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Chemical Characterization of *Sclerocarya birrea* Fruits and Kernels Oil (Sudan)

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Abstract

Sclerocarya birrea tree (Marula), is known in Sudan as Homeid tree. The different parts of the tree find wide traditional and medicinal uses. This study was carried to evaluate the chemical composition of the fruit seeds and kernels oil from nutritional value sight of view. Fresh fruits were collected from Darfur and Kordofan States. The proximate constituents of seeds were determined. Kernels oil was extracted by Petroleum ether. The physicochemical properties of the oil were measured. Seed kernels content of some minerals was determined by AAS. The extracted oil was analyzed by GC-MS. The proximate seed constituents were ash (4.93%), moisture (5.74%), protein (44.17%), vitamin C (19.47mg/100g) and Fiber (5.32%). The physicochemical properties were pH (6.36), acid value (0.42mg KOH/g), Peroxide value (4.64meq O_2/kg), saponification value (199mg KOH/g), viscosity (62.1), refractive index (1.467), density (0.919g/cm^3) and un-saponified matter (3.17%). The AAS analysis showed high P (220.25mg/100g) and K (86.10mg/100g) in the kernels. The oil yield was (53.47%). The GC-MS characterization showed a presence of five constituents, Dominated by Oleic (65.97%), Palmitic (17.53%) and Stearic acid (12.84%).

Keywords: *Sclerocarya Birrea*, Homeid, GC-MS, Kernels, Oil Yield.

1. INTRODUCTION

Sclerocarya birrea (Marula) is an indigenous fruit tree that has numerous socioeconomic contributions to human livelihood, as a source of seed oil which can be utilized for domestic and industrial purposes (Mussa Kamanula, 2022). In Africa *Sclerocarya birrea* forms an integral part of traditional diet and culture of many rural communities (Wynberg1 2002, Abdelwahab, 2012). *Sclerocarya birrea* is a savannah tree which belongs to the family *Anacardiaceae*, with a plum-like pale yellow fruit of 3-4 cm in diameter, with a juicy mucilaginous flesh (Abdelwahab, 2012). The tree has a vast geographic distribution, incorporating three subspecies, *caffra* in the South, *birrea* in North and West Africa, and *multifoliolata*, which occurs in small areas where, the other two subspecies overlap (John B. Hall, 2002). The female trees yield edible mango-like fruits which have oil bearing seeds (K. F. Petje, 2008). The tree is naturally present in Malawi, Namibia, Botswana, Zimbabwe, Zambia, Mozambique, Swaziland, and South Africa (K. Beckett, 2012). Marula seeds oil was reported to be good for cooking, meat preservation, cosmetic formulations, and as raw material for biofuels production (B. R. Moser, 2009, Mussa, 2022). The barks, wood, root, leaves, fruits and kernels oil have multiple nutritional, and medicinal uses (Sheona E. Shackleton, 2002). In Sudan the tree is known as Homeid tree, where, the fruits are normally consumed by children, camels, cows and goats. Marula seeds and leaves are nutritionally rich sources that may enhance the quality of animal-derived foods (Mthiyane, 2019). The fruit pulp is rich with vitamin C, and the kernels are good source of oil (Ndlovu, 2016). The fresh edible fleshy, mesocarp of ripe Homeid fruit is rich with minerals and vitamins (Petje, 2008). Figure (1) shows Homeid tree, fruits, crushed seeds, and kernels. *Sclerocarya birrea* kernels oil was reported to be rich source of oleic, palmitic, stearic and linoleic fatty acids (A. O. Etim *et al*., 2021). Marula oil has a clear, pale, yellowish-brown color and a pleasant nutty aroma with an excellent slip factor, which make it ideal as massage oil (Abdul-Razak, 2016). The oil was reported to be good for cosmetic and antioxidant purposes (K. Beckett, 2012). Athanasia O. Matemu *et al.*, (2017) reported major fatty acids composition ranges of dried

Sclerocarya birrea fruits as Palmitic (55.92-71.31%), stearic (9.11-17%) and oleic (5.33-18.82%).

Fig. 1: (a) Homeid tree (b) fruits (c) crushed seeds and (d) kernels.

2. METHODOLOGY

Homeid (*Sclerocarya birrea*) fruits were randomly collected from eighteen (18) Homeid trees, ten from Darfur and eight from Kordofan. The fruits were dried at room temperature for four weeks. The seeds were mechanically separated and their proximate composition was determined. The kernels were isolated from the crushed seeds and left for three days to dry. K, Mg, Ca, Fe, Zn and P concentrations in seed kernels were measured by AAS. 95 grams of crushed kernels were extracted by petroleum ether. The oil yield percentage was calculated. The oil color, density, refractive index, viscosity, saponification number, peroxide value, iodine number, and free fatty acids content were determined. GC-MS analysis was carried for fatty acids content of kernels oil. Analytical grade chemicals were used.

3. RESULTS AND DISCUSSION

3.1. Homeid Seeds

Table (1) shows the proximate constituents of Homeid seeds, as moisture (5.74%), ash (4.93%), fiber (5.32%), protein (44.17%), fat (31.64%), carbohydrates (8.2%) and vitamin C (19.47mg/100g). Ahmed *et al.*, (2015), reported moisture as (2.73%), ash (3.4%), fiber (6.16%), protein (20.35%) and carbohydrate (6.46%). Gebeyehu (2021) reported proximate composition of Marula seeds as, moisture (5.90%), ash (4.27%), crude fiber (11.84%) and fat content (47.66%).

Table 1: The proximate composition of Homeid fruit seeds

Constituent	Percentage
Moisture	5.74%
Ash	4.93%
Fiber	5.32%
Protein	44.17%
Fat	31.64%
Carbohydrate	8.2%
vitamin C mg/100g	19.47mg/100g

As shown by Table (2), Marula seeds kernels may be described as a good source for P (220.25mg/100g), K (86.10mg/100g), Fe(6.14mg/100g), Ca (3.51mg/100), Mg (1.28 mg/100) and Zn(0.71 mg/100). Mussa Kamanula *et al.,* (2022) reported Marula seeds constituents as Vitamin C (6-81mg/100g), Ca (1.8- 5.3 mg/100g), Fe (1.4- 3.3 mg/100g), Zn (0.3- 0.8 mg/100g), fat (51.6- 57.7%) and fiber (4.1-6.9%). According to Wynberg, (2002) and Petje, (2008), Marula seeds are rich in protein (28-31%), oil (56-61%), K (677mg/100g), Mg (467mg/100g) and P (836mg/100g).

Table 2: Some essential minerals in Homeid seed kernels (mean)

Mineral	Concentration (mg/100g)
K	86.10
Mg	1.28
Ca	3.51
Fe	6.14
Zn	0.71
P	220.25

3.2. Homeid Kernels Oil

The oil yield was (53.47%), which is lower than that reported by Ahmed *et al.,* (2015) as (60.9%). The oil yield of Homeid seeds was significantly high when compared with, Sesame (40-49%), Sunflower (37-42%), Cotton (15-20%), and peanut (31.52 - 44.9%) according to Gupta (1992) and Ahmed *et al.,* (2015). Therefore, Homeid seeds may be a good source of edible oil. *Sclerocarya birrea* kernels oil was suggested to be suitable for cooking and meat preservation (B. R. Moser, 2009), as raw material for biofuels production (R. Layton *et al*., 2008), and cosmetic formulations (K. F. Petje, 2008, K. Beckett, 2012). The physicochemical properties of the extracted Homeid seed kernels oil (Table 3) were, yellow color (35.5), red color (5.9), density (0.919g/cm^3), refractive index (1.467), viscosity at 40^{o}C (62.1 mm^2/s), saponification number (199 mg KOH/g), peroxide value (4.64 meq O_2/kg), iodine number (99.49 gI_2/100g) and acid value (0.42 mg KOH/g). Abdul-Razak (2016) reported density as (0.919g/cm^3), saponification number (188 to 199mg KOH/g), peroxide value (1.3meq O_2/kg), iodine number (19.56 gI_2/100g) and acid value (4.20). Ahmed *et al.,* (2015), reported yellow color (35), red color (2.3), refractive index (1.462), viscosity (4.4), saponification value (196.35 mg KOH/g), Peroxide value (1.30meq O_2/kg), Iodine number (102.44 gI_2/100g) and Acid value (8.41 mg KOH /g). P. Zharare and N. Dhalamini, (2000) reported average oil yield as (55.9%), saponification value (180-189mgKOH/g oil), Iodine value (66- 70 gI_2/100g), acid value (3.6%), Mussa Kamanula *et al.,* (2022), reported some variations in oil yield and physicochemical properties ranging as, oil yield (41.1 to 52.2%), free fatty acids (1.96 to 4.07%), acid value (3.91 to 8.13 mg KOH/g) and peroxide value (1.84 to 5.15 meq·O_2/kg). According to Bikila Gebeyehu (2021) the properties of *S. Birrea* seeds were, oil content (41.57%), Viscosity (92.8mpas), specific density (0.923), acid value (7.52), saponification value (229mgKOH/g oil), free fatty acids (3.8%) and kinematic viscosity (0.1024mm^2/s). On the other hand Gadisa, (2014) reported Average oil content (61.36%), acid value (3.6mg KOH/g), free fatty acids (1.81%), saponification value (190mg KOH/g), and refractive index (1.467).

Table 3: Physiochemical properties of Marula kernels oil

Property	Value
Yellow color	35.5
Red color	5.9
Density g/cm^3	0.919
Refractive index	1.467
Viscosity at 40^{o}C (mm^2/s)	62.1
Saponification number mg KOH/g	199
Peroxide value meq O_2/kg	4.64
Iodine number gI_2/100g	99.49
Acid value mgKOH/g	0.42

3.3. GC-MS Analysis of Kernels Oil

The GC-MS characterization of Homeid seeds oil showed a presence of five constituents (Figure 2, Table 4). The identified compounds were, oleic acid (65.97%), palmitic acid (17.53%), stearic acid (12.84%), 2-[(4-Nitro-phenyl)-hydrazono]-3-oxo-3-(5-oxo-5H-3-thia-1,4,9b-triaza-cyclo (2.11%) and Nonadecanoic acid (1.55%). Komane B. (2015) reported oleic acid as (69%), palmitic (15.3%), linoleic (9.2%), palmitoleic (4.1%) and stearic (1.5%). According to Cheikhyoussef (2018), the major constituents of Marula seeds oil were oleic acid (67%),

palmitic (17.1%) and stearic (10.9%). Wilma F. Bergfeld (2011), reported (22.56%) for Palmitic acid and (8%) for Stearic acid. P. Zharare and N. Dhalamini, (2000) reported fatty acids profile as Oleic (72.1%), palmitic (10.6%), stearic, and linoleic (8.5%). Mussa Kamanula *et al.*, (2022), reported free fatty acids (1.96 to 4.07%). The obtained results may strongly enhance the findings reported by Wilma F. Bergfeld (2011), Komane B, (2015) and Cheikhyoussef (2018).

Table 4: The constituents of Homeid Kernels oil

Peak No.	Compound	Common name	Peak area%
1	Hexadecanoic acid, methyl ester	Palmitic acid	17.53
2	2-[(4-Nitro-phenyl)-hydrazono]-3-oxo-3-(5-oxo-5H-3-thia-1,4,9b-triaza-cyclo	-	2.11
3	9-Octadecenoic acid, methyl ester, (E)-	Oleic acid	65.97
4	Methyl stearate	Stearic acid	12.84
5	Methyl 18-methylnonadecanoate	Nonadecanoic acid	1.55
	Total		100.00

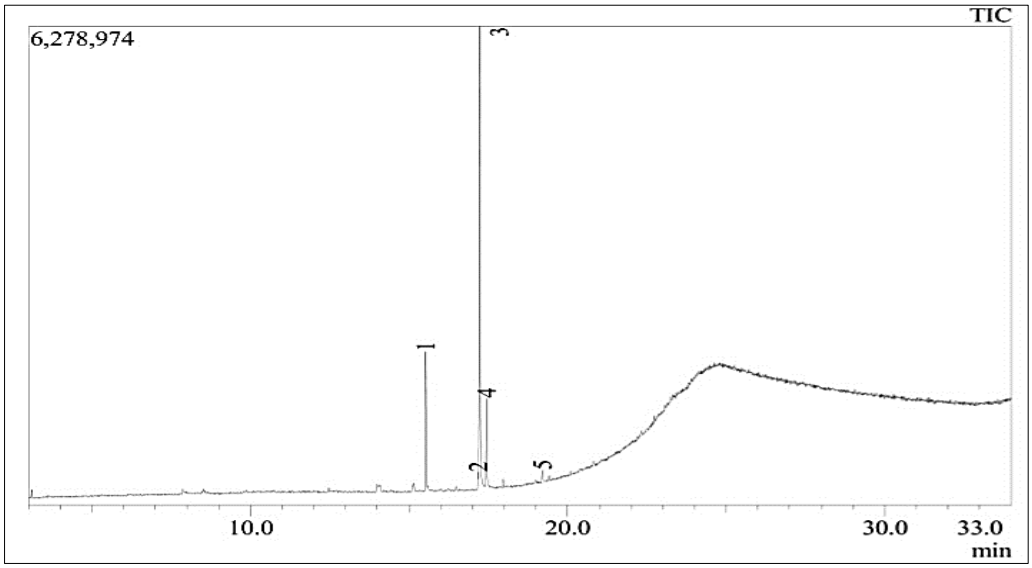

Figure 2: GC-MS chromatogram of Homeid Kernels oil

4. CONCLUSION

Homeid seeds may be described as a good source of fat, protein, vitamin C, P, K, Mg, Fe, and Zn. Homeid fruit kernels oil was found to be rich with oleic, palmitic, and stearic acids, therefore it may be good for use as edible oil.

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