

EFFECT OF PH AND TEMPERATURE ON FUNCTIONAL PHYSICO-CHEMICAL PROPERTIES OF ASPARAGUS BEAN (*VIGNA SESQUIPEDALIS*) FLOURS AND MOIN-MOIN PRODUCTION FROM THE FLOUR

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ABSTRACT: *Asparagus bean (Vigna sesquipedalis) seeds of black colour species were processed into full fat flour, defeated flour, protein concentrate and isolate. The physic-chemical, functional properties and sensory evaluation of moin-moin produced from the flour samples were investigated. The effects of pH and temperature on some of the seed weight were 0.09 ± 0.01 g and seed size of 0.7348 ± 0.09 . the protein content of the concentrate and isolate had a higher value of $66.85 \pm 0.350\%$ and $88.98 \pm 0.02\%$ respectively when compared with that of full fat flour ($23.32 \pm 0.02\%$) and defatted flour ($25.10 \pm 0.20\%$). The protein concentrate and isolate had no fat and crude fibre content and carbohydrate content of $24.27 \pm 0.39\%$ and $2.04 \pm 0.217\%$ respectively. There was significant difference ($p < 0.05$) between the protein concentrate, isolate and Asparagus bean flour. The effect of temperature on foaming, swelling and water absorption showed increased functionality with increasing temperature while the effect of pH on foaming, swelling and water absorption decreased with increasing pH. The sensory evaluation of the moin-moin produced from the different flour samples showed significant difference ($p < 0.05$) in the sensory attribute.*

KEYWORDS: Moin-moin, physic-chemical, functionality, Asparagus bean

INTRODUCTION

Legumes belong to the family leguminosae. Legumes are the edible seeds of a leguminous plant. These used as food are divided into two (2) groups namely; the pulse and oil seed (Ihekoronye and Ngoddy 1985), grain legumes contribute the main sources of protein in the diet of the average African home. The high protein content of varieties of legumes make them important source of protein in the diet of population groups of many countries. The serve as food for large number of people in topical region and constitute a very important source of dietary protein in many West African countries including Nigeria (Siegel and Fawcett, 1996, Akinjaueju and Francis, 2008). The widespread occurrence of malnutrition traced to low level of protein in diets of those in many developing countries of the world has refocused on the importance of legumes as excellent but cheap source of protein most especially when consumed with cereal grains to which the act as extenders of protein. Some legumes are commonly used as commercial cash crops in West Africa while some are lesser known, neglected or underutilized outside their indigenous areas. Common legumes in Nigeria include cowpea, soybean, African locust bean, African yam bean, Bambara nut, black bean, asparagus bean etc. Asparagus bean (*Vigna sesquidalis*) also referred as “akidi oji” in Igbo speaking regions is an annual vegetable cowpea that belongs to the leguminous family.

It is referred to as “akidi oji” due to its black colour at maturity (Enwere, 1998). It is grown mostly in the eastern part of Nigeria like Enugu state, Abia state, Anambra state, Ebonyi state. Asparagus beans like most other legumes are important source of dietary protein which complements protein gotten from cereals (Nwosu, 2011). The different processing methods of legumes such as asparagus bean and their subsequent derivation into different food product affect their acceptability characteristics. It can be processed into akara (fried bean balls), or moin-moin (steamed cowpea paste) for both household and commercial purposes. The mature seed are consumed in a variety of ways such as whole or dehulled seeds, cooled in boiling water for varying period and consumed after addition of salt and other ingredients. The major constraint in the utilization of this bean is the difficult method of preparation; the long cooking time, the traditional method of dehulling the bean which involves manual removal of hulls from individual soaked beans. This method is quite laborious and time consuming and does not favor effective utilization of asparagus bean. Due to malnutrition caused by protein deficiency, one way to increase protein supply is to make plant protein available for human consumption and develop the production of unconventional protein foods. The high cost for conventional protein foods particularly animal protein will be increasing exploited in developing countries. The search for nutritional balanced food to make available to a substantial proportion of the population has stimulated using desiccators before grinding and sieving took place.

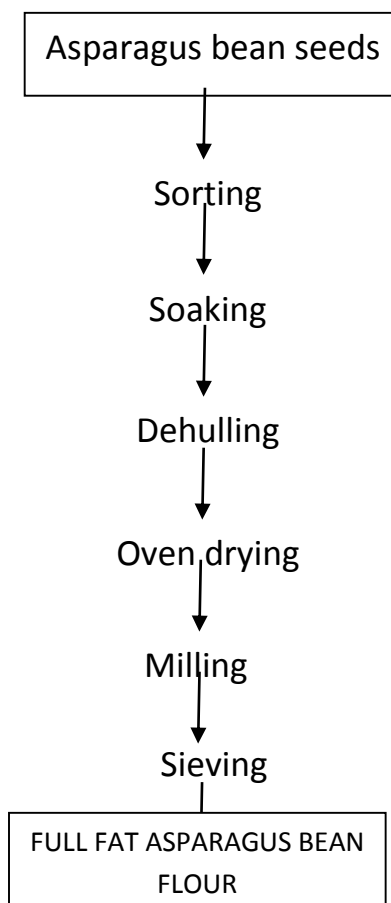


FIG. 1: Flow diagram for the production of dehulled full fat asparagus bean flour

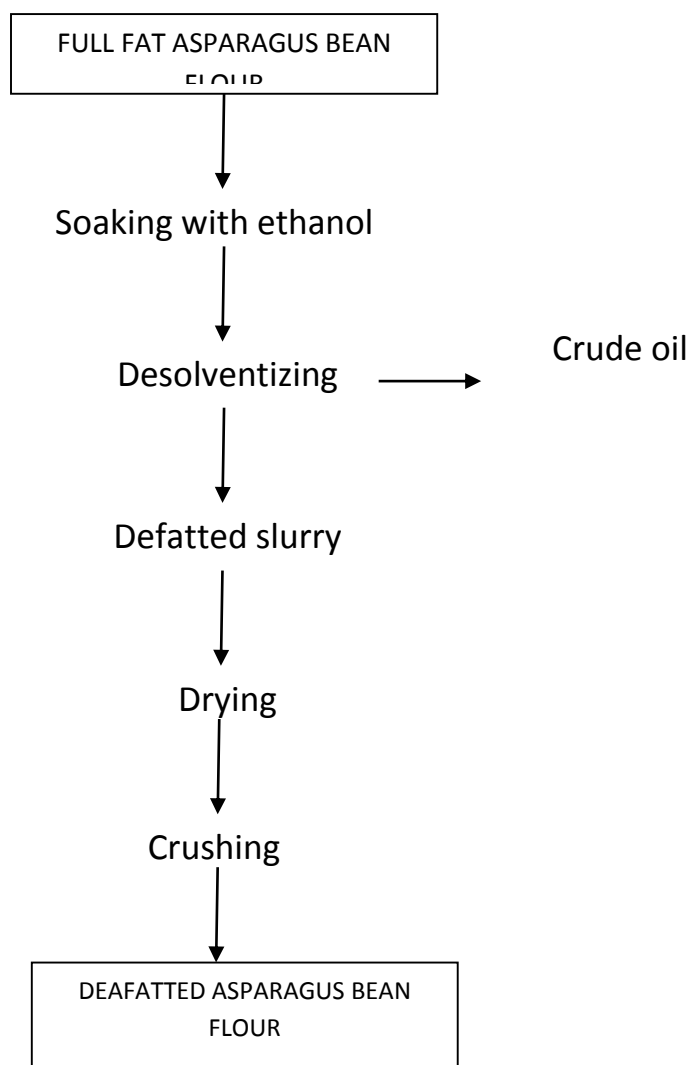


Fig. 2: Flow diagram of commercial processing of defatted asparagus bean flour

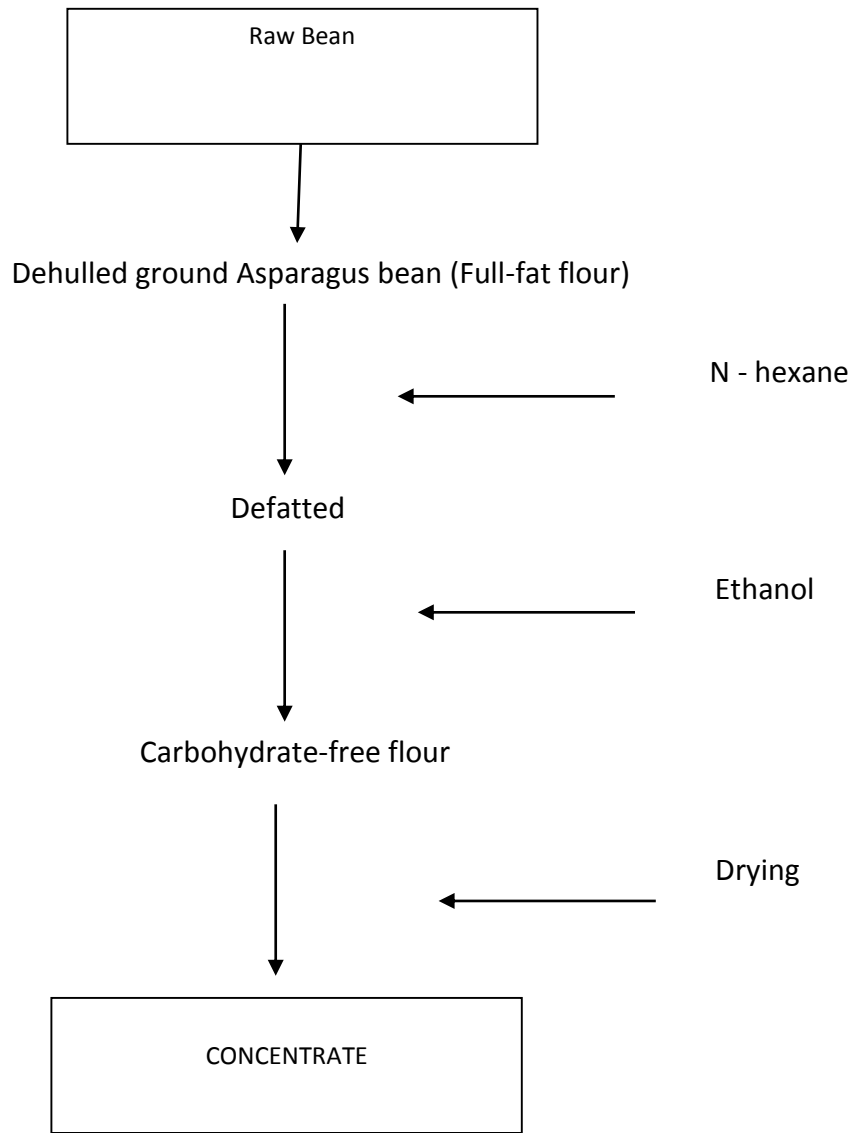


FIG 3: Flow diagrams of the production of protein concentrate from defatted Asparagus bean flour

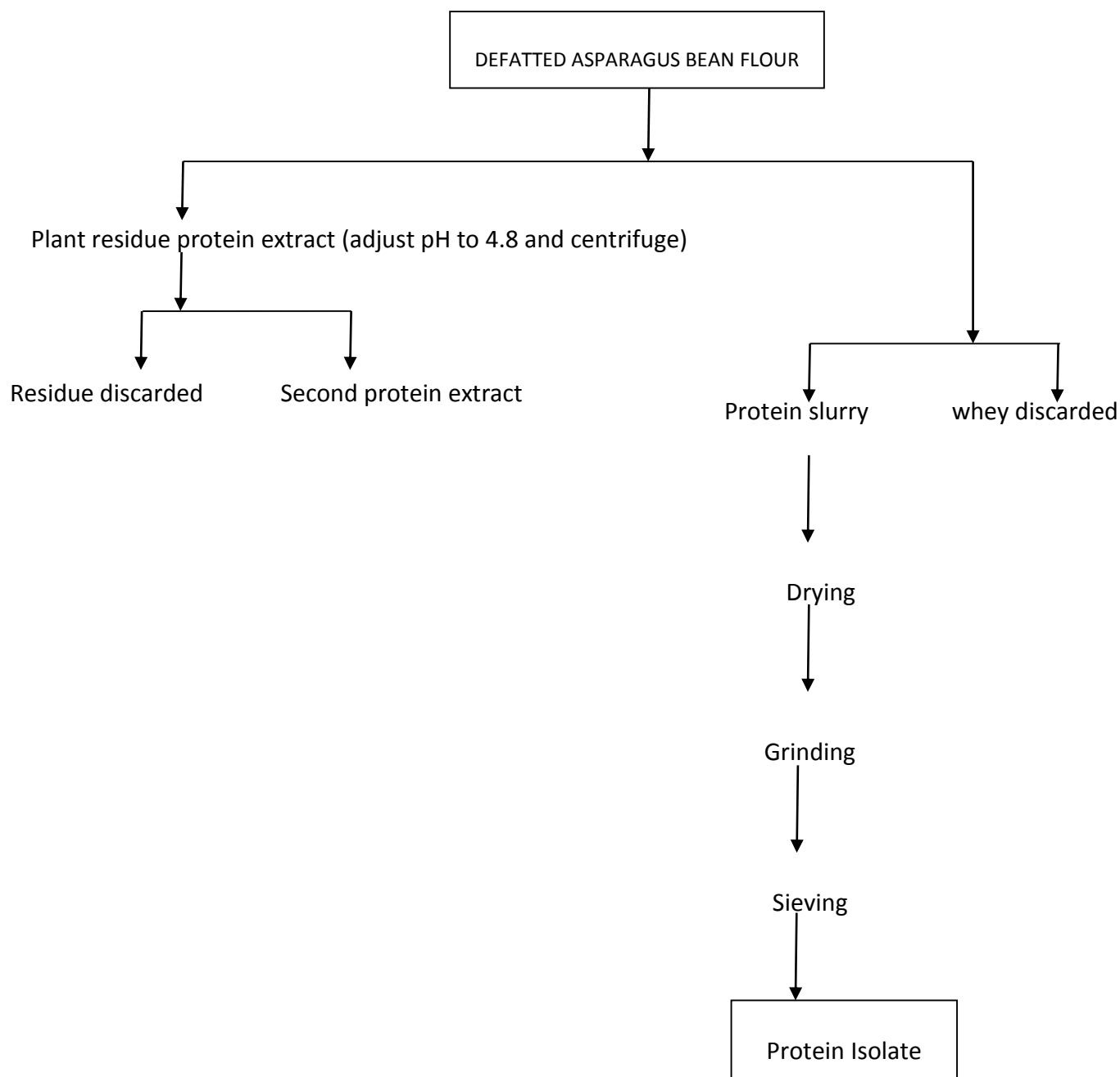


Fig 4: Flow Diagram for the production of isolated protein from defatted asparagus bean seed

Production of Moin-Moin from Asparagus Bean Flour

The Asparagus bean flours (defatted and full fat) were used in the production of moin-moin. The moin-moin was prepared according to the method described by Nwosu (2011). Flour samples of 50g were used in preparing moin-moin by adding two spoonful of power horse vegetable oil, 5g of each of ground crayfish, and onions 2g of salt and pepper. Maggi of 8.03g was also added and was mixed till a homogenous mix (slurry) was obtained. The paste was then put in aluminum cups, covered and steamed for 2 hours using a kerosene stove. After steaming it was allowed to cool for 10-15 minutes before the analyses of the sensory evaluation was carried out.

Sensory evaluation of the moin-moin samples

The moin-moin samples were subjected to sensory evaluation 15 minutes after steaming by untrained 15- member panel that were familiar with moin-moin to evaluate the appearance, taste, aroma, texture and general acceptability. Degree of acceptance or likeness was expressed on a 9 point hedonic scale quality analysis- 9 = like extremely, 8 = like very much, 7 = like moderate, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 dislike very much 1 = dislike extremely.

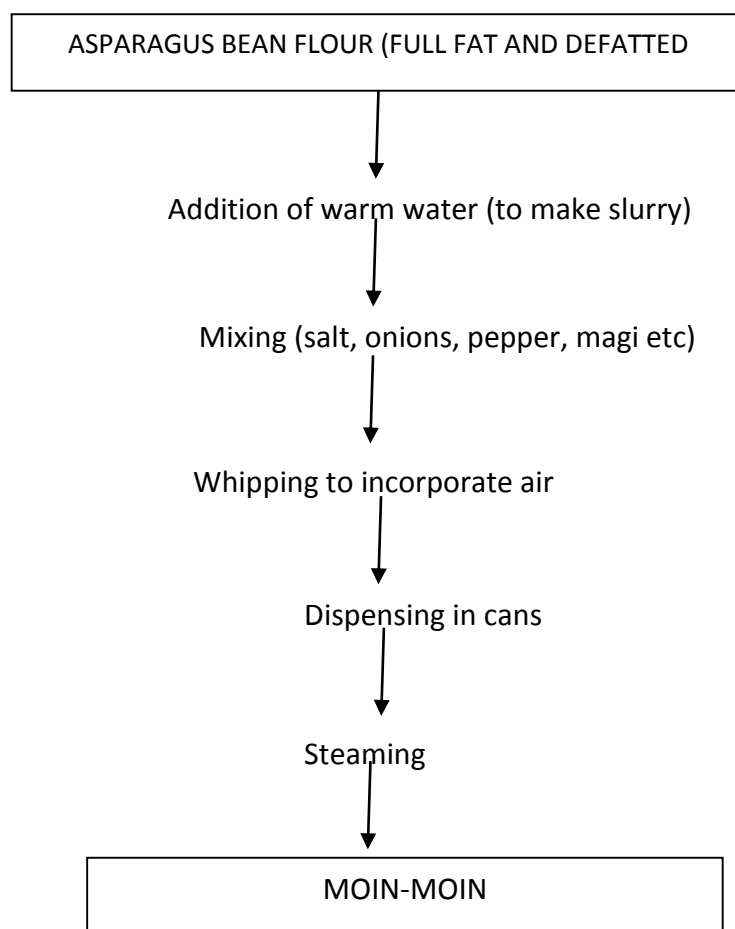


Fig 5: Flow diagram for the production of moin-moin

METHODS

Seed characteristics

The characteristics were obtained following the procedure of Fashakins and Fasanya (1988). The raw needs were randomly selected and then examined by subjective methods for shape, texture, seed colour, eye colour, and testa attachment to the cotyledon. The degree of attachment was described as smooth or rough depending on how the seeds appear to the eye.

Seed Weight

Weight of 100 seeds randomly selected was determined by weighing (AOAC, 1984). The average seed weight was evaluated.

Proximate Composition

The, procedure for the chemical of moisture, crude protein, ash, crude fibre, carbohydrate and fat content were outlined by the association of official analytical chemists (AOAC, 1990). The analyses were carried out in both full fat, defatted and protein isolate from asparagus bean seeds and results obtained in tricates.

Determination of moisture content

The gravimetric method as described by (AOAC, 1990) was used to measure weight of samples was weighed into a previously weighed moisture can. The Samples in the can were dried in the oven at 105⁰ C for 3hours. It was cooled in a desiccator and weighed. They were again reheated and dried. Drying, cooling and weighing were done at hourly interval until a constant weight was obtained.

The weight of moisture lost was calculated and expressed as a percentage of weight of samples analyzed. It was given by the expression below;

$$\% \text{Moisture Content} = (W3-W1) / (W2-W1) \times 100\%$$

Where W1 = weigh of empty moisture can

W2 = weigh of empty can + sample before drying

W3 = weight of can + sample dried to constant weigh

Determination of Protein

This was done by kjeldhal method described by Chang (2003). The total N₂ was determined and multiplied with factor 6.25 to obtain the protein content. I gram of sample was mixed with 10mls of concentrated H₂ SO₄ in a digested flask. A tablet of selenium catalyst was added to it before it was heated under a fume cupboard until a clear solution was obtained (i.e. the digest). The digest was diluted to 100ml/s in a volumetric flask and used for analysis. Then 10mls of 4% Buric acid containing 3 drops of mixed indicator (bromocressol green / methyl red). A total of 50mls of distillates was collected and titrated against 0.02N EATA from green to a deep red end point. The reagent blank was calculated using the formula below;

$$\% \text{ protein} = \% \text{ nitrogen} \times 6.25$$

$$\%N = (100/w) \times (N \times 14/1000) \times (V_t/V_a)^{T-B}$$

W = weight of sample (1g)

N = Normality of titrant (0.02N. H₂ SO₄)

V_t = total digest volume (100mls)

V_a = volume of digest analyzed (10mls)

B = Blank

T = sample titre value

Ash Determination

This was carried out by furnace incineration gravimetric method (James, 1995; AOAC, 1984). 5g of the processed sample was measured into a previously weighed porcelain crucible. The sample was burnt to ashes in the muffle furnace at 550 °C 5 hours. When it has become completely was calculated by difference desiccators and weight. The weight of ash obtained was calculated by difference and expressed as a percentage of the weight of sample analyzed as shown below.

$$\% \text{ Ash} = [(w_2 - w_1) / (w_1 \text{ of sample}) \times 100\%]$$

Where w₁ = weight of empty crucible

w₂ = weight of crucible and ash.

Determination of Crude Fibre

The weende method (James, 1995) was employed. 2g of the processed samples was boiled in 150ml of 1.25% H₂SO₄ solution for 30mins under reflux. The boiled samples were washed in several portion of hot water using two fold of muslin cloth to trap the practices. It was return to the flask and boiled again in 150mls of 1.25% NAOH for another 30 minutes under some conditions. After washing in several portion of hot water, the sample was allowed to drain dry before being transferred quantitatively to a weighed crucible where it was dried in the oven at 105°C to a constant weight. It was there after taken to a muffle furnace in which it was burnt until only ash left in it. By difference, the weight of sample analyzed. It was given by the formula below;

$$\% \text{ crude} = 100(w_2 - w_3) / \text{weigh of samples}$$

Where

w₂ = weight of crucible + sample after boiling, washing and drying

w₃ = weight of crucible + sample ash

Fat Determination

The solvent extraction gravimetric method (Kirk and Sawyer, 1980) was used. 1g of the sample was wrapped in a porous paper (Whiteman filter paper) and put in a timble. The timble was put in sohxlet reflux flask and mounted into a weighed extraction flask containing 200mls of hexane. The upper end of a reflux flask was connected to a water condenser.

The solvent hexane was heated, boiled, vaporized and condensed into a flask. Soon the sample in the thimble was covered with the solvent until the reflux flask was filled up then siphoned over, carrying its oil extract down to the flask. This process was allowed to run repeatedly for 4 hours before defatted sample was removed, the solvent recovered, and the oil extracted was left in the flask. The flask (containing the oil extract) was dried in the oven at 60°C for 30mins to remove any residual solvent. It was cooled in a desiccator and weighed. By difference, the weight oil/fat was determined and expressed as the percentage of the weight of the sample analyzed and given by the expression below;

$$\% \text{ fat} = [(w_2 - w_1)/(\text{weight of sample}) \times 100]$$

Where

w_1 = weight of empty extraction flask

w_2 = weight of flask and oil extract

Determination of Carbohydrate

Carbohydrate content was by difference. It was calculated using the formula below as described by AOAC (1990) and James (1995).

$$\% \text{ carbohydrate} = 100 - \% (\text{moisture} + \text{crude protein} + \text{crude fat} + \text{crude fibre} + \text{ash}).$$

Functional Properties of Flour Samples

The functional properties of Asparagus bean flour samples were determined using the method specified by Okaka and Potter (1997), Okezie and Bello (1988), and Narranyana and Rao (1982).

Bulk Density

The method of Okaka and Potter (1997) was used. Two gram of flour sample was measured into a calibrated measuring cylinder. The bottom of the cylinder was tapped repeatedly on a pad placed on a laboratory bench. Tapping was done until there was no further reduction in the volume occupied by the sample. The bulk density was determined as the ratio of the weight of the sample to its volume calculated as shown below;

Bulk density = w/v where

w = weight of sample in gram

v = volume of sample in ml

Swelling Index

Swelling index was calculated using the method of Ukpabi and Ndinele (1990). One gram of the processed sample was weighed and dispersed into a test tube, leveled and the height noted. Distilled water (10mls) was added / stirred and allowed to stand for 1 hour. The height was then recorded and the swelling index calculated as the ratio of the final height and the initial height.

Swelling index = H_2/H_1 where

H_2 = final height

H_1 = initial height

Water Absorption Capacity

This is determined as the weight of water absorbed and held by 1 gram of sample (Okaka and Potter, 1997). One gram of the sample was weighed and put into a test tube. 10mls of distilled water was added into the sample and mixed well. The mixture was allowed to stand for 30 minutes at room temperature. The mixture was centrifuge at 3500rpm for 30mins. The supernatant was decanted and measured.

Therefore $WAC = v_1 - v_2$

v_1 = initial volume of the distilled water

v_2 = final volume of the distilled water

Oil Absorption Capacity

This was determined in the same way as water absorption capacity. However, a refined vegetable oil was used in place of water and the time allowed for absorption was longer (1 hour at room temperature as against 30 minutes for water). The oil absorption capacity was determined by difference, as the volume of oil absorbed and holds as 1 gram of the sample shown below;

Oil absorption capacity = (initial volume of oil) – (final volume of the oil).

Gelation Capacity

5grams of sample was weighed into a beaker with 20mls of water and heated until gelling point. The temperature at which it gels was measured using thermometer.

Emulsion Capacity

The method used was described by Okezie and Bello (1988). 1 gram of sample was mixed with 10mls of distilled water in a test tube and shake for 30 seconds. 10mls of refined oil was also added and shake continuously until properly mixed. The test was left to stand for 30 minutes. The height of oil separated from the sample was measured. The emulsion capacity was expressed as the amount of oil emulsified and held per gram of the sample. It is shown below;

Emulsion Capacity = Emulsion height/water height x 100

Foaming Capacity

The method of Narranyana and Rao (1982) was used. 1 gram of the sample was mixed with 10mls of distilled water and blended for 5 minutes. After the resulting mixture, the height of the foam was recorded for 30 seconds. The foaming capacity was expressed as a percentage of foam produced after whipping. It is calculated as;

Foaming capacity = $(v_a - v_b)/v_b \times (100/1)$

Where v_a = height after whipping

v_b = height before whipping

Wettability

This was determined as the time in seconds taken by a unit weight (1g) of the flour sample to get completely wet on the sample of water under laboratory conditions. The method used was described by Okezie and Bello (1988).

About 500mls of water was measured into a clean glass beaker (600mls capacity). With the aid of retort stand, it was arranged such that a clean test tube was clamped in an inverted position over

the water in the beaker. The clamped position was adjusted such that the distance from the mouth of the test tube to the surface of water in the beaker was exactly 10cm. Both the water in the beaker and the clamped position were marked with masking tape. Subsequently, 1 gram of the sample was weighed into the marked test tube and its mouth covered with a thumb. It was carefully inverted over the water and clamped with the retort stand at the marked spot without removing the thumb. With the stop watch set to read, the thumb was removed and the sample allowed to fall into the water surface as the stop watch was put to stop simultaneously.

The flour samples were observed and the stop watch stopped as the last few samples got wet. The experiment was repeated three times for each sample and the mean values taken.

Statistical Analysis

Experimental data were analyzed using analysis of variance (Anova) and Fisher's least significant difference (LSD) was used to determine significant difference among the means at 0.05 level of confidence.

RESULT AND DISCUSSION

Seed Characteristics

The result of the seed characteristics of asparagus is presented in table 1. The seeds were black in colour, cream eye colour, firm attachment to the cotyledon, of a smooth testa when fresh and average seed weight of $0.9 \pm 0.11\text{g}$.

Proximate Composition of the Flour Samples

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. The proximate compositions of test samples are shown in table 2 below. The result revealed a high protein content of $23.23 \pm 0.20\%$ of the seed full fat flour. This result falls within the same range of other legumes like pigeon pea ($24.46 \pm 0.32\%$) and cowpea ($24.13 \pm 0.31\%$) as reported by Olalekan, and Bosede, (2010); Olawuni *et al.*; (2013). However, the Asparagus bean protein concentrate and isolate had an average protein content of 66.85% and 88.98% respectively. There was significant difference ($p < 0.05$) between the protein concentrate, isolate and asparagus bean flours. The ash contents of the protein concentrate ($3.61 \pm 0.04\%$) and isolate ($3.71 \pm 0.04\%$) had a significant at $p < 0.05$. However, that of protein isolate is higher than the report given by Okezie and Bello, (1988) for winged bean (3.4%) and lower for soy bean (5.5-7.5%).

The full fat flour and the defatted flour contains fibre of $1.15 \pm 0.02\%$ respectively which slows down the release of glucose into the blood stream, hence, high legume diet is commented for diabetic patients. There was little or no traces of fibre and fat found in the protein concentrate and isolate of asparagus bean. Asparagus bean concentrate and isolate was found to have values which were significantly different at ($p < 0.05$) from those of the full fat and defatted flour.

Table 1: Seed Characteristics of Asparagus bean seed

Average seed weight	Seed colour	Testa characteristics	Testa attachment
0.09±0.01g	Black	Smooth when freshly harvested, wrinkled with storage	Firm

Table 2: Proximate composition of asparagus bean flour, defatted flour, protein concentrate and protein isolate.

Parameter						
Ples	Moisture	Ash	Fibre	Fat	Protein	Carbohydrate
Fat	6.50 ^b ±0.02	3.30 ^c ±0.02	1.15 ^b ±0.02	4.00 ^a ±0.02	23.32 ^d ±0.02	61.73 ^a ±0.02
Ted	12.00 ^a ±0.02	1.93 ^d ±0.02	2.50 ^a ±0.02	2.00 ^{b0.02}	25.10 ^c ±0.02	56.47 ^b ±0.02
Protein concentrate	5.27 ^c ±0.02	3.61 ^b ±0.02	0.00 ^c	0.00 ^c	66.85 ^b ±0.02	24.27 ^c ±0.02
Protien	5.23 ^d ±0.02	3.71 ^a ±0.02	0.00 ^c	0.00 ^c	88.98 ^a ±0.02	2.08 ^d ±0.02

Mean values within the column are significantly different (p<0.05).

Functional Properties

The functional properties of the full fat flour and the defatted flour samples are shown in Table 3 below. The result revealed relatively high bulk density. The bulk density of the defatted showed a higher density than that of the full fat and can be attributed to increase in density during processing. Significant differences of $p > 0.05$ exist between the two samples. The foam capacity of the defatted flour (8.33%) is significantly lower than that of the full fat flour (16.67%). This means that the defatted does not have the ability to retain stable foam when whipped. it can therefore be used to enhance a higher nutritional value as it may not do well as an aerating or foaming agent in food formulations like ice cream. The emulsion capacity of the defatted flour was found to be 45% and comparatively higher than the full fat flour sample. The relatively high emulsion capacity of the defatted flour could be due to the nature and type of protein. Sathe and Salunkhe, (1982) reported that emulsion capacity and stability is higher in protein with globular nature. The defatted flour had a lower swelling capacity when compared with the full fat. This could be attributed to the extent of starch damage due to thermal and mechanical processes. According to Ezema, (1989) the extent of swelling in the presence of water depends on the temperature, availability of water, starch species, extent of starch damage and other carbohydrates and protein. The gelling capacity of the full fat and defatted flour samples had no significant difference ($p > 0.05$). The full fat and defatted flours were found to get at temperature 86°C and 85°C respectively. Sathe and Salunkhe, (1982) associated the variation in gelling properties to different constitutes – proteins, lipids, and carbohydrate that make up the legume. Protein was attributed to globulin fraction and gelling point is indeed an aggregation of denatured molecules. This property suggests that the full fat and defatted flours samples will be suitable in food systems such as pudding, sauces and moin-moin which require thickening and gelling properties and also important in the baking of bread and other

flour products where it contributes to the desired bread crumb texture and structure of the product (Ihekoronye and Ngoddy, 1985; Ukhun, 1980). The affinity of the flour samples for water was also showed on water absorption capacity of 2g/ml for full fat and 2.4g/ml for the defatted flour. The low values of the water absorption capacity of the different flour samples suggest that Asparagus bean flour is less hydrophobic than other legume flours.

Therefore, Asparagus bean flour have more useful functional ingredient in viscous foods like baked products, gravies, soup etc. to increase viscosity. The oil absorption capacities of 1.62g/ml and 1.43g/ml for defatted and full fat flour samples respectively are far lower when compared to other legumes. This result shows that Asparagus bean have lower flavor retention than other legumes of higher oil absorption capacity such as soy bean flour. This may be due to low hydrophobic protein in the Asparagus bean flour. Consequently, the low oil absorption capacity shows that it decreases the mouth feel when used food preparations such as, meat analogues.

Table 3: Table showing the functional properties of Asparagus full fat bean flour and defatted flour

SAMPLES	BD	FC	PARAMETER		GT	WAC	OAC
			EC	SI			
FUL FAT	0.625 ^b ± 0.05	16.67 ^a ± 0.5	37.5 ^b ± 0.5	0.375 ^a ± 0.05	86.0 ^a ± 1.0	2.0 ^a ± 0.02	1.43 ^b ± 0.02
DEFATTED	0.72 ^a ± 0.02	8.33 ^b ± 0.03	45.0 ^a ± 0.5	0.11 ^b ± 0.01	85.0 ^a ± 0.5	2.4 ^a ± 0.5	1.62 ^a ± 0.05
LSD	0.264	0.0818	1.135	0.018	1.795	0.864	0.056

Mean values within the column are significantly different (p<0.05).

Where: BD = Bulk Density (g/cm³)

SI = Swelling Index (g/cm)

WAC = Water absorption capacity (g/mls)

OAC = Oil absorption capacity (g/mls)

FC = Foaming capacity (%)

EC = Emulsion capacity (%)

GT = Gelling temperature (°C)

Sensory and Physical Analysis

Table 4 shows the mean sensory and physical quality of moin-moin samples prepared with full fat flour and defatted flour. The sensory scores on 9- point hedonic scale ranged from 5.93 to 7.20 for colour, 4.0 to 7.13 for texture, 3.27 to 7.73 for taste, 4.87 to 7.40 for aroma and 3.60 to 8.70 for general acceptability (table 4). The colour was generally accepted as all had a mean score higher than the mid mark (4.5). However the full fat has a higher sensory attributes than the defatted. There seems to be loss in the taste in the moin-moin produced with defatted flour, this can be attributed to the fat removal. The different flour samples have significant difference (p> 0.05) in the sensory attribute. Therefore the use of defatted flour in moin-moin production is not advisable

but the defatted flour can be incorporated to other flour to form composite (since it is rich in protein).

Table 4: Sensory Evaluation

Samples	Aroma	Taste	Texture	Colour	General ACCEPTANCE
A	7.40a 1.12	7.73 ^a ± 0.79	7.20 ^a ± 1.06	7.20 ^a ± 1.52	8.07 ^a ± 0.79
B	4.870 ^b ± 2.13	3.27 ^b ±2.15	4.00 ^b ±1.51	5.93 ^b ±1.16	3.60 ^b ±1.84
LSD	2.90	2.64	1.70	1.53	2.02

Mean values within the column are significantly different (p<0.05)

Effect of Changes in Temperature and pH Condition

The effect in temperature and pH conditions on the functional properties of Asparagus bean flours are shown below in the graphical representation (figs. 6-11) below.

Effect of pH on the Flour Samples

The effect of the pH conditions on some functional properties of Asparagus bean flours, concentrate and isolate are shown in figs 9-11. The result in fig. 10 revealed that the foaming capacity decreased with increasing pH for full fat and defatted flour. Stable foam formation as reported by Tessari, *et al*, (2001) and Horozov, (2008) depends on factor including pH, degree of denaturation, temperature, protein type and whipping method. The swelling index in fig 9 decreased with increasing pH. The water absorption capacity of the flour samples as shown in fig 11 was also affected by pH conditions full fat flour which increased to a maximum at pH 5 and declined.

Effect of Temperature on the Flour Samples

The effect of temperature change on some functional properties of Asparagus bean flours are shown in figs 6-8. The result in fig 7 showed that the water absorption capacity alternates with increasing temperature from 30°C to 60°C. Similarly, the Foaming capacity was stable but decreased at 60°C temperature. However, the swelling index of the increase with temperature. The change in functional properties due to temperature change agrees with earlier report which observed temperature change as one of the initial factors that affects the functional properties of flours.

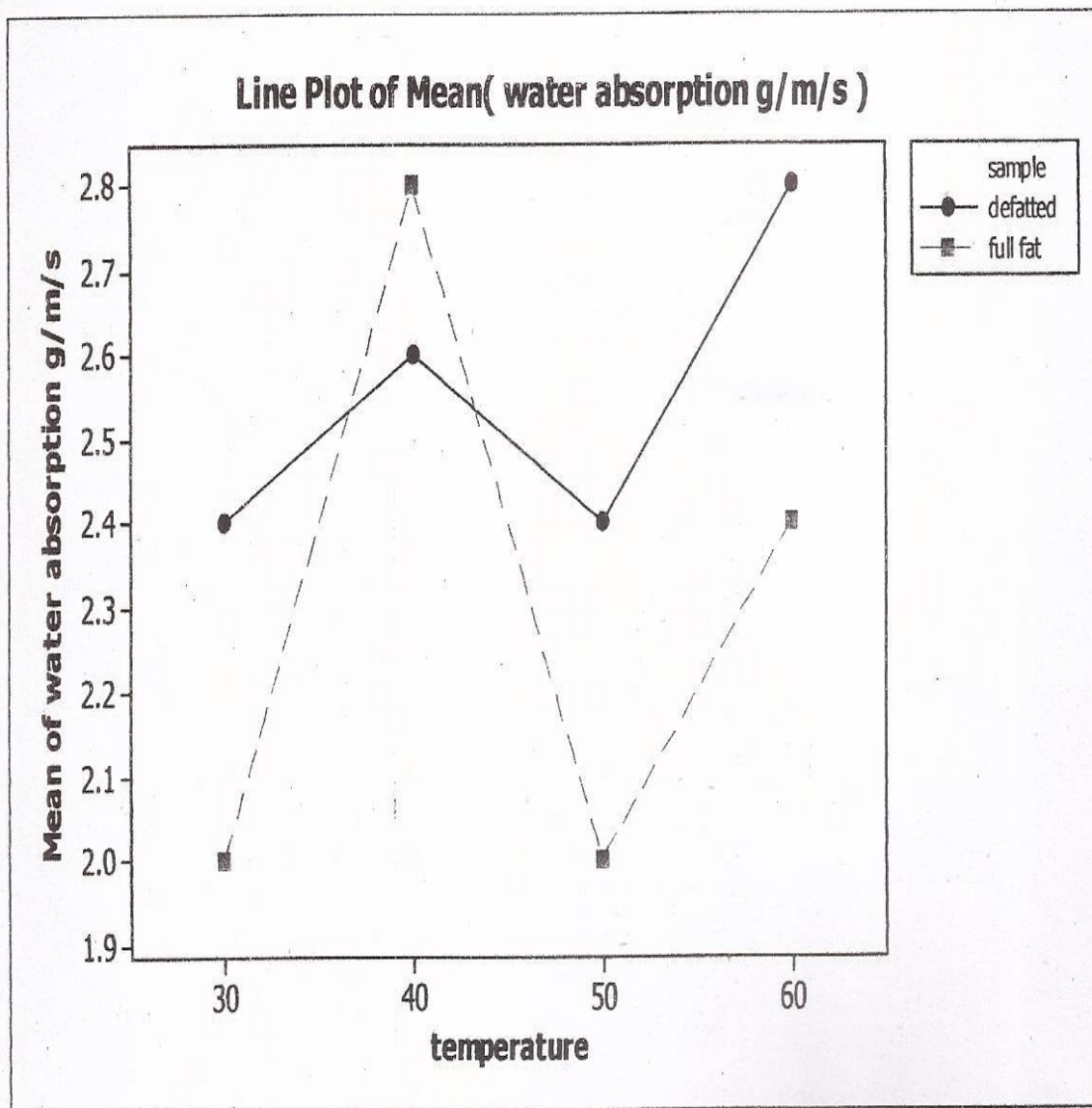


Fig. 7: The effect of Temperature on Water Absorption of full fat and defatted flour

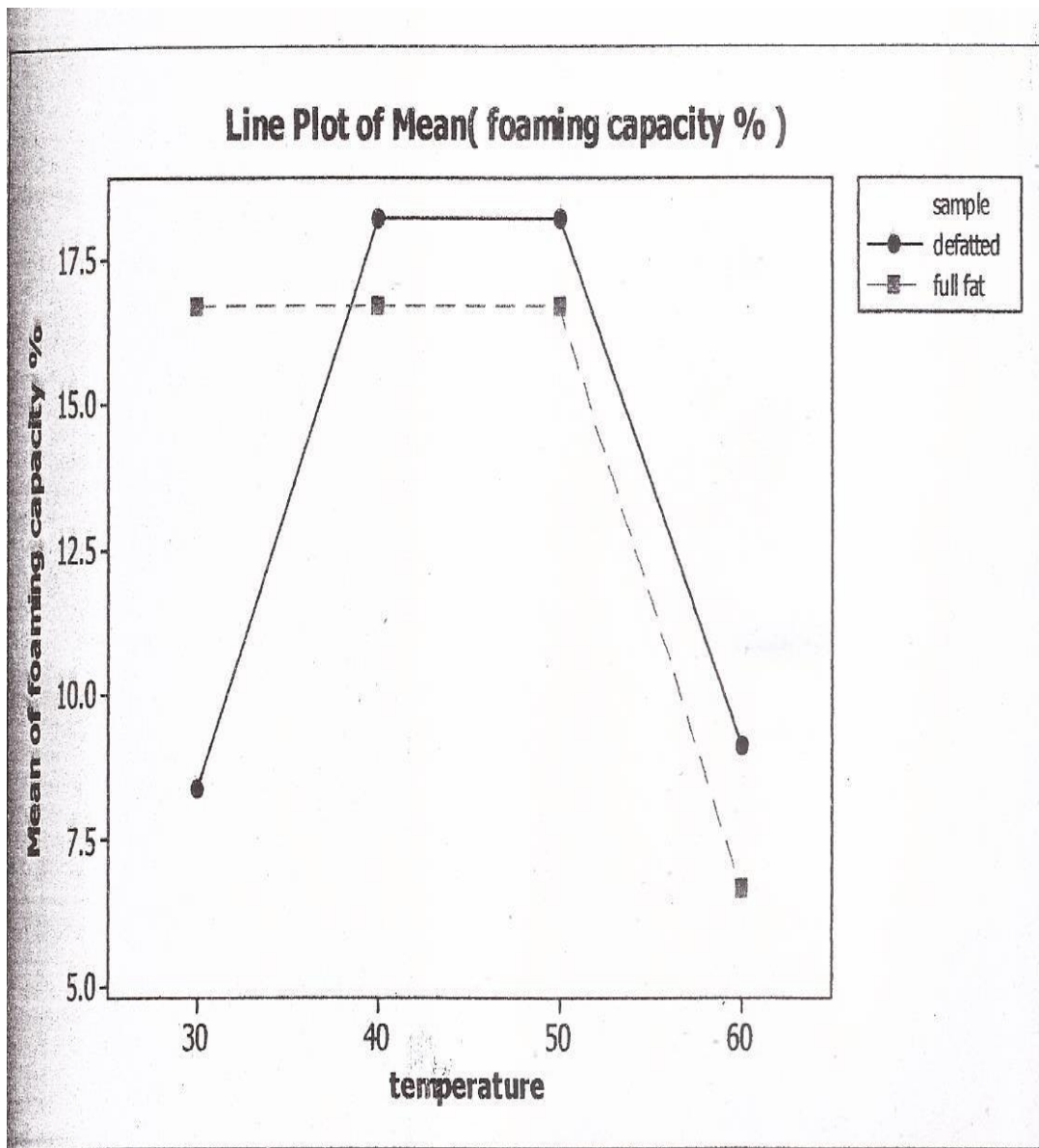


Fig. 8: The effect of Temperature on Foaming Capacity of full fat and defatted flour

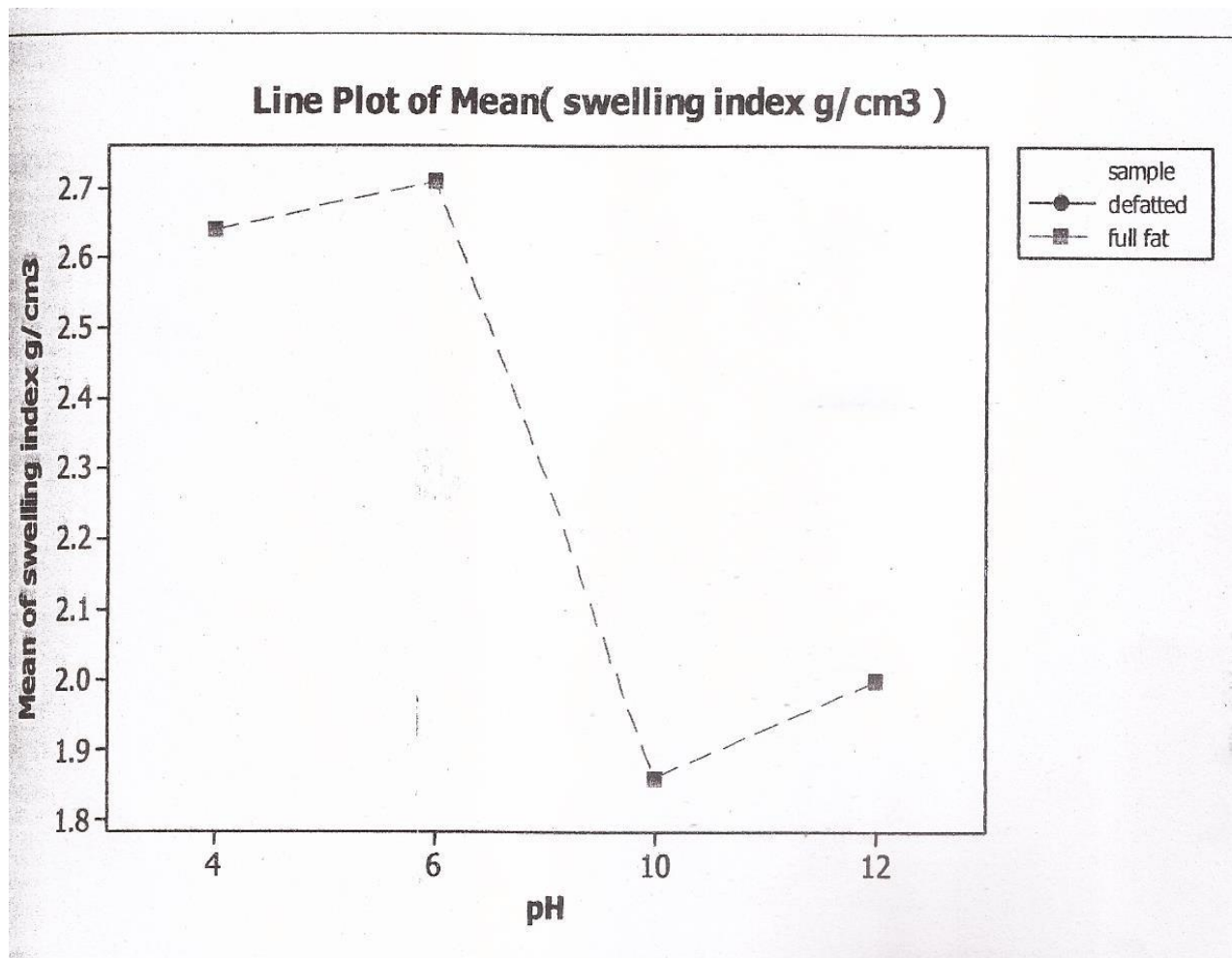


Fig. 9: The effect of pH on Swelling Index of full fat and defatted flour

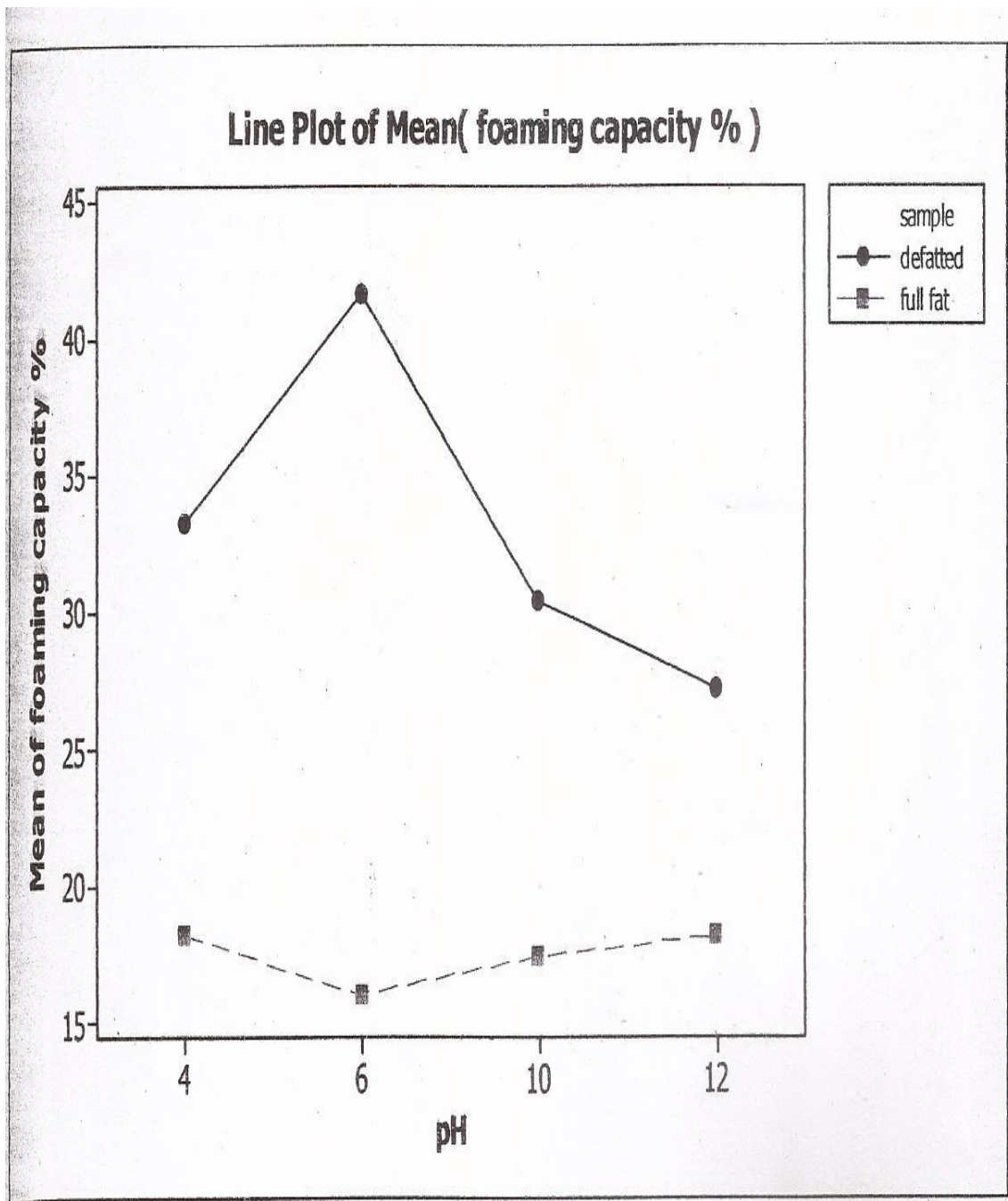


Fig. 10: The effect of pH on Foaming Capacity of full fat and defatted flour

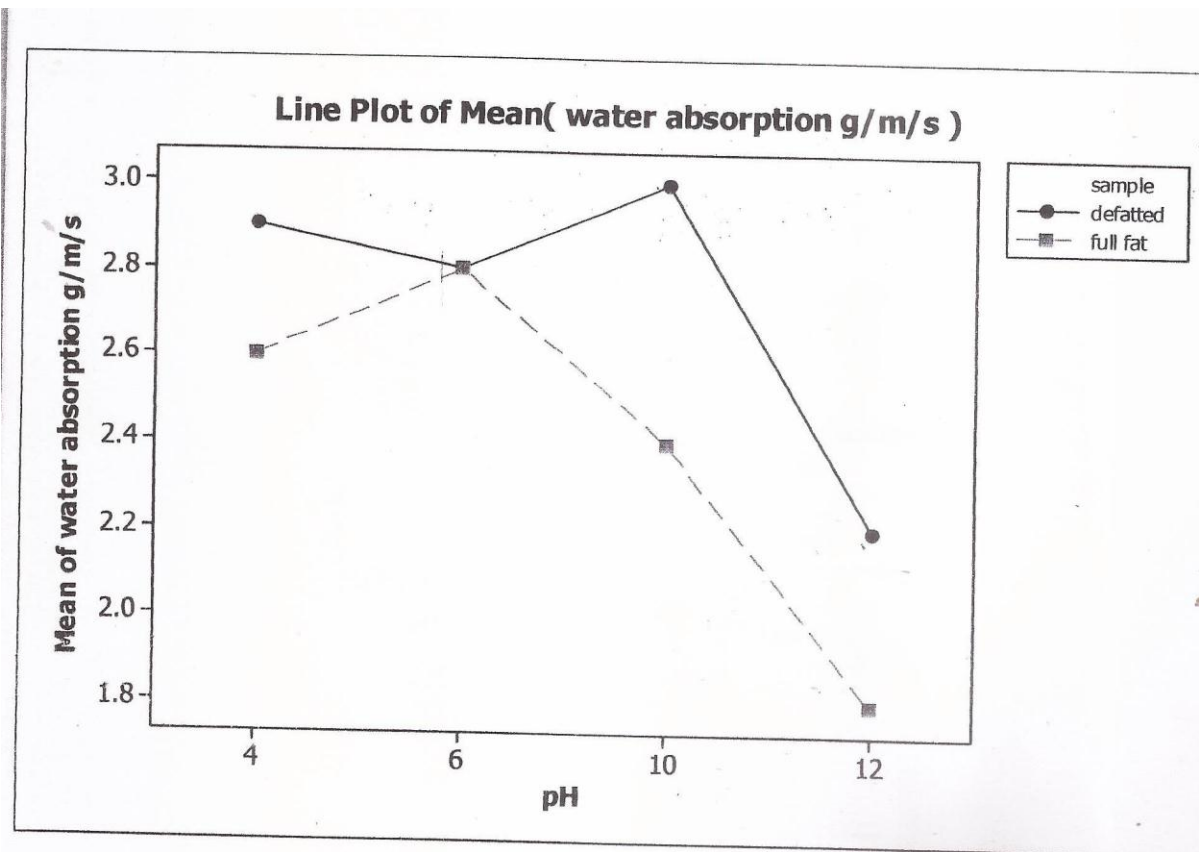


Fig. 11: The effect of pH on Water Absorption of full fat and defatted flour

CONCLUSION AND RECOMMENDATION

Conclusion

The result obtained from this study revealed that Asparagus bean flour is good substitute for flour from other legume such as cowpea. The proximate composition showed that Asparagus bean is good protein source due to its high protein content. The also showed that temperature and pH has effect on the water absorption, swelling index, foaming capacity of the flour sample which are important parameters in food formulations and utilization. It is therefore concluded that Asparagus bean represent a source alternative protein supplement.

Recommendation

With the potential contribution of Asparagus bean to nutrition, it is therefore recommended that cultivation and utilization of this bean be encouraged while research effort should continue to maximize the processing of Asparagus beans. Again to be more acceptable and useful in the incorporation of other foods, Asparagus should be well dehulled and processed into flour as a complement to cereal flour in the preparation of other products. Defatted flour can be incorporated into other flour samples to form composite flour. Further work should be done on the shelf stability

of Asparagus bean flour and the suitability of this bean flour in baking of products like bread and biscuit.

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