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The coastal red-milkwood (*Mimusops caffra*) seed: Proximate, mineral, amino acid and fatty acid composition

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ABSTRACT

Mimusops caffra is an indigenous fruit-bearing tree in the coastal dune forests on the eastern coastline of South Africa. The tree is endangered by communities who use it for fuel-wood and construction timber. In an effort to promote sustainable utilisation of *M. caffra*, we evaluated the potential of its seed as a source of nutrients and cottage industry raw materials by determining the seed's proximate, mineral, fibre and amino acid composition and the seed oil's fatty acid profile. The seed had a gross energy content of 25.07 ± 0.23 MJ kg^{-1} and contained 10.02% crude protein, 26.19% ether extract, 4.73% ash and 84.90% organic matter on DM basis. The neutral detergent fibre and acid detergent fibre content were 27.15% and 9.65%, respectively. Calcium (2.33%) and aluminium (285.55 mg kg^{-1}) were the most abundant macro- and micro-minerals, respectively. Tryptophan (0.10 g 100 g^{-1}) was the least concentrated essential amino acid. The seed oil contained 37.08% saturated fatty acids (SFAs), 48.10% monounsaturated fatty acids (MUFAs) and 14.34% polyunsaturated fatty acids (PUFAs). Palmitic acid (18.58%) and stearic acid (10.70%) were the major SFAs. Oleic acid (46.37%) and linoleic acid (13.97%) constituted the dominant MUFA and PUFA, respectively. Seeds of *M. caffra* are high in calcium and energy. At community level *M. caffra* seed's potential as a dietary ingredient for foods and feeds and the seed oil's potential as a dietary supplement needs to be investigated. Due to its high oleic acid content the seed oil's potential as a raw material for community-based cottage industries that specialise in indigenous beauty products needs to be explored.

1. Introduction

Sub-Saharan Africa (SSA) is home to diverse indigenous fruit-bearing trees (IFBTs) whose fruit are rich in nutraceuticals. In addition to supplying fruit which are sources of carbohydrates, proteins, fats, minerals and vitamins, IFBTs are used in ethnomedicine due to the presence of various phytochemicals (Street and Prinsloo, 2013; Kadam et al., 2012; Kamatou et al., 2011).

Mimusops caffra (M. caffra), family Sapotaceae, is one of the major IFBTs in southern Africa. It is a small to medium sized (15–20 m) and is a major species in the coastal vegetation of southern Mozambique and eastern South Africa (Louppe et al., 2008). Ecologically the tree is important as a dune stabiliser and is regarded as a key-stone species in coastal dune forests. Its demise is likely to result in primary dune collapse. The tree has a number of uses: its wood is used for construction of fish traps and boats and as a fuel wood (www.plantzafrica.com). It is important for reclamation of coastal sand dunes and is planted as an ornamental tree in the United States of America and South Africa (Avis, 1995). Its fruit, which turn from orange to red when ripe, are one-seeded berries that are ovoid-shaped measuring 2.5 cm × 1.5 cm (Wilson and Downs, 2012; Thomas and Grant, 2004). The sweet *M. caffra* fruit is consumed by humans, monkeys and many bird species. Sucrose (4.40 mg g^{-1}), glucose (33.65 mg g^{-1}) and fructose (45.98 mg g^{-1}) are the major monosaccharides of *M. caffra* fruit pulp (Wilson and Downs, 2012). The fruit pulp is characterised by low protein and lipid (5.65% and 6.76%, respectively) content (Wilson and Downs, 2012). In the food industry, *M. caffra* fruit pulp is used for jelly and alcohol production (Engels et al., 2002). The seeds of *M. caffra* measure 1–1.5 cm long with a small basal scar (Louppe et al., 2008).

M. caffra extracts and decoctions are used in ethnomedicine and its bark extracts are used to treat wounds and sores in Zululand, South Africa (Louppe et al., 2008). A bark maceration of *M. caffra* is used as an emetic (Neuwinger, 2000) while the root extracts are used in the treatment of sexually transmitted infections such as gonorrhoea (De Wet et al., 2012). Interestingly, *M. caffra* leaf extracts contain ursolic acid which has anti-plasmodial activity and is (leaf extract) used to manage malaria (Simelane et al., 2013).

Despite *M. caffra*'s designation as a protected species and its protection under the South Africa National Forest Act of 1998 (South African

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Government Gazette, 2013), the tree is under threat from unsustainable utilisation practices which include use as: fuel (fire-wood), construction timber for boat making, traditional medicine, and the increased biome invasion by invasive alien species (www.durban.gov.za). Ecologists have noted that a threat to conservation and sustainable utilisation of protected shared communal resources such as trees is a lack of economic benefit to the local communities. Marula nut oil (Mokgolodi et al., 2011), *Trichilia emetica* oil (Orwa et al., 2009) and *Schinziophyton rautanenii* (Vermaak et al., 2011) have successfully been commercialised with benefits for the local communities who (local communities) sustainably utilise the trees. Previous studies on *M. caffra* have focused on the ethnobotanical and pharmacological benefits of extracts from the bark, leaves and roots. While nutritionists recommend dietary inclusion of complex plant foods like seeds, nuts and whole grains since they are rich sources of phytonutrients, fibre, vitamin E, magnesium and mono- and poly-unsaturated fatty acids (King et al., 2008; Ros, 2010; Tuso et al., 2013), the chemical nutrient and nutraceutical composition of *M. caffra* seed has not been investigated. There is a paucity of data on the potential of *M. caffra* seed as a source of nutrients, plant-derived oils, nutraceuticals, and health-promoting phytochemicals. This study sought to encourage the sustainable use of *M. caffra* in coastal communal areas by assessing the nutritive and economic potential of *M. caffra* seed by determining its proximate, mineral, fibre, amino acid and fatty acid profiles.

2. Materials and methods

2.1. Source and preparation of M. caffra seeds for analyses

The *M. caffra* fruit, from which the seeds were extracted, was collected from Chintsa coastal area of the Eastern Cape (close to East London), South Africa. The seeds were manually decorticated and the kernels were then ground to a meal using a laboratory blender. It is from the composite meal from which all the assays were done.

2.2. Chemical determinations

The chemical composition (proximate, fibre and mineral composition and amino acid and fatty acid profile) of the *M. caffra* seed was done at the Agricultural Research Council's Irene Analytical Services Laboratories, Pretoria, South Africa. Each of the assays was done in triplicate.

2.2.1. Determination of the proximate composition of the seed

The dry matter content of the seed was determined as outlined by the Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC, 2005). The seed's crude protein (CP), ether extract (EE/lipid), ash and organic matter (OM) content were determined as described by AOAC (1995). Available carbohydrate content of the seed was estimated by difference using the equation:

Available carbohydrate = [100 − (% ash + % moisture + % crude protein + % crude lipid + % neutral detergent fibre + % acid detergent fibre)]. The seed's gross energy (GE) content was determined using an MC-100 Modular Calorimeter (Energy Instrumentation, Centurion, South Africa) equipped with a PC and MC1000 software.

2.2.2. Determination of the fibre content of the seed

The neutral detergent fibre (NDF) and acid detergent fibre (ADF) content of the seed were determined according to the method outlined by van Soest et al. (1991). In summary, the determination of NDF involved the refluxing of 0.5 g sample for 1 h in 100 mL of sodium lauryl sulphate and ethylenediamine-tetraacetic acid (neutral detergent solution) to which 20 350 IU mL^{-1} thermally stable α-amylase (dietary fibre kit, Sigma-Aldrich, St. Louis, MO, USA) was added. Immediately following filtration the resultant residue was dried and then weighed. To determine the ADF content of the seed, 0.5 g sample was refluxed for 1 h in acid detergent solution (20 g cetyl-trimethyl ammonium bromide dissolved in 1 L 1 N H_2SO_4) after which the mixture was filtered. The residue was dried and then weighed.

2.2.3. Determination of the mineral composition of the seed

Standard procedures were used to determine the mineral composition of the seed. Briefly, 0.5 g of the milled sample was digested in concentrated nitric acid and perchloric acid at 200 °C to generate the digest solution (Zasoski and Burau, 1977). The digest solution was then used to spectrophotometrically determine the mineral (aluminium, boron, calcium, copper, iron, magnesium, manganese, potassium, sodium, phosphorus, selenium, sodium, sulphur, zinc) content of the seed using inductively coupled plasma-atomic emission spectrometry (ICP-AES) on a Varian Liberty 200 spectrometer (Varian, Perth, Australia) as explained by Huang and Schulte (1985).

2.2.4. Determination of the amino acid profile of the seed

The amino acid profile of the seed was determined using high performance liquid chromatography as outlined by Einarssom et al. (1983). Briefly, the preparatory phase involved acid hydrolysis of the samples using 6 N hydrochloric acid at 110 °C for 24 h which was immediately followed by the derivatisation of amino acids using 9-fluorenylmethyl chloroformate reagent. The amino acids were then extracted with pentane and separated by gradient elution on a chromatograph which consisted of a SpectraSystem P4000 Quaternary HPLC (Rigas Labs S.A.,Thessaloniki, Greece) equipped with a SpectraSystemFL3000 fluorescence detector and Rheodyne 7125 valve with 20 μL injection loop. To separate the amino acids, an OmniSper 5 C18 150 × 4.6 analytical column and guard column (Varian, Perth, Australia) were used. Individual amino acid identification was done at excitation wavelength of 264 nm and an emission wavelength of 340 nm. Quantification was performed by using external calibration on a PC equipped with TSP software.

2.2.5. Determination of the fatty acid profile of the seed oil

The Soxhlet method was used for fat extraction. The preparation of methyl esters and the subsequent profiling and quantification of individual fatty acids was done as described by Christopherson and Glass (1969).

2.3. Data analysis

The mean and standard deviation of each analyte was computed from the triplicate assays. Data are given as mean ± SD.

3. Results and discussion

The proximate and fibre content of *M. caffra* seed is shown in Table 1. The seed had a GE content of 25.07 ± 0.23 MJ kg^{-1} DM. On a DM basis, the EE constituted largest proximate component of the *M. caffra* seed followed by the CP. When combined, the EE and CP made up about 36.21% of the seed's dry matter content. Table 2 shows the seed's

Table 1
Proximate and fibre content of *M. caffra* seed on dry matter basis.

Constituent	Mean ± SD
Proximate components	
Dry matter (%)	89.65 ± 0.06
Ash (%)	4.73 ± 0.02
Organic matter (%)	84.90 ± 0.02
Crude protein (%)	10.02 ± 0.16
Ether extract/fat (%)	25.07 ± 0.23
Available carbohydrate (%)	11.91 ± 0.81
Gross energy (MJ kg^{-1})	25.20 ± 0.41
Fibre components	
Neutral detergent fibre (%)	27.15 ± 0.13
Acid detergent fibre (%)	9.65 ± 0.92

Values (n) are means and standard deviation of 3 replicates.