Quality Characteristics of *Luffa aegyptiaca* seed oil.

*O.M Abayeh [2], I.H Garba[1], H.M Adamu[1] and O.J Abayeh[1],

[1]Chemistry Programme, Abubakar Tafawa Balewa University, P.M.B 0248, Bauchi, Nigeria

[2] Industrial Training Fund, Warri, Nigeria.

Abstract.
The oil content and quality characteristics of Luffa aegyptiaca seed oil are described. The straight vegetable oil (SVO) was extracted from the seed using hexane. On a dry matter basis, the oil content was 19-25% of ground seeds. The quality characteristics of the seed oil were: saponification value (SV), 168mg KOH/g of oil , iodine value (IV), 130g iodine/100g of oil, peroxide value (PV), 280 meq peroxide/kg of oil, free fatty acid (FFA) 10.36% of oil and acid value (AV) 20.62%. The density of the oil was 0.91g/cm^3 and the specific gravity was 0.92g/ml oil and kinematic viscosity 13.98mm^2/s at 30^{0}C. The saponin content and the unsaponifiable matter of the oil were also determined. The oil quality parameters suggest that the oil may find use as feedstock for biodiesel production. Owing to its iodine value, the oil may also be used in surface coating applications.

Key words: *Luffa aegyptiaca*, *Luffa* seed oil (LSO), saponin, quality characteristics, saponin content, unsaponifiable matter.

Introduction

The Luffa gourd (*Luffa aegyptiaca)* is a fast growing annual vine which grows ubiquitously and matures within four months. The luffa plant is a cucurbit, a group of plants including gourds, pumpkins and cucumbers; all belonging to the Cucurbitaceae family. The luffa has many names, some of the common names are: 'smooth loofah, loofah, loofah sponge, sponge gourd, vegetable sponge, dishrag gourd and Chinese okra'. The species of luffa are *luffa cylindrica* and *luffa aegyptiaca* (www.floridata *luffa aegyptiaca*. htm; www.luffa.info.htm, 2009). It is called 'soso' in Hausa, 'kankan' in Yoruba and 'asisa' in Ibo in Nigeria (www.luffa 10.htm, 2010). Loofah is a rampant vine that produces pretty yellow flowers and strange looking fruits that are edible (in southern USA and China) and used as back scrubbers or sponges when fully mature. Probably native to Africa, loofahs grow like weeds, needing a little sunny spot and something to climb on, usually seen growing on back fences or walls, the immature fruits (3-6 inches in length) can be fried whole or sliced, or they can be grated for use in soups and omelets (www.floridata *luffa aegyptiaca*. htm;, 2009) .

When matured, the fruits turn brown and are easily peeled for use as back scrubbers or kitchen pot scrubbers; once the brown dry outer skin is peeled off, seeds are shaken out of the fruits. The sponges so obtained are soaked in household bleach solution to make them neat and white. Loofahs are also used as filters and edible oil is pressed from the seeds (www.floridata *luffa aegyptiaca*. htm, 2009).

The properties of seed oil and protein of three underutilized edible cucurbitacea have been reported (Abeboye, 2010), literature search also revealed the transesterification of *Balanites aegyptiaca* oil to produce biodiesel (www.faqs.org/patents/app, 2009).

The use of luffa fruit for food and cleaning purposes as mentioned above have equally been reported, however, not much has been reported on the quality parameters of the luffa seed oil; neither has any use of it been reported. This study was thus conducted to investigate the quality parameters of luffa seed oil and as such determine other outlets for the oil.

Materials and Methods

The luffa gourds utilized for this research were collected (already matured and dried) from the walls fencing the Abubakar Tafawa Balewa University, Kari Housing Estate, Bauchi on Maiduguri road in Nigeria.

The gourds were opened, the dry seeds shaken out and collected in a bowl. Defective seeds and dirt were selected and removed. The dry luffa seed has a black coat that is difficult to break, peel off or remove. The seeds were thus pounded in a mortar and pestle, to give a green coloured powder with speckles of the black coat. The ground seeds were kept in a dry plastic container with a tight cover (to prevent moisture sorption) until ready for soxhlet extraction.

Determination of Moisture Content

The ground seed (2g) was placed in a dried and weighed crucible. The crucible with the ground seed was placed in the Griffin temperature adjustable oven at 110^0 C. Heating and weighing were carried out at intervals of 1 (one) hour until a constant weight was obtained. The crucible was allowed to cool, the weight taken and percentage (%) moisture content calculated

Determination of Oil Yield

The ground seed was weighed and loaded into a thimble and soxhlet extracted for eight (8) hours with n-hexane (Analar Grade). The hexane extract was filtered and evaporated under vacuum to give a thick mass of oil; the oil was poured into a beaker of known weight and kept in a Griffin temperature adjustable oven at 60 – 70^0C to evaporate the residual solvent. The Luffa seed oil (LSO) so obtained was kept in an air tight bottle with no air space and labeled as the First Hexane Extract [FHE] and kept for further analysis. The residual seed was air dried, weighed and further re-extracted to ensure complete extraction of the oil, treated as above and labeled as the Second Hexane Extract (SHE). The combined oil extract was weighed and the % yield calculated on a dry matter basis and found to be between 19-25% wt/wt.

The LSO was also tested and found to contain 3.98% of unsaponifiable matter

Physical Properties of LSO

The oil has a yellowish green colour, a sweet fruity smell and a very viscous texture. Specific gravity, viscosity, free fatty acid (FFA), saponification value (SV), acid value (AV), peroxide value (PV) and iodine value (IV) were determined by standard procedures (BSI methods, 1982), while unsaponifiable was determined by a literature procedure (Oloyede, 2009). The results are shown on Table 1.

Results and Discussion

The low percentage oil yield (Table 1) may not be unconnected to the fact that manual removal of the seed coat was impossible, as such the cotyledons were inseparable from the coat. The black seed coat and cotyledons were thus ground into a powdery form for the purpose of extraction. The seed coat with little or no oil is inclusive in the weight of the ground seed, consequently leading to a reduction in the calculated oil yield.

Table 1: Oil properties of Luffa Seed Oil (LSO).

Oil yield (%)	19 - 25
Density (g/cm3)	0.91
Specific gravity	0.92
Iodine value, IV (%)	130
Saponification value, SV (mgKOH)	168
Free fatty acid, FFA (%)	10.36
Acid value, AV (%)	20.62
Unsaponifiable matter(%)	3.98
Peroxide value PV (meq/kg)	280
Moisture content (%)	4.62
Colour of oil	Yellowish green
Texture of oil	Very viscous
Fragrance	Sweet fruity
Unsaponifiable matter (%)	3.98

The oil yield would be higher if the weight of the ground seed was exclusive of the seed coat. The oil content is however high when compared to the oil from mango seed (Nzikou J.M *et al*, 2010)

The percentage moisture content of LSO indicates that the seed oil could be stored for a long period without deterioration (Abayeh *et al*, 2011). Moisture content is an important oil quality parameter indicative of the length of storage of the oil. Seed oils with high contents of moisture readily undergo enzymatic reactions which affect other properties of the oil such as acid value, free fatty acid and peroxide value.

Table 2: Comparison of Oil Quality Characteristics of LSO, and Some SVOs from Literature.

	LSO	Canola oil[a]	Soybean oil[b]
Specific gravity	0.92	0.90	0.92
Density (g/cm^3)	0.91	0.92	0.89
Iodine value (%)	130	130	125
Saponification value (mgKOH)	168	110-126	189-195

[a]Barnwal and Sharma (2005)
[b]G.Knothe (2002)

Specific gravity and density are important physical characteristics indicative of the handling and storage of oils and fuels as well. The specific gravity of oil is the ratio of the mass of a given volume of oil to the mass of an equal volume of water; it is related to the fatty acid content of the oil and the average molecular weight. The specific gravity and density values (Table 1) obtained for LSO in this research compares favourably with those of Canola oil and Soybean oil (Table II, Barnwal & Sharma, 2005; G.Knothe, 2002). The values suggest that LSO may find outlets in the manufacture of lubricants and other purposes like biodiesel production.

The LSO was found to contain saponins which are glucosides extracted from plants that form a soapy lather when mixed with water; they are used in detergents. It thus implies that LSO can possibly provide some cleansing effects; this can be an advantage in a biodiesel produced from LSO.

The LSO contains low (3.98%) unsaponifiable matter. Typical crude soybean oil contains as much as 16% unsaponifiable matter, which consists of plant sterols, tocopherols and hydrocarbons as major components. (Iowa Soybean Promotion Board Report, 1996). Unsaponifiable matter content has been known to affect physical properties of oils as shown by a study on coffee seed oil (Hartman *et al*, 1968). The unsaponifiable matter of coffee seed oil has been shown to be responsible for the comparatively low melting-point (approximately 8°C) of this oil. The melting point of coffee oil fatty acids, free of unsaponifiable matter, was 40−42°C, whereas on esterification with glycerol produces an oil with a melting point of 34−36°C. The unsaponifiable matter has also been probably responsible for high refining losses of coffee oil since the surface activity of its main constituents facilitates a partial saponification or emulsification of neutral oil during the treatment with alkalis, especially in oils with high acidity.

The acid value is a measure of the free fatty acid content in an oil. It is affected by the duration and conditions of storage of the oil. Acid value is an indicator of the edibility of an oil and its suitability for industrial use (Abayeh *et al*, 2011, Abu Sayeed *et al*, 2004, Carrol and Noble 1957). The recommended values for virgin and non virgin edible fats and oils are 0.6 and 10mgKOH/g oil respectively. (Adelaja, 2006). The acid value obtained for LSO shows that it may not be suitable for edible use. The free fatty acid value of the oil on the other hand is a measure of the enzymatic hydrolysis the oils have undergone in the parent source before extraction.

Iodine value measures the degree of unsaturation on the hydrocarbon ends of oils; it is useful in predicting the drying property of oils (Abayeh *et al*, 2011; Özcan M.M et al 2006). Generally, oils are classified into three categories based on their iodine values; oils with iodine values of 80 – 120 are non – drying oils, 120 – 150, semi drying oils and drying oils have iodine values greater than 150 (Seatons, www.iodine value.htm;2010). Thus going by this classification, LSO with an iodine value 0f 130 can be classified as semi drying oil. As such in addition to its possible use for biodiesel production, LSO can also be useful in surface coating applications like paints, resins and printing inks. The iodine value of LSO compares favourably with those of seed oils like Canola and Soybean oils (Table 2, Barnwal & Sharma, 2005; G.Knothe, 2002).
Seed oils like safflower, sunflower and soya bean oils with iodine values ranging between 112- 148 are semi- drying oils; containing linoleic acids (50-80%) and 18 C atoms with 2 double bonds (Seatons, www.iodine value.htm, 2010). Comparatively, LSO is in the same class with an iodine value of 130.

Saponification value gives an indication of the size of the hydrocarbon chain; it is a measure of the average molecular weight of the triacylglycerol in oil. This parameter is significant in soap manufacturing industries and also in biodiesel production. The lower the saponinfication value, the higher the molecular weight of the hydrocarbon and vice versa. The saponification of LSO (Table 1) shows that the oil can be used for soap manufacture

The peroxide value indicates the level of deterioration of oil as a result of oxidation owing to the availability of oxygen during storage. Peroxide value can be a useful early indicator of oxidative deterioration and a decrease in the effectiveness of the oils own antioxidants. During oxidative deterioration the peroxide value first rises and then falls after reaching a maximum value. During storage, peroxides are generated by oxygen access. A rise of viscosity and gummy deposits can be the consequence (Sustainable Energy Ireland (2000-2006). Fats and oils are oxidized when they come in contact with oxygen which may exist in the headspace of oil storage containers and dissolve in the oil. The value obtained in this work showed that the LSO had undergone oxidative deterioration during storage, this can however be curtailed by proper storage.

Conclusion

The quality characteristics of LSO obtained in this research has shown that LSO is a semi-drying oil that can be used in surface coating applications like paints, resins and printing inks. LSO is also a potential feedstock for biodiesel production and soap manufacture. However, owing to its acid value and FFA content, the oil is not suitable for edible use.

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