

Research Article

Quality Evaluation of Oil from Seeds of Wild Plant *Tylosema fassoglensis* in Kenya

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Tylosema fassoglensis is a plant species that is native to Sub-Saharan Africa. The aim of this study was to evaluate the physicochemical properties of oil from *T. fassoglensis* in Kenya. Seeds of *T. fassoglensis* were collected from Mombasa, Taita Taveta, Homa Bay, and Siaya regions. Counts of *T. fassoglensis* in each region were recorded during the entire survey period. The highest distribution was recorded in Homa Bay followed by Siaya region. Distribution was the least in Taita Taveta and Mombasa regions. The analysis of the physicochemical characteristics of the oil was performed according to the official methods of analysis and the recommended practices of the American Oil Chemists Society. Oil content of 36.4% was obtained. The oil had refractive index 1.47 at 40°C, peroxide value 6.34 meq O₂/kg, iodine value 94.06 g of I₂/100 g, saponification value 145.93 mg KOH/g of oil, acid value 2.49 ± 0.56 mg KOH/g of oil, and unsaponifiable matter 5.87 g/kg. The oil had Lovibond color index of 2.0Y+28.0R. Oil content of *T. fassoglensis* is comparable with those of most oil crop under commercial production. The physicochemical properties of oil from *T. fassoglensis* are within the range recommended by FAO/WHO and hence suitable for human consumption.

1. Introduction

Oils from plant sources are widely used for food and industrial applications. The predominant world sources of edible oil are palm, rapeseed, soy bean, and sunflower [1, 2]. With new applications of edible oils such as in the production of biodiesel, demand for edible oils in the international market has significantly increased.

Production of oil crops is a major economic activity in Kenya. Currently, Kenya produces approximately 380,000 tons of edible oils. This figure accounts for just about one-third of its annual demand [3]. The deficit is imported at a cost of \$140 million. The country is currently exploring various alternatives to help bridge the deficit in vegetable oil sector with local manufacturers engaging in the production of selected oil crops. Much effort has been directed to growing oil crops with emphasis on palm oil [3].

Several species of edible wild plants in Kenya have not been exploited despite their potential as new sources of edible oils. Members of the genus *Tylosema* are herbaceous plants that have numerous traditional uses. The plant is reported to be native to Africa and has been traditionally used in ethnomedicine and as source of food in South Africa, Zambia, Zaire, and Congo [4]. In Kenya, many traditional rural communities use its seeds as food [5]. Recent studies have confirmed antimicrobial properties of extract from this plant species [6]. The species has also been used in the formulations of herbal remedy with the ability to halt the replication of HIV virus in human blood [7, 8]. Previous study reported oil content of 24–35% on a dry weight basis [4]. Climatic conditions, among other factors, have been reported to influence the amount and properties of oil in plant seeds. This study was therefore undertaken to evaluate the physicochemical properties of oil from seeds of *T. fassoglensis* that are native to Kenya.

2. Materials and Methods

2.1. Materials. Seeds were obtained from wild plant, *T. fassoglensis*. All reagents and chemicals used in this study were of analytical grade unless stated otherwise.

2.2. Distribution Survey. Four regions in Kenya, Mombasa, Taita Taveta, Homa Bay, and Siaya, were selected for this study. Each region was divided into five blocks of 0.1 ha. Each block consisted of idle land densely covered with herbaceous plants. The number of individual *T. fassoglensis* on each block was counted and recorded. The survey was conducted during the long and short rainy seasons every year for three consecutive years.

2.3. Seed Collection and Preparation. Mature seeds were collected and cleaned to remove stones, dirt, and any other foreign materials. Deformed seeds were also sorted out. The cleaned seeds were decoated and dried in an electric oven to a moisture content of 8.3%. Single dried seeds were then weighed and then milled into fine powder using laboratory blender (Dynamic Corporation, USA). The fine powder was passed through 80-mesh sieve.

2.4. Solvent Extraction. The ground seed material was fed into a Soxhlet extractor fitted with a 0.5 L round-bottom flask and a condenser. The extraction was carried out for 6 h with 0.3 L *n*-hexane on a water bath. After extraction, hexane was distilled off under vacuum using a rotary evaporator (Eyela, N-N Series, Rikakikai Co. Ltd., Tokyo, Japan) at 45°C.

2.5. Refining of Oil. Aliquots of the crude oil (25 mL) were degummed at 65°C with 0.1 NaOH. Then, 12.5 mL portions of degummed oil were bleached using 0.7 g of fuller's earth at 105°C for 1 h. The refined oil was then stored at 4°C for further analysis.

2.6. Determination of Physicochemical Properties of Extracted Oil

2.6.1. Acid Value. Acid value was determined by titrimetry according to AOCS method Cd 3d-63/99 [10].

2.6.2. Iodine Value. The iodine value was determined by Wijs titrimetry according to AOCS method Cd 1b-87/97 [10].

2.6.3. Saponification Value. Saponification value was determined by titrimetry according to AOCS method Cd 3-25/02 [10].

2.6.4. Refractive Index. The refractive index was determined by refractometry according to AOCS method Cc 7-25/02 [10].

2.6.5. Peroxide Value. Peroxide value was determined by titrimetry using isoctane as described in AOCS method Cd 8b-90/02 [10].

2.6.6. Unsaponifiable Matter. Unsaponifiable matter content was determined by titrimetry according to AOCS method Ca 6b-53/01 [10].

2.6.7. Determination Oil Color. The liquid oil samples were placed into 1 in. cells using a Lovibond Tintometer model E (Salisbury, England); the color was determined at 30°C by achieving the best possible match with the standard color slides of red and yellow indices according to AOCS method Cc 13b-45 [11].

2.7. Statistical Analysis. Values represented are the means and standard deviations for three replicates. Statistical analysis was carried out by Excel Version 8.0 software. Significance was defined at $P < 0.05$.

3. Results and Discussions

3.1. Distribution of *T. fassoglensis*. Figure 1 illustrates the number of individual *T. fassoglensis* recorded in each study site. The highest number of *T. fassoglensis* was recorded in Homa Bay. Block 5 in Homa Bay and block 1 in Siaya recorded 295 and 201 plant counts, respectively. No *T. fassoglensis* was observed in block 1 in Mombasa for the entire survey period. Both Taita Taveta and Mombasa regions recorded the least average number of *T. fassoglensis*. Information on the distribution and abundance of *T. fassoglensis* may help in deciding suitable regions for setting up enterprises for *T. fassoglensis* oilseed processing in the country.

3.2. Oil Content. Seeds of *T. fassoglensis* exhibited oil content of 36.4% (w/w) on dry weight basis. This is slightly more than the 24–35% oil content reported by Dubois et al. (1995). The variation could be due to various factors including differences in plant varieties, climatic conditions, season and time of harvest, type of pretreatment of the seed prior to oil extraction, and the type of solvent used for the extraction [12]. The recovered amount of oil is comparable to oil content of many conventional oil-bearing seeds which already have commercial value [13, 14] as illustrated in Figure 2.

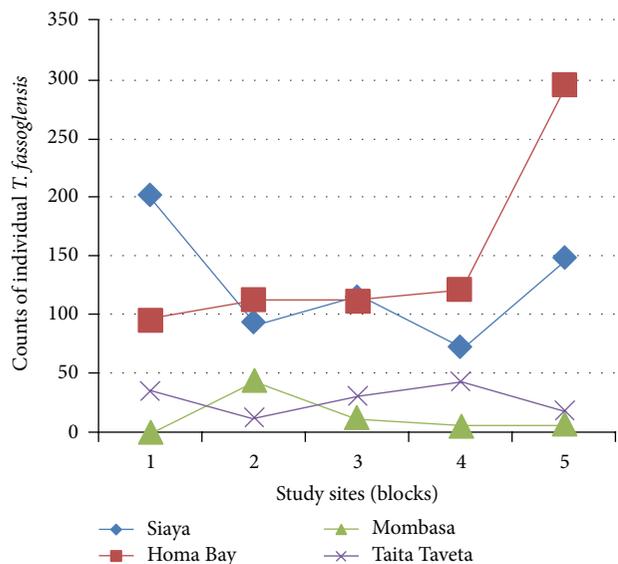
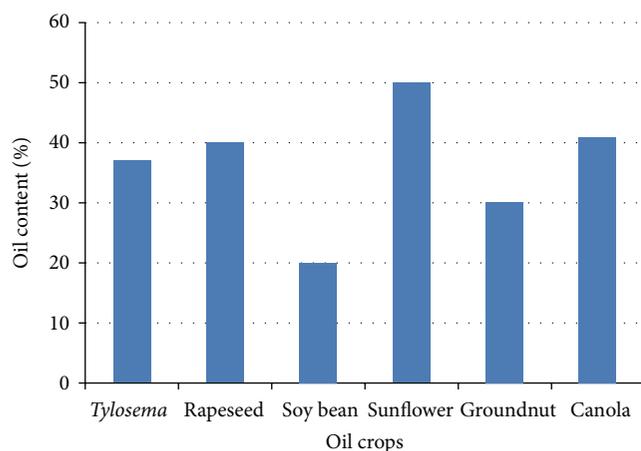
3.3. Physicochemical Properties of Extracted Oil. Table 1 illustrates properties of oil from *T. fassoglensis* seeds compared with selected crop oils under commercial production.

3.3.1. Acid Value. Acid value (AV) indicates the level of oxidative deterioration in oils by enzymatic and/or chemical oxidation. The acceptable limit for edible oils is ≤ 10 mg KOH/g [15]. The extracted oil had AV of 2.49 ± 0.56 mg KOH/g. This is lower than AV of cottonseed oil (11.50 ± 0.33 mg KOH/g) and groundnut oil (4.40 ± 0.10 mg KOH/g) but higher than soy bean oil (2.72 ± 0.17 mg KOH/g), sunflower oil (1.02 ± 0.76 mg KOH/g), and canola oil (0.071 ± 0.49 mg KOH/g) as shown in Table 1. This implies that *Tylosema* seed oil is likely to stay longer without forming off-flavors.

TABLE 1: Comparison of physicochemical properties of *T. fassoglensis* oil with other seed oils.

Parameter	<i>Tylosema</i> *	Cotton	Soy bean	Groundnut	Sunflower	Canola
Acid value (mg KOH/g)	2.49 ± 0.56	11.50 ± 0.33	2.72 ± 0.17	4.40 ± 0.10	1.02 ± 76	0.071 ± 0.49
Iodine value (gm I/100 gm)	94.06 ± 0.14	94.7 ± 0.12	119.21 ± 0.40	95.30 ± 0.43	119.92 ± 0.00	116.10 ± 0.50
Peroxide value (meq/kg)	6.34 ± 0.58	9.25 ± 0.47	21.38 ± 1.61	1.97 ± 0.10	6.32 ± 12	7.36 ± 0.14
Refractive index (at 40°C)	1.47 ± 0.33	1.46 ± 0.56	1.47 ± 0.10	1.46 ± 0.50	1.47 ± 12	1.46 ± 0.00
Saponification value (mg KOH/g)	145.93 ± 0.69	189 ± 0.38	199.63 ± 1.81	189.90 ± 0.10	182.23 ± 0.37	184.10 ± 0.61
Unsaponifiable matter (g/kg)	5.87 ± 0.47	1.5 ± 0.11	1.76 ± 0.28	5.77 ± 0.25	1.5 ± 0.06	1.394 ± 0.3

* Values are mean ± SD for triplicate determinations; source: FAO/WHO [9].

FIGURE 1: Distribution of *T. fassoglensis* in each study region.FIGURE 2: Comparison of oil content in *T. fassoglensis* seeds with selected oil plants.

3.3.2. Iodine Value. Iodine value (IV) is the degree of unsaturation in oil. The extracted oil had IV of 94.06 ± 0.14 gm I/100 gm. This value is comparable to the IV of cottonseed oil (94.7 ± 0.12 gm I/100 gm) and groundnut oil (95.30 ± 0.43 gm I/100 gm). However, it is lower than IV of soy

bean oil (119.21 ± 0.40 gm I/100 gm), sunflower oil (119.92 ± 0.00 gm I/100 gm), and canola oil (116.10 ± 0.50 gm I/100 gm) (Table 1). The indicated IV implies that oil from the seeds of *T. fassoglensis* has longer shelf-life and storability [16, 17]. It also indicates that *Tylosema* seed oil is nondrying oil [18].

3.3.3. Peroxide Value. The extent to which the oil has undergone rancidity can be determined by the peroxide value (PV). The PV of *Tylosema* seed oil was 6.34 ± 0.58 meq/kg. This is comparable with PV of sunflower oil (6.32 ± 12 meq/kg) and canola oil (7.36 ± 0.140 meq/kg) as indicated in Table 1. However, it is lower than those of cotton oil (9.25 ± 0.47 meq/kg) and soy bean oil (21.38 ± 1.61 meq/kg) but higher than groundnut oil (1.97 ± 0.10 meq/kg). The reported PV is within the permitted peroxide level of not more than 10 meq/kg of oil [9]. Oils having high percentages of peroxide are unstable and grow rancid easily [19]. *Tylosema* seed oil therefore has a lower degree of rancidity.

3.3.4. Refractive Index. Refractive index (RI) is a good measure of oil purity following refining. Values of RI for different oils generally vary between 1.447 and 1.482 [20]. The RI of extracted oil was 1.47 ± 0.85 which is close to the values reported for other seed oils like groundnut, soy bean, and sunflower (Table 1). Oils with RI between 1.48 and 1.49 are more viscous [21]. This implies that the *Tylosema* seed oil is less viscous.

3.3.5. Saponification Value. Saponification value (SV) was 145.93 ± 0.69 mg KOH/g of oil. This is lower than SV reported for some common oils such as palm oil (196–205 mg KOH/g), corn oil (187–196 mg KOH/g), groundnut oil (188–96 mg KOH/g) [16], coconut oil (253 mg KOH/g), and palm kernel oil (247 mg KOH/g) (Table 1). However this value is within the SV range reported for many edible oils [22, 23]. The reported SV indicates high percentage of fatty acids in *Tylosema* seed oil, hence potential for application in soap industry.

3.3.6. Unsaponifiable Matter. Unsaponifiable matter (UM) in oils is important raw materials in cosmetic and soap industries [24, 25]. The content of UM in *Tylosema* seed oil was 5.87 g/kg. This is higher than those of most plant oils (Table 1). It means, therefore, that *Tylosema* seed oil is good in cosmetic and soap production.

3.3.7. *Oil Colour*. The oil had a Lovibond color index of 2.0Y+28.0R. The red and yellow indices are comparable with those of most commercial edible oils [26]. The low oil color intensity indicates that the oil is well refined [27]. This implies, therefore, that bleaching during refining of *Tylosema* seed oil may not be necessary thereby lowering the overall processing costs.

4. Conclusion

Tylosema fassoglensis is not widely distributed across Kenya. The highest distribution is on the western part of the country. Seeds of *T. fassoglensis* are rich in oil. The oil content is comparable with most oil crops currently under commercial production. Similarly, quality attributes of oil from seeds of *T. fassoglensis* are identical to those of most commercial edible oils. The *T. fassoglensis* therefore has prospects as a good source of edible oil with commercial potential in Kenya.

Conflict of Interests

The authors declare no conflict of interests.

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