0.50%	0.65^a	1.47^a	75^b	17.01^a	116^b	88^b	6.30^a	2.99^b	2.06^b	11.5^a	3.41^a
	0.75%	0.65^a	1.43^a	76^b	16.88^a	118^b	89^b	6.27^a	3.00^b	1.97^b	10.0^b	3.33^a
	1.00%	0.64^a	1.42^a	78^b	16.14^a	118^b	91^a	6.23^a	3.09^b	1.83^b	9.0^b	3.30^a
	1.25%	0.63^a	1.40^a	78^b	14.31^a	137^b	93^a	6.08^a	3.11^b	1.71^b	8.5^b	2.97^b
	1.50%	0.62^a	1.36^a	79^b	13.99^a	164^a	95^a	5.94^a	3.17^b	1.68	8.5^b	2.89^b
	1.75%	0.60^a	1.34^a	80^c	12.12^a	165^a	95^a	5.90^a	3.19^b	1.51^c	7.5^b	2.89^b
	2.00%	0.58^a	1.33^a	84^c	10.09^b	169^a	96^a	5.87^a	3.20^b	1.42^c	6.0^c	2.87^b
	LSD	**ND**	**ND**	**4.30**	**6.01**	**30.21**	**5.62**	**ND**	**1.02**	**0.48**	**3.36**	**0.37**
48h	0.00%	0.66	1.40^a	80^a	19.61^a	131^b	96^a	6.88^a	1.48^a	1.66^a	10.0^a	3.40^a
	0.25%	0.72^a	1.40^a	70^b	17.65^a	103^a	80^C	6.58^a	2.26^a	1.60^a	10.0^a	3.39^a
	0.50%	0.71^a	1.38^a	70^b	16.61^a	115^a	82^C	6.30^a	2.31^a	1.58^a	9.0^a	3.36^a
	0.75%	0.70^a	1.37^a	73^b	15.69^a	125$^{a\,b}$	84^C	6.01^a	2.36^a	1.58^a	8.0^a	3.31^a
	1.00%	0.69^a	1.32^a	74^b	15.69^a	128$^{a\,b}$	85^b	5.72^a	2.40^a	1.54^a	7.5^a	2.99^b
	1.25%	0.67^a	1.23^a	76^c	11.76^b	140^c	86^b	5.60^b	2.53^a	1.40^b	6.5^a	2.92^b
	1.50%	0.64^a	1.21^a	78^c	11.76^b	160^c	88^b	5.36^b	2.59^a	1.40^b	5.5^b	2.86^b
	1.75%	0.61^a	1.19^b	78^c	9.80^b	161^c	90^b	5.21^b	2.61^a	1.39^b	5.0^b	2.83^b
	2.00%	0.61^a	1.17^b	79^c	7.80^b	184^c	93^a	5.10^b	2.68^a	1.32^b	4.0^b	2.80^b
	LSD	**ND**	**0.20**	**4.62**	**4.42**	**26.65**	**5.21**	**1.22**	**ND**	**0.19**	**3.99**	**0.300**

a-c mean followed by the same superscripts are not significantly different at P = 0.05
LSD – least significant difference; ND – No difference in their mean at P = 0.05; BD – Bulk density;
SI – Swelling index; GPT – Gelling point temperature; FC – Foam capacity; BPT – Boiling point temperature
WAC – Water absorption capacity; OAC – Oil absorption capacity; EM – Emulsion capacity

4. Discussion

4.1 Changes in the proximate composition of the Flour Samples from Asparagus bean

Analysis was carried out on the proximate composition of the flour samples as soon as they were ready, in order to prevent loss of value due to deterioration

Table 1 above, showed that the protein content of the bean flour decreased with increase in time and concentration in all cases. This might have resulted from the breakdown of protein molecules causing it to be easily lost by leaching. Samples steeped for 24h in trona and alum showed no significant difference among their means when compared to the control sample. After 48h, trona concentration as small as 0.25% caused a significant decrease in the protein content of the flour. This decrease remained insignificant down to 2.0% concentration of the trona in solution. For samples steeped in alum for 48h, the variations ranged from 0.0% - 1.5% and 1.75% - 2.0% significant decrease in protein.

Therefore, for economic reasons and better retention of protein value, it is best to steep in water for 24h, as this had the highest protein value; since beans has become the major source of protein in the country for an average Nigerian.

From table 1 above, it was observed that increase in concentration decreased fat content of the flour samples in all cases. This is likely due to the breakdown of fat molecules over time and concentration, thereby, enhancing its leaching into the solution. Samples, steeped in alum and trona for 24h decreased slightly but no significant difference was observed. After 48h, samples steeped in 0.25% - 1.50% concentration showed no significant difference with that of control. While samples steeped in 1.75%- 2.0% though not significantly different from each other, was different from the control samples. The same trend was also noticed with samples steeped in alum for 48h, except that the variations occurred between 0.0% - 1.25% and 1.5% - 2.0% decrease in fat content.

Therefore for a better keeping quality it is desirable to steep Asparagus bean seed in 1.75% or 2.0% of trona, solution for 48h. This had the lowest fat content, hence reducing losses due to rancidity on storage.

Table 1 also showed that, the Ash content of the samples had a direct relationship with concentration in all cases. At the end of 24h, the increase in ash content for samples steeped in trona was small as not to cause significant differences among their mean and that of the control sample. After 48h, concentration as small as 0.25% of trona caused a difference in the ash content when compared to control and this remained insignificant down to 2.0% of the steep solution. This was also the same with samples steeped in alum for both 24h and 48h. It probably means that 24h was too small to cause a difference significantly among their means, but on further steeping to 48h possible chemical reaction over time caused a slight increase in their Ash content. This may be owed to the possibility of attached mineral of Aluminum, sodium bond over time (Michell and Robert, 1981).

Table 1 above also showed that, in all cases increased concentration increased fibre content but not so much as to cause any significant difference. This might have been due to the fact that the time and steeping solution concentration was too small to cause a change or that trona and alum has little or no effect on the fibre content of the flour samples. From the results gotten, Asparagus bean flour steeped in water for 24h can be used for weaning foods formulation, due to its low content of fibre.

From table1 above it was observed that increase in concentration decreased moisture content of the flour samples in all cases. This probably might have resulted from the replacement of water molecules by the solutes, causing loose water bonds to be lost easily during drying. For samples steeped for 24h in trona, variation occurred between 0.0% - 1.0% and 1.25% - 2.0% significant decrease in moisture content. In alum for 24h, a similar result was obtained as the values were not far from those steeped in trona, though a step forward at 2.0%; significant decrease was observed. After 48h, variation occurred in the moisture content for alum and trona with respect to concentration, significantly. This might have resulted from increased chemical reactions as time increased.
Therefore for storage reasons, it is preferable to steep Asparagus bean seed in 2.0% alum solution concentration for 24h, as this had the lowest moisture content. Hence it is required to retard biological and chemical reactions that would take place in the bean flour on storage.

Table 1 also showed that carbohydrate increased with concentration after 24h for both alum and trona. At the end of 48h, coherent increase or decrease was not obtained. This resulted from the increased chemical reaction, deterioration/leaching over time of the other proximate components which were not steady; since carbohydrate value was dependent on them as it was determined by difference not chemically.

4.2 Changes in the Functional Properties of the Flour Samples from Asparagus Bean

Table 2, above showed that increase in concentration of trona slightly increased the bulk density of the flour from Asparagus bean after 24h, but no significant difference occurred in their mean; this was also applicable to samples steeped for 48h in trona. It means that either the steep solution concentration variance was too small to cause a change in the bulk density or that trona does not have an effect on the flour from Asparagus bean. But in the case of alum from Table 3, increased concentration, slightly decreased bulk density with no significant difference in their mean for both samples steeped in 24h and 48h. This decreasing effect might have been due to the cleansing effect of alum in the beans as applied to coagulation in water treatment.

Therefore, it is better to steep Asparagus bean in water for 24h as this is more economical and should be adopted in the processing/production of infant food, which requires light meal.

The same trend as bulk density was observed with swelling index in all cases, except for samples steeped in 1.75% - 2.0% of Alum for 48h, which showed a significant decrease from the control. This probably might have resulted from steep solution variation of trona being too small to cause change or that trona had no effect on the swelling index of the flour, while Alum required time to cause a change on the swelling index of Asparagus bean flour. Hence steeping in water for 24h is more economical and should be utilized in foods like moin-moin or akara, where increased swelling ability is needed during processing.

Table 2 also showed that, Sample steeped for 24h in trona caused a decreasing effect in gelling point temperature as concentration of steep solution increased. Samples steeped in 0.25% - 1.00% of trona showed no significant difference from the control sample. This probably means that the quantity of trona in the solution was too small to cause a significant change. While sample steeped in 1.25% - 2.0% of trona, though not significantly different from each other, caused a significant decrease in the gelling point temperature when compared to control. After 48h of steeping in trona, increase in concentration decreased slightly the gelling point temperature, but no significant difference was observed. This means that the steep solution concentration had little or no effect on the gelling point with increased time, as the values were closely related to those steeped for 24h. But with alum (Table 3), the trend was different, in that, increase in concentration increased gelling point temperature. It was noticed that Alum as small as 0.25% caused a significant difference in the gelling point temperature when compared to the control sample. This remained insignificant until 1.5% concentration of the solution, which showed a further significant increase in gelling point temperature. This was also similar for samples steeped for 48h in alum, though the figures were low generally.

Therefore for economic reasons, it is best to steep in 0.25% concentration of alum for 48h or 1.25% of trona for 24h. These had the lowest gelling point temperature, hence saving time and energy cost, and should be utilized in foods where gelling property is required e.g. thickeners in soups and sauces.

It was also observed from table 2 that, samples steeped in trona caused an increase in foam capacity as concentration increased. For 24h samples, increase in foam capacity remained insignificant until 2.0% concentration of the solution, which showed a significant increase in foam capacity. After 48h, foam capacity only remained insignificant until 1.0% when compared to control. On further increase in concentration to 1.25% foam capacity increased slightly until 2.0%, but significant from control.

This increase in foam capacity is desirable as it is required in the processing of ice cream, because trona with its thickening ability enhances the trapping of air in the bean flour slurry during whipping; steeping in trona at 1.25% for 48h is best. In contrast from Table 3, samples steeped in alum decreased foam capacity as concentration increased, but their significant variations in mean were related to those of trona steeped sample. This decrease could be desirable in food processes where excessive foaming is not required as it reduces loss due to foam spillage or the need for including an extra step or antifoaming agent to check foaming. Therefore steeping in alum at 2.0% for 24h is advisable.

Table 2 also showed that wettability increased with concentration in all cases. Samples steeped in alum appeared to have marked reduced difference in their wettability values when compared to those steeped in trona. This is because alum causes a reduction in density (Freeman *et al*., 2001), of the flour. This is desirable as it reduces processing time and cost in food where wettability is of interest.

Therefore, if wettability is a critical characteristics for choosing the sample then it should be steeped in 0 .25% of alum solution for 48h as this had the lowest value.

The boiling point temperature of Asparagus bean flour decreased as concentration increased for samples steeped in trona (Table 2). After 24h, this decrease remained insignificant with control sample, until 1.25% concentration of trona where a slight further decrease was noticed, though not different from those steeped in 2.0% solution. For samples steeped for 48h, significant difference was only observed in samples steeped in 2.0% of trona when compared to control. This decrease generally might have resulted from the fact that trona being a tenderizing agent in food, had caused a softening effect on the molecular network of the flour. This made them easily attacked by heat, and is desirable as it reduces energy cost and damage of heat liable nutrients during processing. From table 3 increase in boiling point temperature was directly related to alum concentration, for both 24h and 48h samples. Concentrations as low as 0.25% – 0.75% caused a significant decrease in boiling point temperature from the control sample. After which the boiling point gradually increased towards the control mean value though samples steeped for 48h generally had lower values with a step further in variation.

Therefore it is techno-economically better to either steep in 1.75% - 2.0% solution of trona for 24h or 0.25% of alum for 48h as they had the lowest boiling point temperature.

It was observed that samples steeped in trona for 24h had a slight increase in pH as concentration increased, which was insignificant for all concentration (Table 2). This probably means that the time and concentration difference was too small to cause a significant difference in the pH of Asparagus bean flour. A similar result was gotten after 48h except for only the sample steeped in 2.0% concentration of trona, which showed a significant increase in the pH. This general increase is because trona is slightly alkaline in nature. While samples steeped is alum (Table 3) decreased in pH as concentration increased. After 24h no significant change occurred among the mean values but after 48h, Variation occurred from 1.25% - 2.0% concentration.

Therefore steeping in water is best as it maintains the almost neutral pH of Asparagus bean flour needed for the processing of certain foods.

The water absorption capacity has a direct relationship with concentration in all cases (table 2 and table 3). This probably could have resulted from the loss of moisture during drying, causing a high water affinity of the flour. Concentration as low as 0.25% caused a significant increase in the water absorption capacity of the flour when compared to control after 24h of steeping. The increase was slight until 1.25% of the trona solution, where a further significant increase was observed in the water absorption capacity of the control samples; but it remained insignificant until 2.0% of the solution. After steeping for 48h, only the control sample showed a decrease in concentration from the result of the samples. For samples steeped in alum for 24h the same variation was observed with those steeped in trona for 48h. But at the end of 48h, no significant difference occurred in the means of all the samples.

Therefore it is better to steep Asparagus bean in 1.25% of trona for 24h as this had the highest water absorption capacity and should be utilized in food where water absorption capacity is required as this causes an increase in volume e.g. Bread

For oil absorption capacity, samples steeped in trona for 24h decreased slightly as concentration increased without significant variations in their mean(Table 2). After 48h a similar trend was observed with a generally lower figure when compared to 24h steeped samples. But this decrease remained insignificant until 1.75% steeping solution, where a further significant increase was observed. For sample steeped in alum as shown in table 3, the decreasing trend was observed, with variations occurring between 0.0% – 0.25%, 0.5% - 1.5% and 1.75% - 2.0% decrease. After 48h the concentration decreased insignificantly from control until 1.25% concentration where a further significant decrease

was observed, which remained insignificant until 2.0% concentration. This general decrease in oil absorption capacity with respect to concentration over time, which assumed the same trend with fat, was found to have resulted from increased breakdown in fat molecules, hence increasing their leaching (Gaman and Sherington, 1977). This low oil absorption capacity is desirable in frying of Akara-balls as less oil is absorbed by the balls, hence reducing losses due to rancidity in the Akara-ball on storage. It is therefore best to steep in 1.25% of alum for 48h as this had the lowest oil absorption capacity.

Also table 2 showed that samples steeped for 24h in trona caused an increase in viscosity with concentration increase. This remained insignificant with control until 2.0% concentration. After 48h the same trend was observed, but this time with relatively higher values with variations in 0.0% - 0.5% and 0.75% - 2.0%. This increase in viscosity over time and concentration is relative to the emulsifying ability of trona in the making of palm oil emulsion for African salad (Ankrah and Dovlo, 1978). It is therefore best to steep in 2.0% for this purpose. In contrast from Table 3, alum steeped samples had an inverse relationship with concentration. After 24h variation occurred between 0.0% - 0.5%, 0.75%-1.75% and 2.0% decrease in viscosity. After 48h, samples showed generally slight lower values from that of 24h concentration with variations among 0.0% - 0.5%, 0.75% - 1.75% and 2.0% decrease. This lower variation in viscosity over time might have been due to the lowering effect on emulsion by alum on the Asparagus bean over time. This decrease in viscosity with alum is traced to the use of alum in washing snail or breadfruit as it reduces the viscosity of the sliming materials.

From table 2 above, it was observed that increase in concentration increased emulsion capacity as trona concentration increased.

For samples steeped for 24h in trona, the increase in emulsion capacity was slight as not to cause a significant difference among the mean values. After 48h of steeping, significant variations occurred between 0.0%-1.00% and 1.25%-2.0%. This increase in emulsion capacity is desirable as it can be utilized in foods such as sausage. For samples steeped in alum as shown in table 3, increase in concentration decreased emulsion capacity. At the end of 24h of steeping, emulsion capacity decreased but slightly down to 1.0% when compared to control, while samples steeped in 1.25%-2.0% showed a significant decrease from control but insignificant from each other. After 48h of steeping a similar trend was observed with slight decrease in their mean. This decrease might have resulted from alum being a coagulant (cleanser), (Freeman *et al.,* 2001), thereby resulting in the separation of oil and water

5. Conclusion

The results obtained from this study have shown that steeping Asparagus bean seed in alum and trona separately at different concentration (0.0%, 0.25%.....2.0%) for 24h and 48h, caused significant variations in the proximate and functional properties of its flour

Based on this, Asparagus bean can be suited for various products due to its diverse nature by combining any or all of the above conditions. For better retention of nutrients, it should not be steeped for more than 24hours. Also trona was found to have more positive placement in asparagus bean processing than alum.

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