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A comparison of the lipid and fatty acid profiles from the kernels of the fruit (nuts) of *Ximenia caffra* and *Ricinodendron rautanenii* from Zimbabwe

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ABSTRACT

The lipid profile of nuts from *Ximenia caffra* and *Ricinodendron rautanenii* was determined and compared. Although the total oil content of *X. caffra* and *R. rautanenii* nuts was similar (47.6 ± 7.5% versus 53.3 ± 13.7%), the fatty acid profiles differed significantly. *X. caffra* had a higher content ($p < 0.05$) of saturated fatty acids than *R. rautanenii* (20.19 ± 1.07% versus 13.87 ± 3.68%) and contained C22:0 and C24:0 which were lacking in *R. rautanenii*. Total monounsaturated fatty acids were higher in *X. caffra* than *R. rautanenii* (71.48 ± 0.99% versus 36.66 ± 1.95%). Oleic acid (C18:1n9) was the major monounsaturated fatty acid (MUFA) in *X. caffra* whereas erucic acid (C22:1n9), the major MUFA in *R. rautanenii*, was undetectable in *X. caffra*. *R. rautanenii* had a greater polyunsaturated fatty acid content than *X. caffra* which contained C18:3n3 (α-linolenic acid) and nervonic acid (24:1n9). *X. caffra* is potentially an important source of essential fatty acids.

1. Introduction

The current high prices, coupled with the rapidly depleting stocks of fossil fuels is driving scientists to investigate the use of sustainable renewable energy resources and bio-fuels. For centuries, ancient and modern civilizations have exploited plant-derived oils for a variety of purposes. Apart from yielding edible oils, the other uses of plant oils include production of lubricants, cosmetics, soaps, surfactants, and the treatment of ailments such as dandruff, muscle spasms, varicose veins and wounds (Lee, 1973; Goldberg and Williams, 1999; van Wyk, 2002; van Wyk and Gericke, 2003; Mohammad and Mahmood, 2005). Additionally, the plants have been, and continue to be, sources of vitamins, minerals and energy critical for human health (Saka and Msonthi, 1994).

The tree *Ricinodendron rautanenii* (also known as *Schinziophyton rautanenii* Schinz.) is a native of Southern Africa predominantly found in the latitudes 15–21°S. It grows in a rough band from the border of northern Namibia and Angola stretching through southern Zambia, the Okavango of Botswana, northwest and central Zimbabwe, central Mozambique and the Limpopo province of South Africa (Nerd et al., 1990; van Wyk and Gericke, 2003) The oil from *R. rautanenii* (Mangetti nut tree), is rich in vitamin E (tocopherol) at 565 mg 100 g^{-1} of the kernel, making it very stable. The oil is edible and rich in phytosterols and proteins (Mohammad and Mahmood, 2005). It is also a highly prized emollient that leaves the skin well protected (Mohammad and Mahmood, 2005).

The large Sour Plum, *Ximenia caffra* var. *caffra* (*X. caffra*) is a Southern African species whose distribution spans across

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Tanzania, Zambia, Zimbabwe, Botswana, Namibia, Mozambique and South Africa (Lee, 1973). The tree can withstand moderate frost and is drought resistant when mature. The flesh of the fruit of *X. caffra* immediately around the stone is sour. The fruit pulp has a high protein value and is rich in ascorbic acid at 27 mg 100 mg^{-1} (Roodt, 1998). People add the dried flesh or the fresh juice to porridge to add taste and protein. The fruit also produces good quality jelly that is useful in making tarts (Roodt, 1998). The kernel is edible and is also used to make jam. Sixty-five percent of the kernel is oil. The oil, which is yellow, viscous and non-drying, is used as biofuel in lamps (Venter and Venter, 1996). Roodt (1998) indicated that Ximenic acid, an unsaturated acid has been isolated from the kernel oil. The Khoi San tribe uses the oil for softening skin and also rub it on chapped hands and feet. van Wyk and Gericke (2003) indicated that the seed contains tannins and that oil extracted from the seed is used in softening clothing leather such as for leather boots and skirts.

There is quite a lot of literature on the lipid profile of nuts from *R. rautanenii* but a dearth of information on the lipid profile of the nuts of *X. caffra*. We aimed to establish the lipid profile of *X. caffra* nuts from Zimbabwe, in an effort to establish the potential uses of the various lipid fractions and to compare its lipid profile with that of *R. rautanenii* a species found in the same eco-environment whose oil has established commercial value.

2. Materials and methods

All reagents used for the lipid extraction and fatty acid methyl ester preparation were from Merck chemicals.

2.1. Plants

The fruit of the plants *R. rautanenii* and *X. caffra* were collected from Zhombe District (latitude 14°45′S and longitude 26°50′E) in the Midlands Province of Zimbabwe. Zhombe District is characterized by low annual rainfall with a mean of 550 mm and a mean temperature of 26 °C. Tree samples (branches and seeds) were submitted to the National Botanical Gardens of Zimbabwe for identification. Ten trees of each species were randomly sampled for seeds that were used in the lipid and fatty acid assays. A 100 fruit-stones were randomly picked from each selected tree. Out of the 100 fruit-stones from each tree species, 10 fruit-stones were randomly selected and used. The fruit-stones were cracked to extract the nuts. The extracted nuts from each species were then chopped finely to generate a composite sample. Each composite sample (of finely chopped nuts) from each tree species was then divided into three equal portions that also acted as replicates. It is from these replicates that analyses were made.

2.2. Moisture determination

Samples of the compounded kernels were dried in an oven at 60 °C until they reached a constant weight (after 4 days).

2.3. Lipid extraction and profiling

Standard procedures were used for lipid extraction (Bligh and Dyer, 1959). In summary, 10 g of sample was mixed and blended in 100 ml chloroform–methanol mixture (2:1) and left to extract overnight at 4 °C. The samples were then filtered through filter paper (Whatmann No.1, size 18 mm) and 30 ml 0.9% saline added, mixed, and allowed to stand overnight at 4 °C to allow separation into two phases. The bottom (chloroform) phase was collected and reduced to dryness under vacuum at 37 °C and then made up to 20 ml with chloroform and stored at −20 °C for future analysis. Lipid dry weights were determined by drying an aliquot of extract at 50 °C for 30 min. Methyl esters of the fatty acids were prepared using 10% acetyl chloride in methanol with incubation at 50 °C overnight. The methyl esters were extracted into hexane. They were separated on a Varian 3400 gas chromatograph isothermally at 195 °C with a 10% SP2330 on chromosorb 100/120 WAW 2 m × 3.2 mm column and quantitated using FID and a Varian 4270 integrator. Peaks were identified by comparison with authentic fatty acid standards. The lipid and fatty acid standards were obtained from Sigma Aldrich.

2.4. Statistical analysis

Data is expressed as mean ± S.D. The Student's *t*-test was used to test for statistical differences between the parameters investigated in the two different plant seeds. The level of significance was set at $p < 0.05$.

3. Results

3.1. Dry matter and oil content

The kernels had a mean dry mass of 97.9 ± 0.1% and 96.6 ± 0.4% for *X. caffra* and *R. rautanenii*, respectively, and a mean oil content of 47.6 ± 7.5% and 53.3 ± 13.7% for *X. caffra* and *R. rautanenii*, respectively.

3.2. Lipid profile

The lipid profile of the kernels from the two plants is shown in Table 1. There were significant differences in the profile of the fatty acids in the kernels from the two plants. *X. caffra* had a higher percentage of total saturated fatty acids (TSFA) than *R. rautanenii* (20.19 ± 1.07% and 13.87 ± 3.68%, respectively) and also contained C22:0 and C24:0 fatty acids which were not detected in *R. rautanenii*. The total monounsaturated fatty acid (TMUFA) content of *X. caffra* (71.48 ± 0.99%) was higher ($p < 0.01$) than in *R. rautanenii* (36.66 ± 1.95%). Oleic acid (C18:1n9) was the major monounsaturated fatty acid (MUFA) in *X. caffra*. In *R. rautanenii*, C22:1n9 (which was not detected in *X. caffra*) was the dominant MUFA. The content of polyunsaturated fatty acids (PUFA) in *R. rautanenii* (49.46 ± 4.27%) was almost five times more than that of *X. caffra* (7.80 ± 0.84%).