Original Research

Volume 3, Issue 1, pp 97-104, June 2021
ACHIEVERS JOURNAL OF SCIENTIFIC RESEARCH
Opecn Access Publications of Achievers University, Owo
Available Online at www.achieverssciencejournal.org

Physicochemical Analysis and Functional Properties of Sponge Gourd (*Luffa cylindrica Linn.*)Seed Oil Obtained from Owo, Ondo State Nigeria

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Submitted: March 21, 2021, Revised: April 24, 2021, Accepted: June 3, 2021 Published: June 28, 2021

ABSTRACT

Physicochemical analysis and Functional properties of powder and oil of shelled seed, deshelled seed, and mixture of shelled and deshelled seedof *Luffa cylindrica* (sponge gourd) were determined using standard analytical procedure. The Functional properties of powder are water absorption capacity ranged from 10.37% to 12.54% with the highest value recorded from Seed$_{\text{-DS}}$ and the lowest value recorded from Seed$_{\text{-S}}$, oil absorption capacity shows Seed$_{\text{-DS}}$ with the highest oil absorption capacity of 14.10%, Seed$_{\text{-S/DS}}$ (12.87%) and the lowest recorded from Seed$_{\text{-S}}$ (11.56%), The foaming capacity of the *Luffa cylindrica (Linn.)* seed powder are 9.03%, 15.56% and 11.50%and foaming stability are 1.62%, 3.30% and 1.73% for Shelled Seed (Seed$_{\text{-S}}$), Deshelled Seed (Seed$_{\text{-DS}}$) and Shelled/Deshelled Seed (Seed$_{\text{-S/DS}}$) respectively, emulsion capacity and stability of the *Luffa cylindrica (Linn.)* seed powder ranges from 27.13% to 41.98% and emulsion stability ranges from 36.33% to 52.13% with the highest value recorded from Seed$_{\text{-DS}}$ and the lowest value recorded from Seed$_{\text{-S}}$. Least gelation concentration (LGC) obtained in this research shows Seed$_{\text{-DS}}$ with the highest oil absorption capacity of 4.21%, Seed$_{\text{-S/DS}}$ (2.07%) and the lowest recorded from Seed$_{\text{-S}}$ (1.96%). The Physicochemical analysis are percentage oil yield from Shelled Seed Oil(Oil$_{\text{-S}}$), Deshelled Seed Oil(Oil$_{\text{-DS}}$), and Shelled/Deshelled Seed Oil (Oil$_{\text{-S/DS}}$) are 26.63%, 42.80% and 31.33% respectively. pH of the *Luffa cylindrica (Linn.)* seed oilranges from6.40 to 6.60 with the highest value recorded from Oil$_{\text{-S/DS}}$ and the lowest value recorded from Oil$_{\text{-DS}}$, specific gravity of Oil$_{\text{-S}}$, Oil$_{\text{-DS}}$, and Oil$_{\text{-S/DS}}$ are 0.70, 0.79 and 0.75 respectively, refractive index of the extracted oil obtained ranges from 1.32 to 1.45, acid value of Oil$_{\text{-S}}$, Oil$_{\text{-DS}}$, and Oil$_{\text{-S/DS}}$ are 2.38 mg KOH/g, 2.91 mg KOH/g and 2.70 mg KOH/g respectively, saponification value of Oil$_{\text{-S}}$, Oil$_{\text{-DS}}$, and Oil$_{\text{-S/DS}}$ are 148.90 mg KOH/g, 161.50mg KOH/g and 154.21 mg KOH/g respectively, iodine value ranges from77.97mgI/g to 86.96 mgI/g with the highest value recorded from Oil$_{\text{-DS}}$ and the lowest value recorded from Oil$_{\text{-S}}$.

Keywords- Functional Properties; *Luffa cylindrica (Linn.)*; Physicochemical Analysis, Seed Oil; Sponge Gourd

1. Introduction

Seeds have been discovered to have energy and nutritive value which makes them important in our daily food consumption. They are also well known as a good source of edible fats and oils (Agbede, 2000). The importance of seed legumes in the diet of animals and man in the developing countries is also well recognized. They are well known to be rich in nutrients such as amino acids, minerals and digestible proteins. Leguminous seed have been reported to be an excellent source of energy in animals and human diets. Aside from the domestic use of oil and fat as cooking oil, they also find major and wide application in industries for paints, creams, fertilizers, soap, cosmetics production etc. The percentage crude protein of legumes seeds ranged from 20 to 50% dry weight, and has been judged as a good source of minerals (Oyeleke, 2011). These seeds also have nutritive and calorific values which makes them necessary in diet (Arawande and Borokini, 2010). Due to insufficient availability of animal protein sources and high cost of few plant protein sources, there is need for intense research into harnessing the nutrient potentials of some underutilized legumes and oil crop (Enujuigha and Akanbi, 2005). Cucurbits (*Cucurbitaceae*) seeds have been found to be a good source of food particularly oils and proteins (Hassan *et al.*, 2008) and this has made them to be widely accepted and recognized. Example of these cucurbitaceae include *Luffa cylindrica*, (sponge gourd), *Curcubita pepo*, *Cucurbita maxima, Cucurbita moshata* and host of other gourds. The genus *Luffa cylindrica* belongs to family *Cucurbitaceae*. In Nigeria, it is locally called “baskalsoosoo” in Hausa, “Nza” in Igbo, “fluionoyibo” in Edo, “kainkain Oyinbo” in Yoruba and “Ochiga” in Ibira(Oyeleke, 2011). It is found as wild in wasteland especially along the coastal area in Africa and Asia. In Nigeria, *Luffa cylindrica* plant grows in uncompleted building, abandoned building structures, fences, walls in towns and villages (Warra *et al.*, 2011).

The seed are black smooth (Slightly tubercle) when the fruit becomes old and dry the endocarp becomes a persistent fibrous muscular network which is used in various ways such as when used as water filter (Dairo*et al.*, 2007). The seed oil of sponge gourd contains oil with percent of free fatty acids. In the pure state, the oil is colourless liquid at an ordinary temperature and of semi-drying type which can be used for food (Ahmad *et al.*, 2010). The sponge gourd seed flour has a higher crude protein which could play a valuable role as a supplemental nutrient source to some farm products used food formulation for animals and human most especially in developing countries where hunger is endemic (Ogunbanjo, 2011). The seeds have been reported to possess both medicinal and nutritional properties, having laxative properties and it is also used in the treatment of asthma, sunicitis fever (Aletor *et al.*, 2002). In cosmetics, *Luffa cylindrica* seed oil is used in sunscreens, sunless tanning products, anti-aging products, facial moisturizers and treatments, body oils and facial cleansers because of its antifungal, anti-inflammatory and anti-tumor properties since its prevent synthesis of certain proteins and also considered as toxic to skin cancer cells (Ahmad *et al.*, 2010). *Luffa* sponge is fast becoming an indispensable crop because of its very wide industrial applications and many medicinal properties, for these reasons physicochemical and functional characteristic of the seed oil is worthwhile.

2. Materials and methods

2.1 Sample Collection and Preparation

The samples (*Luffa cylindrica*) were harvested in anabandoned uncompleted building at Iseluowo near a refuse dumping site in Owo, Ondo State Nigeria. The fruits were cut into two equal halves and the seeds were scoop out and separated from the fiber. The seeds were washed with double distilled water and sundried for 48 hrs. The first part of the seeds wasdeshelled, washed, dried, screened to remove bad seed and pulverized with the aid of a grounding machine and the second part of the seeds was washed, dried and pulverized without deshelling while the third part is a mixture of the deshelled and shelled seed in the ratio 1:1. The three parts were kept in a sealed plastic for further analysis.

2.2 Method

2.2.1 Determination of Functional Properties

2.2.1.1 Determination of Water and Oil Absorption Capacity

1.0 g of the powdered sample was accurately weighed and 10 mL of water was added. The mixture was then transferred into a centrifuge tube. Themixture was centrifuged at 1000 rpm for 20 minutes and oil absorption was then calculated using the equation 1

$$\text{Water Absorption Capacity} = \frac{\text{vol. of water added} - \text{vol. of water absorbed}}{vol.\ of\ water}\ x\ 100\ (1)$$

2.2.1.2 Determination of Foaming Capacity and Stability

The method of Coffman and Garcia (1977) was employed in the study of foaming capacity and stability. 1g of each sample was whipped with 50 mL of distilled water for 5 mins in a kenwood blender at speed set at "max" and was poured into a 100 mL graduated cylinder. Total volume at time interval of 5 mins, 10 mins, 20 mins, 30 mins and 1 h were noted to study the foaming stability. The percentage volume increase was calculated according to the following equation 2 to obtain the foaming capacity.

$$\%\ \text{vol. Increase} = \frac{\text{vol. after whipping} - \text{vol. before whipping}}{vol.\ before\ whipping}\ x\ 100\ \ (2)$$

2.2.1.3 Determination of Emulsion Activity and Stability

The emulsion activity and stability was determined by the method of Yasumasu *et al.* (1972).The emulsion (0.5g sample in 5 mL distilled water, 5 mL executive oil) was prepared in a calibrated centrifuged tube. The emulsion was centrifuged at 1000rpm for 10 minutes. The ratio of the height of the emulsion layer to the height of the mixture was calibrated as the emulsion activity expressed in percentage. The emulsion stability was estimated by heating the emulsion contained in a calibrated centrifuged tube at 80^{o}C for 30 minutes in a water bath, cooling for 15 minutes under running tap water and centrifuged (Gallenkamp. UK) at 1000rpm for 15 minutes. The emulsion stability expressed as a percentage was calculated as the ratio of the height of the emulsified layer to the total height of the mixture.

$$\%\ \text{Emulsion Capacity} = \frac{\text{Emusified oil volume}}{Total\ volume}\ x\ 100\ (3)$$

2.2.1.4 Least Gelation Concentration

The modified procedure of Coffman and Garcia (1977) was used to determine gelation property. Appropriate sample of 2%, 4%, 6%, 8%, 10%, 12%, 14% and 16% were prepared in 5 mL distilled water. The test tubes containing this suspension were heated for 1 hour in boiling water followed by rapid cooling for 2 hours at 4^{o}C. The least gelation concentration was the concentration when the sample from the inverted test tubes did not slip or fall down.

2.2.1.5 pH

1.00 g of sample was dissolved in 20 mL of distilled water and subjected to continuous stirring with magnetic stirrer for 2 h after which the pHwas then measured using a pH meter.

2.2.2 Extraction of Oil

The extraction of oils from seeds was carried out using Soxhlet extraction apparatus. A 100 g each of the shelled, deshelled and shelled/deshelled powdered seed sample was put into a porous thimble and placed in a Soxhlet extraction apparatus, using 150 mL of n-hexane (with boiling point of 40 - 60 ^{o}C) as extracting solvent for 6 h. The oil was obtained after the solvent was removed under reduced temperature and pressure and refluxing at 70 ^{o}C to remove excess solvent from the extracted oil. The oil was then stored in freezer at -2 ^{o}C for subsequent physicochemical analyses (Wara*et al.*, 2011). After extraction, the samples were analyzed according to the official methods of analysis described by Association of Official Analytical Chemist (A.O.A.C 1990). All analyses were carried out in triplicate.

2.2.3 Statistical Analysis

All analyses were done in triplicate to evaluate experimental reproducibility and reported as Mean ± Standard Deviation. The data obtained were subjected to one-way analysis of variance (ANOVA) using SPSS version 21. Duncan's multiple range test was used to determine means that were significantly different at a level of significance (α) of 0.05.

3. Results and Discussion

3.1 Functional Properties

The results obtained for the functional properties of *Luffa cylindrica (Linn.)* seed powder are presented in the Table 1 below. The water absorption capacity obtained in this research ranged from 10.37% to 12.54% with the highest value recorded from Seed$_{-DS}$ and the lowest value recorded from Seed$_{-S}$. This value is higher than the value obtained by Olaofe *et al.* (1994) for melon seed (9.0%), pumpkin seed (11%) and gourd seed (10%). The high value in Seed$_{-DS}$ could be attributed to the absence of shell which makes it absorb more water than Seed$_{-S}$ and Seed$_{-S/DS}$.Water absorption is a function of protein in viscous foods like soup, dough and baked product. The low value obtained indicated that the seed sample will be less hydrophobic and therefore will be useful in application for food formulation (Oyeleke *et al.,* 2012).

The oil absorption capacity obtained in this research shows Seed$_{-DS}$ with the highest oil absorption capacity of 14.10%, Seed$_{-S/DS}$ (12.87%) and the lowest recorded from Seed$_{-S}$ (11.56%). These values obtained are higher than the ones reported by Appiah *et al.* (2011) for three varieties of cowpea where he obtained 1.95%, 2.14% and 2.31%. This trend was also observed in the water absorption capacity test carried out. The relationship observed that the oil absorption capacity increases with water absorption capacity. There are significant differences in the oil absorption capacity test of the Shelled Seed (Seed$_{-S}$), Deshelled Seed (Seed$_{-DS}$), Shelled/Deshelled Seed (Seed$_{-S/DS}$) at P>0.05. This higher value is very useful in food system as this indicate the tendency of protein in the seed to bind in oil inhibition. The seed powder will find application in food industry due to it functional uses such as enhancement of mouth feel and flavor applied in food preparation (Appiah *et al.,* 2011).

The foaming capacity and stability of the *Luffa cylindrica (Linn.)* seed powder are 9.03/1.62%, 15.56/3.30% and 11.50/1.73% for Shelled Seed (Seed$_{-S}$), Deshelled Seed (Seed$_{-DS}$) and Shelled/Deshelled Seed (Seed$_{-S/DS}$) respectively. These values compared favourably with those of full fat fluted pumpkin seeds (10.80/5.0%) as reported by Fagbemi and Oshodi (1991) and Chinma *et al.* (2008) for some Nigerian cowpea varieties. The highest foaming capacity and stability was observed in Seed$_{-DS}$, this could be attributed to the water absorption capacity of Seed$_{-DS}$ which will have effect in enhancing the whipping and aeration of the Seed$_{-DS}$. Kinsella *et al.* (1985) attributed low foaming capacity to lesser electrostatic repulsions and solubility and hence, excessive protein-protein interactions. Since the Seed$_{-DS}$ produced significantly more foam and had the highest stability than both Seed$_{-S}$ and Seed$_{-S/DS}$, it would be most applicable as foam enhancer in food industries. This implies that the powders of *Luffa cylindrica (Linn.)* may be useful as aerating agents in food (Adejuyitan *et al.,* 2009).

The emulsion capacity and stability of the *Luffa cylindrica (Linn.)* seed powder ranges from27.13/36.33% to 41.98/52.13% with the highest value recorded from Seed$_{-DS}$ and the lowest value recorded from Seed$_{-S}$. These values are slightly higher than 25.82/31.2% reported by Chinma *et al.* (2008) for some Nigerian cowpea varieties. There are significant differences in the emulsion capacity and stability test of the Shelled Seed (Seed$_{-S}$), Deshelled Seed (Seed$_{-DS}$), Shelled/Deshelled Seed (Seed$_{-S/DS}$) at P>0.05.The values obtained suggest that the seed powder can be used as additive for stabilization of emulsion in the production of dough and cakes in food industries (Aletor *et al.,* 2002)

The least gelation concentration (LGC) obtained in this research shows Seed$_{-DS}$ with the highest oil absorption capacity of 4.21%, Seed$_{-S/DS}$ (2.07%) and the lowest recorded from Seed$_{-S}$ (1.96%). These values obtained are higher than the ones reported by Appiah *et al.* (2011) for three varieties of cowpea where he obtained 1.24%, 1.69% and 1.51% and lower than that of pigeon pea (15.1%) and lupin seed (17.8%w/v) reported by Sathe *et al.* (1982) and of the flour of the Great Northern bean (16.2%) reported by Sathe and Sahunkhe (1981). Significant difference was observed between Shelled Seed (Seed$_{-S}$), and Deshelled Seed (Seed$_{-DS}$) while there was no significant difference between Shelled Seed (Seed$_{-S}$) and Shelled/Deshelled Seed (Seed$_{-S/DS}$)at P>0.05. This result suggests that *Luffa cylindrica*

(Linn.) seed powder may not be a good gel forming agent (Ragab *et al.,* 2004).

The pH of the *Luffa cylindrica (Linn.)* seed powder ranges from6.00 to 6.70 with the highest value recorded from Seed$_{-DS}$ and the lowest value recorded from Seed$_{-S}$. The variation in pH may be attributed to shell of the seed having effect on the pH of the seed powder as it was discovered that the powder containing the shell tend to have a lower pH compare to that of the seed powder. However, the pH result is within the permissive neutral range for consumption. This was also established in earlier research carried out (Aletor *et al.*, 2002). These values suggest that *Luffa cylindrica (Linn.)*seed powder is safe for application in food industries.

3.2 Physicochemical Properties

The results obtained for the physicochemical properties of *Luffa cylindrica (Linn.)* seed powder are presented in the Table 2. The percentage oil yield from Shelled Seed Oil (Oil$_{-S}$), Deshelled Seed Oil(Oil$_{-DS}$), and Shelled/Deshelled Seed Oil (Oil$_{-S/DS}$) are 26.63%, 42.80% and 31.33% respectively. The highest value was recorded in Oil$_{-DS}$ and this can be as a result of the effect of deshelling the seed before extraction. The results obtained are lower than 48% as reported by Warra *et al.* (2012) for jatrophacurcas seed oil and 44.8% and higher than the 25.7% reported by Elemo *et al.* (2011) from *luffa aegyptiaca* seed and 22.5% recorded by Gafar *et al.* (2012) from *allium sativum*. Significant difference was observed between Oil$_{-S}$, Oil$_{-S/DS}$ and Oil$_{-DS}$.

The pH of the *Luffa cylindrica (Linn.)* seed oilranges from6.40 to 6.60 with the highest value recorded from Oil$_{-S/DS}$ and the lowest value recorded from Oil$_{-DS}$. The variation in pH may be as a result of interaction of the shell of the seed it was discovered that the powder containing the shell tend to have a higher pH compare to that of the seed powder. However, the pH result is within the permissive neutral range for consumption (Fasuyi, 2006).

The specific gravity of Oil$_{-S}$, Oil$_{-DS}$, and Oil$_{-S/DS}$ are 0.70, 0.79 and 0.75 respectively. There is no significant difference between the values obtained. This implies that the shell had no effect on the specific gravity of the extracted oil. The value obtained is lower to those earlier reported by Gafar *et al.* (2012) and *allium sativum* oil (0.90) and 0.93 for *luffa aegyptiaca*. Low value of specific gravity is an indication that the oil contains low density fatty acids which then have tendency of having high saponification value making it appropriate for application in cosmetics industries (Afolabi, 2008).

The refractive index of the extracted oil obtained ranges from 1.32 to 1.45. These values are within the range of 1.43, 1.45 and 1.47 reported by Eladawy and Taha (2000) for water melon seed oil, pumpkin seed oil and paprika seed oil respectively. The refractive index of observed for *Luffa cylindrica (Linn.)* seed oil shows that the oil is thicker than the common drying oils like linseed oil, soybean oil and cod liver oils with refracted index between 1.475-1.485 (Aletor *et al.*, 2002).

The acid value of Oil$_{-S}$, Oil$_{-DS}$, and Oil$_{-S/DS}$ are 2.38 mg KOH/g, 2.91 mg KOH/g and 2.70 mg KOH/g respectively. The highest value was observed in Oil$_{-DS}$ (2.91 mg KOH/g) and lowest in Oil$_{-S}$ (2.38 mg KOH/g). Significant difference was observed between Oil$_{-S}$), Oil$_{-DS}$ and Oil$_{-S/DS}$at P>0.05. The acid value obtained in this research is higher when compared to 1.20 mg KOH/g of Jatrophacurcas seed oil by Warra *et al.* (2012) and lower when compared with 10.1 mg KOH/g and 9.36 mg KOH/g obtained from *Luffa aegyptiaca* by Elemo *et al.* (2011) and 4.18 mg KOH/g obtained from *Allium sativum L.* oil by Gafar *et al.* (2012). The low acid value obtained indicates maximum purity which makes it suitable for cosmetics production (Oyedele, 2002).

The saponification value of Oil$_{-S}$, Oil$_{-DS}$, and Oil$_{-S/DS}$ are 148.90 mg KOH/g, 161.50mg KOH/g and 154.21 mg KOH/g respectively. The highest value was observed in Oil$_{-DS}$ (161.50 mg KOH/g) and lowest in Oil$_{-S}$ (148.90 mg KOH/g). Significant difference was observed between Oil$_{-S}$), Oil$_{-DS}$ and Oil$_{-S/DS}$at P>0.05. It was observed in this study that the saponification value increase with the acid value.The saponification value obtained is higher when compared to the 122.49 mg KOH/g obtained for *Jatropha curcas* seed oil by Warra *et al.* (2012) and lower than 197 mg KOH/g and 201 mg KOH/g of dehulled and whole seed oil of *Luffa aegyptiaca* reported by Elemo *et al.* (2011). The value obtained is higher than 100 mg KOH/g and this indicates that the oil could be of use in cosmetics industry since higher saponification value justifies the usage of the oil for soap production (Warra *et al.*, 2010).

The iodine value of the *Luffa cylindrica (Linn.)* seed oil ranges from77.97mgI/g to 86.96 mgI/g with the highest value recorded from Oil$_{-DS}$ and the lowest value recorded from Oil$_{-S}$. The value obtained is higher than 12.69 mgI/g for garlic reported by Gafar *et al.* (2012) but lower than 99.3 mg I/g and 106.0 mgI/g of dehulled and whole seed oil respectively of *Luffa aegyptiaca* reported by Elemo *et al.* (2011). Oils with iodine value less than 100 mgI/g are termed as non-drying oils which are useful in the manufacture of soaps, this implies that *Luffa cylindrica (Linn.)* seed oil will be of good use in cosmetics industry

4. Conclusion

This study investigated the functional and physicochemical properties of *Luffa cylindrica* seed powder and oil. Generally, the seed powder and seed oil sample possess good functional and excellent physicochemical properties respectively even when the shell was combined with the seed therefore *Luffa cylindrica (Linn.)* seed powder and oil which has been an underutilized seed will be widely useful in industrial application as this will help and serves as cheap alternative raw material owing to the fact that *Luffa cylindrica (Linn.)* plant is readily available as wild plant and less expensive.

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Figure 1: *Luffa cylindrica (Linn.)* Seed

Table 1: Functional Properties of *Luffa cylindrica (Linn.)* Seed Powder

Test	Seed$_{-S}$	Seed$_{-DS}$	Seed$_{-S/DS}$
Water absorption capacity (%)	$10.37^a \pm 0.24$	$12.54^b \pm 0.39$	$11.22^a \pm 0.34$
Oil absorption capacity (%)	$11.56^a \pm 0.54$	$14.10^b \pm 0.40$	$12.87^c \pm 0.65$
Foaming capacity (%)	$9.03^a \pm 0.21$	$15.56^b \pm 0.40$	$11.50^c \pm 0.79$
Foaming stability (%)	$1.62^a \pm 0.13$	$3.30^b \pm 0.34$	$1.73^a \pm 0.06$
Emulsion capacity (%)	$27.13^a \pm 0.85$	$41.98^b \pm 1.48$	$34.23^c \pm 0.75$
Emulsion stability (%)	$36.33^a \pm 0.58$	$52.13^b \pm 1.02$	$45.30^c \pm 0.61$
Least gelation concentration (%)	$1.96^a \pm 0.15$	$4.21^b \pm 0.44$	$2.07^a \pm 0.14$
pH	$6.0^a \pm 0.30$	$6.7^a \pm 0.40$	$6.3^a \pm 0.35$

Number of replicates = 3; Mean ± Standard Deviation; Mean with different superscript across rows are significantly different at (P>0.05). Shelled Seed (Seed$_{-S}$), Deshelled Seed (Seed$_{-DS}$), Shelled/Deshelled Seed (Seed$_{-S/DS}$)

Table 2: Physicochemical Properties of *Luffa cylindrica (Linn.)* Seed Oil

Test	Oil$_{-S}$	Oil$_{-DS}$	Oil$_{-S/DS}$
Percentage yield (%)	$26.63^a \pm 1.52$	$42.80^b \pm 1.67$	$31.33^c \pm 1.53$
pH	$6.5^a \pm 0.10$	$6.4^a \pm 0.25$	$6.6^a \pm 0.20$
Specific gravity	$0.70^a \pm 0.02$	$0.79^a \pm 0.05$	$0.75^a \pm 0.03$
Refractive Index	$1.32^a \pm 0.02$	$1.45^b \pm 0.07$	$1.38^a \pm 0.03$
Acid Value (mg KOH/g)	$2.38^a \pm 0.13$	$2.91^b \pm 0.12$	$2.70^c \pm 0.17$
Free fatty acid value (%)	$6.36^a \pm 0.17$	$7.71^b \pm 0.18$	$7.10^c \pm 0.13$
Saponification value (mg KOH/g)	$148.90^a \pm 2.80$	$161.50^b \pm 2.61$	$154.21^c \pm 2.18$
Iodine Value (mg I/g)	$77.97^a \pm 1.20$	$86.96^b \pm 1.54$	$81.86^c \pm 1.58$

Number of replicates = 3; Mean ± Standard Deviation; Mean with different superscript across rows are significantly different at (P>0.05). Shelled Seed Oil (Oil$_{-S}$), Deshelled Seed Oil(Oil$_{-DS}$), Shelled/Deshelled Seed Oil (Oil$_{-S/DS}$)