REPORT

The fatty acid composition and physicochemical properties of the underutilised *Cassia abbreviata* seed oil

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Abstract: The fatty acid composition of the underutilised *Cassia abbreviata* seed oil was determined using gas chromatographic methods. *C. abbreviata* seeds yielded 9.53% of yellowish-green oil consisting mainly of oleic acid (37.8%), palmitic acid (26.5%), linoleic acid (26.7%), stearic acid (4.1%) and elaidic acid (2.1%). The oil was solid at room temperature, had a saponification value of 376.16 mg KOH/g and an iodine value of 26.48 g I_2/100g oil. The fatty acid composition and saponification value of the *C. abbreviata* seed oil suggest that it may find application in both cosmetic and pharmaceutical natural product formulations.

Keywords: *Cassia abbreviata*, seed oils, fatty acid composition, physiochemical properties.

INTRODUCTION

The cosmetic and pharmaceutical industries are constantly faced with the challenge of developing new products and improving existing ones in order to satisfy the ever-changing demands of the customer, at the same time keeping abreast with regulatory and safety requirements. There is therefore an increase in the use of natural and organic cosmetic products as alternatives to animal-based and synthetic products (Shackleton *et al*., 2006). The global market for natural cosmetic care products has grown remarkably and natural seed oils have played a big role in the development of new products with not only cosmetic but nutritional and medicinal benefits (Antignac *et al*., 2011). Natural seed oils contain essential and non-essential fatty acids, vitamins, antioxidants and other phytochemicals which make them useful as emolliants, base formulations, active components and vehicle for many cosmetic and pharmaceutical preparations (Vermaak *et al*., 2011). Africa has a rich, diverse, seed-bearing tree population but the seed oils are grossly underutilised.

Cassia abbreviata (Sjambok pod/Long-tail Cassia) is a small deciduous tree (3-10 m in height) mainly distributed in the savannah woodlands of Southern and South-Eastern Africa. The tree grows well on riverbanks and in valleys often on termitaria. It is characterised by yellow flowers, dull green leaves and long pendulous pods that can grow as long as 90 cm (Van Wyk *et al*., 2000). *C. abbreviata* has been used extensively in ethnomedicine for treating various diseases which include diarrhoea, schistosomiasis, veneral diseases, pneumonia, snake bites and malaria (Kawanga, 2008; Sewani-Rusike, 2010; Maroyi, 2011). Root decoctions of *C. abbreviata* are commercially sold on the market for the treatment of black water fever (Van Wyk *et al*., 2000) and root infusions, taken orally, are used as an arbotificient, an aphrodisiac and as a purgative. The root extracts of *C. abbreviata* have been reported to exhibit a direct inhibitory activity against the replication of HIV-1c *in vitro* (Leteane *et al*., 2012). Different preparations of the stem bark, leaves and twigs have also been used for treating headaches, toothache, heavy menstruation and eye infections (Van Wyk *et al*., 2009; Ribeiro *et al*., 2010). *C. abbreviata* possesses antibacterial and antifungal activity hence its widespread use in treating sexually transmitted infectious diseases (Kambizi and Afolayan, 2001; Moshi *et al*., 2007). Most of the research done on *C. abbreviata* has focused on the medicinal properties of its bark, leaves and roots but the potential utilisation of *C. abbreviata* seed oil has not been fully explored. Literature on the composition of the seed oil is not readily available. The present study was carried out to determine the fatty acid composition of *Cassia abbreviata* seed oil and evaluate its potential use in cosmetic and pharmaceutical preparations.

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MATERIALS AND METHODS

Seed material

C. abbreviata seeds were collected from Bikita District, Zimbabwe. Bikita lies within latitude 20.08°S and longitude 31.62°E and has an average annual rainfall of between 400 to 600 mm.

Oil extraction

Dry *C. abbreviata* seeds were milled into a meal using a blender. The seed oil was extracted by soaking the seed meal in n-hexane for 5 days, filtering (Whatman filter paper no 1, 125 mm) and recovering the filtrate and evaporating the solvent at 50°C using a rotor evaporator. The recovered oil was weighed and stored in a dark bottle at 4°C until use.

Iodine value determination

The iodine value of *C. abbreviata* seed oil was determined using Wij's method (AOAC, 1984). One gram of the seed oil was dissolved in 10ml of tetra chloromethane and 20ml of Wij's solution were added before the mixture was incubated in the dark at 25°C. After 30 minutes, 15 ml of 10% potassium iodide solution were added and free iodine was titrated using 0.1N sodium thiosulphate and starch indicator. A reagent blank was simultaneously titrated and the iodine value calculated using the formula:

$$\text{Ioding value} = \frac{12.69\text{N} \times (\text{V}_2 - \text{V}_1)}{\text{Weight of sample (g)}}$$

Where N = Normality of sodium thiosulphate
V_1 = Volume of sodium thiosulphate used in the test titration
V_2 = Volume of sodium thiosulphate used in the blank titration

Determination of saponification value

Two grammes of the seed oil was dissolved in 25ml of 0.5% ethanolic potassium hydroxide and refluxed for 30 minutes. Phenolpthalein solution (1ml) was added to the hot solution and the excess alkali was titrated off using 0.5N HCl. A reagent blank was titrated and the saponification value was calculated using the formula:

$$\text{Saponification value} = \frac{56.1\text{N} \times (\text{V}_2 - \text{V}_1)}{\text{Weight of sample (g)}}$$

Where N = Normality of HCl
V_1 = Volume of HCl used in the test titration
V_2 = Volume of HCl used in the blank titration

Fatty acid determination

The fatty acid profile of *C. abbreviata* seed oil was determined using gas chromatography as described by Christopherson and Glass (1969). The fat extract was transmethylated with 2M methanol-sodium hydroxide. Fatty acid methyl esters were extracted using heptane, filtered and dried under nitrogen. Separation of fatty acids was carried out using a HP6890 GC with a DB-23 capillary column (90cm x 250 μm x 0.25 μm) and a flame ionisation detector (FID). Detector and injector temperatures were set at 300°C. CHEMSTATION software (Chemstations, Deutschland GmbH, Augustastrasse, Germany) was used for quantification of fatty acids. Nonadecanoic acid (C19:0) was used as an internal standard.

RESULTS

The oil yield of *C. abbreviata* seeds was 9.53%. The yellow-green oil which was solid at room temperature had a saponification value of 376. 16 mg KOH/g and aniodine number 26.65gI_2/100 g oil. table 1 shows the physicochemical characteristics and table 2 shows the fatty acid composition of *C. abbreviata* seed oil. The oil contained saturated (32.73%), monounsaturated (39.91%) and polyunsaturated (26.68%) fatty acids. Oleic acid was the dominant monounsaturated fatty acid (37.76%) while linoleic acid (25.65%) and palmitic acid were the most abundant polyunsaturated and saturated fatty acids, respectively. The oil also contained stearic acid (4.09%) and elaidic acid (2.14%).

Table 1: The physicochemical characteristics of *Cassia abbreviata* seed oil

Property	Value/Observation
Percentage yield	9.53
Colour	Yellow green
Iodine value (g I_2/100 g oil)	26.65
Saponification value (mg KOH/g)	376. 16
State at 25°C	Solid

DISCUSSION

C. abbreviata seeds can be classified as a low yielding seed oil source in comparison to other traditional seed oil sources such as soybean (*Glycine max*) about and groundnut (*Arachis hypogea*) which yield about 18% and 43% respectively (Akubugwo *et al*., 2008). *In vitro* micro-propagation techniques can be used to improve the economic viability of *C. abbreviata* seed oil production. Sarasan *et al.*, (2011) reported the viability of micro-propagation of *Cassia abbreviata* explants through *in vitro* rooting and shooting followed by acclimitisation in the field. Micro-propagation could also help alleviate the challenge of unsustainable utilisation and destructive overharvesting of the tree for medicinal purposes and fuel.

Saponification value is an indication of the molecular weight of the oil. Oils with high saponification values are desirable in the soap making industry (Akanni *et al*., 2005). *C. abbreviata* seed oil had a high saponification value (376.16 mg/g), when compared to conventional oils such as palm oil (200.05mg/g) (Hamidah *et al*., 2011) and groundnut oil (185-195mg/g) (Anderson-Foster *et al*., 2012). *Cassia abbreviata* seed oil therefore can be useful in soap and shampoo manufacture. The iodine value measures the degree of unsaturation of oils. The iodine value of *C. abbreviata* seed oil (26.48 I_2/100 g oil) shows that the oil is non-drying and has an appreciable degree of unsaturation and hence could be liable to oxidative degradation. The fatty acid profile is comparable to that of baobab (*Adansonia digitata*) seed oil, which has become a popular ingredient and base in many patented cosmetics (Vermaak *et al*., 2011). Palmitic acid was the predominant saturated fatty acid in *C. abbreviata* seed oil followed by stearic acid, behenoic acid, arichidic acid and the very long chain length fatty acid lignoceric acid. Palmitic acid and stearic acid are non-essential fatty acids that can be produced by the body *de novo* but they are useful in formulating various cosmetics, soaps and shaving creams (Gunstone, 1996).

Table 2: The fatty acid composition of *Cassia abbreviata* seed oil

Fatty acid		%
Saturated		
Lauric	C12:0	0.08
Myristic	C14:0	0.08
Palmitic	C16:0	26.48
Heptadecanoic	C17:0	0.19
Stearic	C18:0	4.09
Arichidic	C20:0	0.69
Heneicosanoic	C21:0	0.04
Behenoic	C22:0	0.62
Lignoceric	C24:0	0.42
TSFA		32.73
Monounsaturated		
Palmitoleic	C16:1n7	0.23
10-heptadecanoic	C17:1	0.05
Oleic	C18:1n9c	37.76
Elaidic	C18:1n9t	2.14
11-eicosenoic	C20:1	0.40
TMUFA		39.91
Polyunsaturated		
Linoleic	C18:2n6c	25.65
Alpha-linolenic	C18:3n3	0.49
Gamma-linolenic	C18:3n6	0.09
11,14-eicosadienoic	C20:2	0.06
5,8,11,14,17-eicosapentaenoic	C20:5n3	0.32
4,7,10,13,16,19-docosahexaenoic	C22:6n3	0.06
TPUFA		26.68
Cis fats		63.41
Trans fats		2.14
Omega-3		0.88
Omega-6		25.75
Omega-9		39.91
PUFA: SFA		2:1

TSFA= total saturated fatty acids; TMUFA= total monounsaturated fatty acid, TPUFA= total polyunsaturated fatty acid.

Oleic acid is a very good percutaneous absorption enhancer and it is widely used in transdermal delivery of drugs (Inayat and Setty, 2009). *C abbreviata* seed oil therefore can be useful as a natural source of oleic acid for improving the absorption of topical and parenteral pharmaceutical formulations. *C. abbreviata* seed oil also had a relatively high level of linoleic acid. Linoleic acid is an essential fatty acid that has remarkable regenerative and skin restructuring properties. Linoleic acid deficiency is usually associated with dry, chapped skin, increased Tran epidermal loss and skin lesions.

Essential fatty acids are also useful in maintaining the integrity and nourishment of the skin, strengthening the skin lipid barrier and improving moisturisation (Alvarez and Rodriguez, 2000). Linoleic acid also promotes the activity of vitamin A and E. With its high level of linoleic acid, *C. abbreviata* seed oil can be used in formulating reconditioning lotions, hand creams, lip balm and scalp conditioners. High levels of polyunsaturated fatty acids (PUFAs) can have a negative impact on the oxidative stability of oils. PUFAs decrease the ability of oils to resist oxidative degradation particularly when tocopherols and iron oxides are added (Kleiman *et al*., 2008). Hydrogenation of unsaturates during refining can help improve the oxidative stability of the oil and reduce the formation of off-flavours, which impact negatively on the quality of the final product.

In the production of anti-aging creams and sunscreen products, screening natural oils for the presence of tocopherols, sterols, phenolic compounds and other phytochemicals is crucial to assess their potential as antioxidants. Future studies could explore the phytochemical composition of *C. abbreviata* seed oil.

CONCLUSION

Cassia abbreviata seed oil is a non-drying oil that is rich in oleic acid, palmitic acid, linoleic acid, stearic acid and elaidic acid. Its fatty acid composition predisposes it favourably for use in the manufacture of natural personal skin care and hair care products. The high saponification value of *C. abbreviata* seed oil could also make it useful in the manufacture of soap and shampoo.

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