Annals. Food Science and Technology
2011

# PROXIMATE ANALYSIS OF THE SEEDS AND CHEMICAL COMPOSITION OF THE OILS OF *ALBIZIA SAMAN*, *MILLETTIA GRIFFONIANUS* AND *TAMARINDUS INDICA* FROM NIGERIA

Adewale Adewuyi [1,3], Rotimi A. Oderinde [2], B.V.S.K. Rao [3], R.B.N. Prasad [3], M. Nalla[3]
[1]Department of Chemical Sciences, Redeemer's University, Mowe, Ogun state, Nigeria.
[2]Industrial unit, Department of Chemistry, University of Ibadan, Ibadan, Oyo state, Nigeria.
[3]Centre for Lipid Research, Indian Institute of Chemical Technology, Hyderabad – 500 007.
walexy62@yahoo.com

**Abstract**
*Analysis of lesser known underutilized seed oils is important as there is little or no information on their composition and uses, since most of them are yearly discarded as waste. Analysis of these underutilized tropical seed oils will help in grouping them and making the best use of them in various applications. The seeds of Albizia saman, Millettia griffonianus and Tamarindus indica were evaluated for their proximate composition while their oils were subjected to chemical analysis. The metal composition of the seeds and oils were determined using AAS while the fatty acid composition was evaluated using GC. A. saman (39.40 ± 0.30 %) had the highest protein content while M. griffonianus (59.49 ± 0.80 %) recorded the highest carbohydrate content. The oil content of the seeds of Albizia saman, Millettia griffonianus and Tamarindus indica were 9.77 ± 1.21 %, 10.91 ± 1.00 % and 3.11 ± 0.41 %; respectively. Oil of Millettia griffonianus (151.20±0.20 g iodine/100g) recorded the highest iodine value. C18:2 was the dominant fatty acid found in the oils while the neutral lipids were the most abundant lipid class in the oils. The seeds as well as the oils were found to be rich in K and Na. The result of the GC-MS revealed hydrocarbons as the major unsaponifiable matters in the oils, other compounds identified includes phytol, sterols, and beta-Tocopherol.*

Keywords: Albizia saman, Fatty acids, Leguminiaceae, Lipid classes, Millettia griffonianus, Tamarindus indica

Submitted: 28.09.2011 Reviewed: 07.11.2011 Accepted: 07.12.2011

## 1. INTRODUCTION

Seed oils are mainly triacylglycerols which are the reaction product of glycerol and fatty acids. They are usually named by their biological sources (such as soybean oil, palm oils etc) which have range of physical and chemical compositional parameters by which it can be recognized. They have different applications which are dependent on these physical and chemical compositional parameters (Frank, 2004). These components determine the properties of the oil and vary from source to source and widely with plant variety and growing conditions. The utility of oils depend on their properties and these compositions (Beare-Rogers, 1983). Lack of information on the composition and utilization of the many and varied lesser known underutilized seed oils indigenous to the tropics are more of problem than the real shortage of oils (Anon, 1987). This is also particularly valid for the Nigerian flora which has one of the most extensive floras in continental Africa. The efficient utilization of these lesser known underutilized seed oils, depend on adequate information on their properties (Tsiaganis et al., 2006). *Millettia griffonianus*, *Albizia saman* and *Tamarindus indica* belonging to the *Leguminiaceae* family fall into this group of lesser known, underutilized seed oils.

*Tamarindus indica* is a long-lived, medium-growth, tree which attains a maximum height of 12.1 to 18.3 metres with a stout hole to 65 cm diameter (Morton, 1987). The crown has an irregular, vase-shaped outline of dense foliage. The leaves are evergreen, elliptical ovular, arrangement is alternate, of the pinnately compound type, with pinnate venation and less than 5 cm (2 inches) in length (Popenoe, 1974). The fruit is a thick, fleshy and sub-cylindrical. The pod is about 10 – 15 cm long containing up to a dozen seeds embedded in a gelatinous pulp (Burkill, 1994). *Albizia saman* is a deciduous tree which is about 20 m tall, it is scarcely buttressed, and bearing a heavy umbrella-shaped crown. The tree is very fast

growing. It is favored by hot or moist conditions but will grow on dry and barren soil. It is commonly grown as a shade-tree in most towns and villages in Nigeria (Burkill, 1994). The pod contains a sugary pulp which is edible and is like a jam. The pods are particularly valuable for feeding to cattle and horses and can be dried for storage. *Millettia griffonianus* is a tree up to 10 m high. It is found close to the forest, especially on river-bank and besides water. It is an ornamental tree with purple to lilac flowers (Burkill, 1994). The leaves are used in fumigation when mixed with other ingredients while the flowers can be used as a soap-substituent or soap-adjuvant for washing cloth.

Analysis of oils and fats by conventional methods plays a key role in maintaining the quality of the product. Knowledge is essential for taking decision on procurement of quality raw material, methods to be adopted for processing and monitoring the course of processing. Moreover, oil composition and quality varies not only from seed oil to seed oil but also depends on seed variety, storage and agro climatic conditions. Analysis of these underutilized seed oils is important as there is little or no information on their composition. To address this, this paper evaluated the proximate constituents and metal composition of the seeds of *Millettia griffonianus*, *Albizia saman* and *Tamarindus indica* as well as the physicochemical properties, lipid classes, metal and fatty acid composition of their seed oils.

## 1. MATERIALS AND METHODS

### A. Materials

The seed samples were obtained from the garden of the University of Ibadan, Oyo State, Nigeria. They were identified at the herbarium unit, Botany Department University of Ibadan. The whole seeds were subsequently ground in a laboratory mill (Gallenkamph, 82942, Brit. Pat, England) and stored in a plastic bag at 4$^{o}$C prior to analysis. Silica gel (60-120 mesh) was purchased from Acme Synthesis Chemicals, Mumbai. This was further activated by heating in an air oven at 110$^{o}$C for 2 h. before being used for column chromatography. All solvents and chemicals used in this study were of analytical grade and were purchased from S.D. Fine Chemicals, Mumbai. Silica coated TLC plates (20 x 20 cm) were procured from Sigma-Aldrich, Hyderabad, India.

### B. Proximate analysis of the seeds of *T. indica, M. griffonianus* and *A. saman*

Proximate constituents of the seeds of *T. indica*, *M. griffonianus* and *A. saman* were evaluated as described by the Association of Official Analytical Chemist (AOAC, 1990).

### C. Extraction and physicochemical analysis of the oils of *T. indica, M. griffonianus* and *A. saman*

Oil was extracted from the seeds of *T. indica*, *M. griffonianus* and *A. saman* using soxhlet extractor with *n*-hexane for 10 h (Ajayi, 2004). The extracted oils were analyzed for iodine value, peroxide value, saponification value, refractive index, specific gravity, free fatty acid and unsaponifiable matter by method described by the Association of Official Analytical Chemist (AOAC, 1984). The refractive indices of the oils (at 25°C) were determined with Abbe refractometer and the specific gravity measurements were also carried out at 25°C using gravity bottles (Oderinde and Ajayi, 2000; Akintayo and Bayer, 2002).

### D. Mineral composition of the seeds and seed oils of *T. indica, M. griffonianus* and *A. saman*

Metals determined were lead, cadmium, copper, zinc, iron, magnesium, calcium, sodium, potassium and manganese. The seeds (0.5 g) as well as the extracted seed oils (0.5 g) of *T. indica*, *M. griffonianus* and *A. saman* were taken separately for analysis. This was achieved by digesting the samples using 5 ml (2:1) of nitric acid (70 % concentration) and perchloric acid (90 % concentration) (Oderinde et al., 2008). These metals were analyzed by atomic absorption spectrophotometry (Perkin-Elmer, GMBH, Ueberlingen, Germany).

**E. Fatty acid composition of the oils of *T. indica, M. griffonianus* and *A. saman***

Fatty acid methyl esters of the oils were prepared by refluxing the samples at 70°C for 3 h. in 2% sulphuric acid in methanol. The esters were extracted into ethyl acetate, washed free of acid and passed over anhydrous sodium sulphate. The ethyl acetate extracts were further concentrated using a rotary evaporator. The fatty acid composition was analyzed using an Agilent 6890 N series gas chromatography equipped with FID detector on a split injector. A fused silica capillary column (DB-225, 30 x 0.32 mm i.d., J & W Scientifics, USA) was used with the injector and detector temperature maintained at 230°C and 250°C respectively. The oven temperature was programmed at 160°C for 2 min and finally increased to 230°C at 4°C/min. The carrier gas was nitrogen at a flow rate of 1.5 mL/min. The area percentages were recorded with a standard Chemstation Data System.

**F. Separation of lipid classes of the seed oils of *T. indica, M. griffonianus* and *A. saman***

Lipid classes of the oils of *T. indica*, *M. griffonianus* and *A. saman* were separated on a 1 g scale into neutral lipids, glycolipids and phospholipids by silica gel column chromatography using a glass column 20 cm x 2 cm OD packed with 30 g activated silica gel (60–120 mesh). Neutral lipids, glycolipids and phospholipids were eluted successively using chloroform, acetone and methanol respectively. The lipid fractions were screened by TLC for the identification of components using hexane – ethyl acetate (90:10, v/v) as developing solvent for neutral lipids, chloroform – methanol – water (65: 25 : 4, v/v/v) for glycolipids and phospholipids (Christie, 1982). The eluted spots were identified using different spray reagents such as iodine vapors for neutral lipids, ammonium molybdate – perchloric acid for phospholipids and α-naphthol for glycolipids (Jacin and Mishkin, 1965). The individual fractions were pooled, distilled under vacuum to remove solvent and weighed for quantification. The individual lipid fractions were converted into fatty acid methyl esters by refluxing with 2% sulphuric acid in methanol for 3 h. The esters were extracted into ethyl acetate, washed with distilled water and dried over anhydrous sodium sulphate and the fatty acid profile was analyzed using GC as described above.

**G. Identification of unsaponifiables of the seed oils of *T. indica, M. griffonianus* and *A. saman***

Oil (2 g) was dissolved in 25 ml of 2 M ethanolic potassium hydroxide and refluxed for 1 h. The reaction mixture was later diluted to 150ml with distilled water and transferred into a separating funnel. The unsaponifiable matter was then extracted three times with 50 ml diethylether. The ether extract was first washed with 100 ml aqueous solution of 0.5 M potassium hydroxide in order to remove any residual fatty acids. This was further washed with distilled water until it was free of potassium hydroxide, dried over anhydrous sodium sulphate and concentrated using a rotary evaporator (Esuoso and Odetokun, 1995). The unsaponifiables were identified by GC-MS analysis using Agilent (Palo Alto, USA) 6890N gas chromatography equipped with an HP-1 MS capillary column connected to an Agilent 5973 mass spectrometer operating in the EI mode (70 ev; m/z 50-550; source temperature 230°C and quadruple temperature 150°C). Structural assignments were made based on interpretation of mass spectrometric fragmentation and confirmation by comparison of retention time as well as fragmentation pattern of authentic compounds and the spectral data obtained from the Wiley and NIST libraries.

## 2. RESULTS AND DISCUSSION

**A. Proximate analysis of the seeds of *T. indica, M. griffonianus* and *A. saman***

The proximate composition of the seeds of *T. indica*, *M. griffonianus* and *A. saman* is presented in Table 1. The oil content of *M. griffonianus* (10.91±1.00 %) was found higher than those of *A. saman* (9.77±1.21 %) and *T.*

*indica* (3.11±0.41 %). The protein content was 36.65 ± 0.60 % in *T. indica*, 17.30 ± 0.30 % in *M. griffonianus* and 39.40 ± 0.30 % in *A. saman*. The least moisture content was found in *M. griffonianus* (1.50 ± 0.30 %) while *T. indica* (5.10 ± 0.20 %) had the highest value for the moisture content. The crude fibre (6.80 ± 0.10 %) and carbohydrate (59.49 ± 0.80 %) content were highest in *M. griffonianus* when compared to the other seeds.

**Table 1 Proximate composition (%) of the seeds of *T. indica*, *M. griffonianus* and *A. saman***

| Assay | *T. indica* | *M. griffonianus* | *A. saman* |
|---|---|---|---|
| Crude fat | 3.11 ± 0.41 | 10.91 ± 1.00 | 9.77 ± 1.21 |
| Crude protein | 36.65 ± 0.60 | 17.30 ± 0.30 | 39.40 ± 0.30 |
| Crude fibre | 4.02 ± 0.30 | 6.80 ± 0.10 | 3.21 ± 0.10 |
| Ash | 5.10 ± 1.00 | 4.00 ± 0.60 | 2.10 ± 0.40 |
| Moisture | 5.10 ± 0.20 | 1.50 ± 0.30 | 4.20 ± 0.11 |
| Carbohydrate | 46.02 ± 1.01 | 59.49 ± 0.80 | 41.32 ± 0.50 |

***Values are mean ± standard deviation of triplicate determinations.***

## B. Extraction and physicochemical analysis of the oils of *T. indica*, *M. griffonianus* and *A. saman*

Table 2 presents the result of the physicochemical analysis of the oils of *T. indica*, *M. griffonianus* and *A. saman*. *Millettia griffonianus* and *Albezia saman* were light yellow in color while *Tamarindus indica* was light green. The free fatty acid content was 2.86±0.30 % in *T. indica* while *M. griffonianus* and *A. saman* had it as 1.06±0.20 % and 3.11±0.20 %; respectively. The iodine value is a measure of the unsaturation in oils. This value was found as 151.20±0.20 g iodine/100g in *M. griffonianus* which placed it as the most unsaturated among the three oils evaluated. *M. griffonianus* (201.90±0.20 mgKOH/g) also had the highest saponification value among the studied oils. The peroxide value was 6.51±0.10 $mgO_2$/g Oil in *T. indica*, 4.62±0.10 $mgO_2$/g Oil in *A. saman* and 1.60±0.50 $mgO_2$/g Oil in *M. griffonianus*. The oils were liquid at room temperature (25$^o$C).

**Table 2 Physicochemical characterization of the oils from *T. indica*, *M. griffonianus* and *A. saman***

| Parameter | *T. indica* | *M. griffonianus* | *A. saman* |
|---|---|---|---|
| Colour | Light green | Light yellow | Light yellow |
| Free fatty acid (%) | 2.86± 0.30 | 1.06±0.20 | 3.11±0.20 |
| Saponification value(mgKOH/g) | 189.80 ±0.20 | 201.90±0.20 | 196.30±0.50 |
| Iodine value(g iodine/100g) | 97.00 ±0.80 | 151.20±0.20 | 110.50±1.50 |
| Unsaponifiable matter (%) | 1.23± 0.10 | 2.05±1.00 | 1.83±0.10 |
| Peroxide value($mgO_2$/g Oil) | 6.51± 0.10 | 1.60±0.50 | 4.62±0.10 |
| Refractive index(25$^0$C) | 1.4110 ±0.04 | 1.3800±0.50 | 1.4610±0.20 |
| Specific gravity (25$^0$C) | 0.9113 ±0.10 | 0.8990±0.20 | 0.9540±0.04 |
| State at room temperature | Liquid | Liquid | Liquid |

***Values are mean ± standard deviation of triplicate determinations.***

## C. Mineral composition of the seeds and seed oils of *T. indica*, *M. griffonianus* and *A. saman*

A total of ten metals (Na, Mg, K, Ca, Fe, Mn, Zn, Cu, Cd and Pb) were determined in the seeds and oils using Atomic Absorption Spectrophotometry (AAS) the results of which is shown in Tables 3 and 4. These minerals are known to play vital roles in both plants and animals (Schwartz, 1975) and they were accumulated in different amount in the seeds and the amount extracted along with the oils also varied. K was detected as the most accumulated metal in the seeds. This was found in the seed of *T. indica* as 950.50 ± 0.10 ppm while the seeds of *M. griffonianus* and *A. saman* had it as 723.10 ± 0.20 ppm and 850.40 ± 0.50 ppm; respectively. Na, Ca and Mg were also detected high in the seeds. Na was highest in *M. griffonianus* (753.20 ± 0.30 ppm), Ca was found highest in *A. saman* (760.00 ± 1.10 ppm) while Mg was also found highest in *M. griffonianus* (215.40 ± 0.40 ppm). The heavy metals were detected low in the seeds. Cu had the lowest amounts in *M. griffonianus* (0.40 ± 0.60ppm). Pb had the least amounts in *A.*

*saman* (0.20 ± 0.40 ppm) while Cd was not detected in the seed of *A. saman*. The amounts of these metals extracted along with the oils are shown in Table 4. The concentrations also varied in the different oils. Again, K had the highest concentration in the oils which was also the oil of *T. indica* (820.20 ± 0.50 ppm). *T. indica* (650.10 ± 0.50 ppm) also accumulated Na highest while Ca and Mg were found highest in the oils of *A. saman* (598.00 ± 0.50 ppm) and *M. griffonianus* (195.10 ± 0.50 ppm); respectively. The amounts of the heavy metals extracted into the oils were found low while Pb and Cd were not detected in the oil of *A. saman*.

**Table 3 Metal composition (ppm) of the seeds of *T. indica, M. griffonianus* and *A. saman***

| Metal | *T. indica* | *M. griffonianus* | *A. saman* |
|---|---|---|---|
| Na | 730.60 ± 0.20 | 753.20 ± 0.30 | 488.10 ± 0.10 |
| K | 950.50 ± 0.10 | 723.10 ± 0.20 | 850.40 ± 0.50 |
| Ca | 675.20 ± 0.50 | 520.50 ± 0.70 | 760.00 ± 1.10 |
| Mg | 106.10 ± 0.50 | 215.40 ± 0.40 | 150.30 ± 0.60 |
| Fe | 185.00 ± 0.40 | 175.80 ± 0.20 | 85.20 ± 0.60 |
| Cu | 1.40 ± 0.20 | 0.40 ± 0.60 | 0.82 ± 0.30 |
| Zn | 65.20 ± 0.30 | 67.30 ± 0.20 | 82.10 ± 0.10 |
| Mn | 44.80 ± 0.50 | 74.10 ± 0.40 | 60.20 ± 0.10 |
| Pb | 1.10 ± 0.20 | 0.30 ± 0.00 | 0.20 ± 0.40 |
| Cd | 0.40 ± 0.10 | 0.40 ± 0.03 | ND |

***Average concentration ± standard deviation of triplicate determinations (ppm) (mg/kg)***
***ND = Not detected***.

**Table 4 Metal composition (ppm) of the oils of *T. indica, M. griffonianus* and *A. saman***

| Metal | *T. indica* | *M. griffonianus* | *A. saman* |
|---|---|---|---|
| Na | 650.10 ± 0.50 | 541.50 ± 0.20 | 362.10 ± 0.50 |
| K | 820.20 ± 0.50 | 693.50 ± 0.10 | 650.20 ± 1.50 |
| Ca | 467.30 ± 0.10 | 370.20 ± 0.50 | 598.00 ± 0.50 |
| Mg | 82.22 ± 0.20 | 195.10 ± 0.50 | 98.50 ± 0.20 |
| Fe | 110.00 ± 0.20 | 142.60 ± 0.20 | 57.10 ± 0.20 |
| Cu | 0.50 ± 0.50 | 0.10 ± 0.40 | 0.30 ± 0.50 |
| Zn | 40.10 ± 0.20 | 49.20 ± 0.50 | 72.60 ± 0.50 |
| Mn | 10.30 ± 0.20 | 65.10 ± 0.30 | 43.40 ± 0.30 |
| Pb | 0.10 ± 0.20 | 0.10 ± 0.05 | ND |
| Cd | 0.02 ± 0.10 | 0.10 ± 0.01 | ND |

***Average concentration ± standard deviation of triplicate determinations (ppm) (mg/kg)***
***ND = Not detected***.

## D. Fatty acid composition of the seed oils of *T. indica, M. griffonianus* and *A. saman*

*T. indica*, *M. griffonianus* and *A. saman* belong to the same plant family (Leguminaceae). The fatty acid composition of the seed oils of these plants is presented in Table 5. C18:2 was the dominant fatty acid in the seed oils of *T. indica* (52.30 ± 0.20 %), *M. griffonianus* (48.70 ± 0.20 %) and *A. saman* (37.00 ± 0.20 %). C12:0 and C14:0 were only detected in *T. indica.* C16:1 was detected in *T. indica* (0.10 ± 0.05 %) and *A. saman* (0.40 ± 0.10 %) only. C18:1 was highest in *A. saman* (21.00 ± 0.50 %) while C18:3 had the highest value in *M. griffonianus* (0.50 ± 0.10 %). C22:1 was only found in *T. indica* (0.20 ± 0.05 %) while C24:1 was found in *T. indica* (0.4± 0.10 %) and *A. saman* (0.10 ± 0.05 %) only.

**Table 5 Fatty acid compositions (wt %) of the oils of *T. indica, M. griffonianus* and *A. saman***

| Fatty acids | *T. indica* | *M. griffonianus* | *A. saman* |
|---|---|---|---|
| 12:0 | 0.20 ± 0.50 | ND | ND |
| 14:0 | 0.30 ± 0.10 | ND | ND |
| 16:0 | 10.40 ± 0.20 | 15.50 ± 0.20 | 7.20 ± 0.20 |
| 16:1 | 0.10 ± 0.05 | ND | 0.40 ± 0.10 |
| 18:0 | 3.70 ± 0.40 | 11.20 ± 0.30 | 7.10 ± 0.10 |
| 18:1 | 14.60 ± 0.40 | 19.80 ± 0.20 | 21.00 ± 0.50 |
| 18:2 | 52.30 ± 0.20 | 48.70 ± 0.20 | 37.00 ± 0.20 |
| 18:3 | 0.20 ± 0.05 | 0.50 ± 0.10 | 0.20 ± 0.05 |
| 20:0 | 1.60 ± 0.10 | 1.80 ± 0.10 | 8.30 ± 0.30 |
| 20:1 | 1.30 ± 0.20 | ND | 1.30 ± 0.40 |
| 22:0 | 4.60 ± 0.10 | 1.10 ± 0.10 | 14.30 ± 0.50 |
| 22:1 | 0.20 ± 0.05 | ND | ND |
| 24:0 | 10.10 ± 0.20 | 1.40 ± 0.20 | 3.10 ± 0.20 |
| 24:1 | 0.40 ± 0.10 | ND | 0.10 ± 0.05 |
| Unsaturated | 72.8 ± 0.20 | 69.00 ± 0.10 | 60.0 ± 0.20 |
| Saturated | 27.2 ± 0.30 | 31.00 ± 0.10 | 40.0 ± 0.20 |

***Values are mean ± standard deviation of triplicate determinations.***
***ND = Not detected***

## E. Separation of lipid classes and fatty acid distribution in the seed oils of *T. indica, M. griffonianus* and *A. saman***

The different lipid classes of the oils of *T. indica*, *M. griffonianus* and *A. saman* is presented in Table 6. Neutral lipids were the most dominant lipid class with the highest value found in *A. saman* (97.50±0.90 %). Phospholipids were found in small amounts in the oils. The least value was found in *A. saman* (0.20±0.10 %) while *T. indica* had the highest

(2.70±0.50 %). The distribution of the fatty acids in the different lipid classes is shown in Table 7. The result showed the amounts of the saturated fatty acids to be higher in the phospholipids than any of the other lipid classes isolated. C18:2 was the dominant fatty acid in the neutral lipids and the glycolipids except in the glycolipids of *M. griffonianus* (26.5±0.1 %) where C18:1 was the dominant fatty acid. C12 and C14 were not detected in the glycolipids of *T. indica*. C22:1 was only detected in the neutral lipids (0.4±0.1 %) and glycolipids (0.7±0.3 %) of *T. indica*. Also, C18:3 was only detected in the neutral lipids (0.1±0.1 %) and glycolipids (2.0±0.10 %) of *A. saman*.

**Table 6 Lipid classes (wt %) of the oils from *T. indica, M. griffonianus* and *A. saman***

| Lipid class | *T. indica* | *M. griffonianus* | *A. saman* |
|---|---|---|---|
| Neutral lipids | 90.00±0.50 | 91.30±0.20 | 97.50±0.90 |
| Glycolipids | 7.30±0.20 | 8.10±0.20 | 2.30±0.20 |
| Phospholipids | 2.70±0.50 | 0.60±0.10 | 0.20±0.10 |

***Values are mean ± standard deviation of triplicate determinations.***

## F. Identification of unsaponifiables of the seed oils of *T. indica, M. griffonianus* and *A. saman*

Hydrocarbons were the major unsaponifiable matters found in the oils of *T. indica, M. griffonianus* and *A. saman* as shown in Table 8. Some of these hydrocarbons include; hexadecane, octadecane, octadecene, docosane, heptadecane, pentadecane and eicosane. Other compounds that were also present in the unsaponifiables are; phytol, sitosterol, stigmasterol and beta tocopherol.

**Table 8 Components present in the unsaponifiable matters of *T. indica, M. griffonianus* and *A. saman* oil**

| *T. indica* | *M. griffonianus* | *A. saman* |
|---|---|---|
| Hexadecane | Hexadecane | Hexadecane |
| Octadecane | Octadecane | Octadecane |
| Hexadecene | Docosane | Octadecene |
| Octadecene | Heptacosane | Eicosane |
| Hexacosene | Heptadecane | Docosane |
| Eicosane | Eicosane | Heptadecane |
| Beta tocopherol | Phytol | Pentadecane |
| Phytol | Beta-tocopherol | Phytol |
| Stigmasterol | | Beta tocopherol |
| | | Stigmasterol |
| | | Sitosterol |

## 3. CONCLUSION

The seeds and oils of *T. indica, M. griffonianus* and *A. saman* have been evaluated for proximate and chemical composition. The results of the proximate analysis revealed the presence of high amounts of protein and carbohydrate in the seeds. The oil of *M. griffonianus* had the highest iodine value as well as the lowest peroxide value. C18:2 was the dominant fatty acid in the studied oils while the neutral lipids were the dominant lipid class in the oils. The GC-MS showed hydrocarbons as the major unsaponifiable content of the oils.

**Table 7 Fatty acid compositions (wt %) in the lipid classes of *T. indica, M. griffonianus* and *A. saman***

| | *T. indica* | | | *M. griffonianus* | | | *A. saman* | | |
|---|---|---|---|---|---|---|---|---|---|
| Fatty acids | NL | GL | PL | NL | GL | PL | NL | GL | PL |
| 12:0 | 0.5±0.10 | ND | 1.0±0.10 | ND | ND | ND | ND | ND | ND |
| 14:0 | 0.3±0.10 | ND | 0.6±0.10 | ND | ND | ND | ND | ND | ND |
| 16:0 | 11.2±0.30 | 10.2±0.1 | 28.6±0.2 | 16.0±0.1 | 15.8±0.3 | 27.2±0.1 | 7.0±0.1 | 5.6±0.1 | 19.3±0.1 |
| 16:1 | 0.5±0.10 | 0.3±0.1 | 0.3±0.2 | ND | ND | ND | 0.4±0.1 | 1.0±0.1 | 0.4±0.1 |
| 18:0 | 2.2±0.20 | 9.4±0.1 | 16.1±0.3 | 6.6±0.1 | 9.2±0.1 | 11.2±0.1 | 7.1±0.1 | 8.4±0.1 | 10.6±0.1 |
| 18:1 | 13.4±0.50 | 15.0±0.2 | 7.3±01 | 21.4±0.1 | 26.5±0.1 | 24.0±0.1 | 20.4±0.1 | 24.1±0.1 | 18.4±0.1 |
| 18:2 | 54.2±0.20 | 49.6±0.1 | 28.1±0.1 | 25.0±0.2 | 13.6±0.2 | 8.5±0.1 | 40.9±0.2 | 38.1±0.1 | 26.5±0.1 |
| 18:3 | 0.5±0.1 | 1.6±0.1 | 0.5±0.3 | 6.9±0.1 | 0.4±0.0 | 0.7±0,1 | 0.1±0.1 | 2.0±0.10 | ND |
| 20:0 | 1.1±0.10 | 1.8±0.1 | 3.3±0.5 | 1.1±0.1 | 1.5±0.1 | 1.4±0.2 | 7.7±0.1 | 5.1±0.2 | 6.2±0.2 |
| 20:1 | 1.1±0.20 | 0.8±0.1 | 0.6±0.1 | ND | ND | ND | 1.2±0.1 | 3.0±0.2 | 1.7±0.2 |
| 22:0 | 3.8±0.10 | 2.4±0.5 | 6.5±0.2 | 14.1±0.0 | 18.1±0.1 | 17.5±0.2 | 12.8±0.0 | 9.4±0.2 | 12.3±0.2 |
| 22:1 | 0.4±0.1 | 0.7±0.3 | ND | ND | ND | ND | ND | ND | ND |
| 24:0 | 10.3±0.20 | 8.2±0.0 | 6.8±0.1 | 8.8±0.1 | 14.9±0.1 | 9.5±0.2 | 2.4±0.1 | 3.1±0.2 | 4.6±0.2 |
| 24:1 | 0.5±0.10 | ND | 0.3±0.1 | ND | ND | ND | ND | 0.2±0.1 | ND |
| Unsaturated | 70.6±0.20 | 68.0 | 37.1 | 63.0 | 40.5 | 33.2 | 63.0 | 68.4 | 47.0 |
| Saturated | 29.4±0.30 | 32.0 | 62.9 | 37.0 | 59.5 | 66.8 | 37.0 | 31.6 | 53.0 |

***Values are mean±standard deviation of duplicate determinations. NL = Neutral lipids, GL = Glycolipids, PL = Phospholipids ND = Not Detected***

## 4. ACKNOWLEDGEMENT

The authors thank the Third World Academy of Sciences (TWAS) for awarding Adewale Adewuyi a research fellowship for carrying out this work at Indian Institute of Chemical Technology (IICT) and also grateful to Dr J. S. Yadav, Director, IICT for his support and encouragement.

## 5. REFERENCES

1 Frank D.G., The chemistry of oils and fats: Sources, composition, properties and uses. Black well publishing Ltd, pp 1-2, 2004.
2 Beare-Rogers J.L., Trans and positional isomers of common fatty acids. In HH Draper (ed.) Advances in Nutritional Research. Vol. 5 Plenum Press, New York, pp 171-200, 1983.
3 Anon A., Word fats and oil report. Journal of American Oil Chemists' Society, 1987; 64: 1058 – 1085.
4 Tsiaganis M.C., Laskari K., Melissari E., Fatty acid composition of *Allium* species lipids. Journal of Food Composition and Analysis, 2006; 19: 620-627.
5 Morton F., Fruits of warm climates. Wipf and stock publishers, pp 115–121, 1987.
6 Popenoe W., Manual of tropical and subtropical fruits. Hafner press, pp 432–436, 1974.
7 Burkill H.M., The useful plants of West Tropical Africa. Royal botanic gardens. 2nd edn. vol 3. pp 62-164, 1994.
8 AOAC., Official Methods of Analysis. 15ed. Association of Official Analytical Chemists, Arlington, VA, 1990.
9 Ajayi I.A., Dawodu F.A., Adebowale K.O., Oderinde R.A., A study of the oil content of Nigerian grown *Monodora myristica* seeds for its nutritional and industrial application. Pakistan Journal of Scientific and Industrial Research, 2004; 47: 60 -65.
10 AOAC., Official Methods of Analysis, 14 ed, vol.67.Association of Official Analytical Chemist, Arlington, VA, pp 503-515, 1984.
11 Oderinde R.A., Ajayi I.A., Physico-chemical and metal composition of *Calophyllum inophyllum* seed and seed oil. Pakistan Journal of Scientific and Industrial Research, 2000; 43: 357 – 358.
12 Akintayo E.T., Bayer E., Characterization and some possible uses of *Plukenetia conophora* and *Adenopus breviflorus* seeds and seed oils. Bioresources Technology, 2002; 85: 95 – 97.
13 Oderinde R.A., Adewuyi A., Ajayi I.A., Determination of the mineral nutrients, characterization and analysis of the fat-soluble vitamins of *Caesalpinia pulcherrima and Albizia lebbeck* seed and seed oils. Seed Science and Biotechnology, 2008; 2: 74 – 78.
14 Christie W.W., Lipid analysis, isolation, separation, identification and structural analysis of lipids, 2nd edn., Pergamoon press, pp 107-111, 1982.
15 Jacin H., Mishkin A.R., Separation of carbohydrates on borate-impregnated silica gel G plates. Journal of Chromatography, 1965; 18:170-173.
16 Esuoso K.O., Odetokun S.M., Proximate composition and possible industrial utilization of *Blighia sapida* seed and seed oils. La Rivista Italiana Delle Sostanze Grasse, 1995; 72: 311 – 313.
17 Schwartz M.K., Role of trace elements in cancer. Cancer Research, 1975; 35: 3481 – 3484.