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RESEARCH ARTICLE

Evaluation of nutrients and chemical composition in underutilized *Eremomastax* (Lindau.) species

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Abstract: *Eremomastax speciosa* (Hochst.) Cufod and *Eremomastax polysperma* (Benth.) Dandy, are understudied plant species with high medicinal potentials, common in Southern Nigeria. Little is available in literature on their nutrients and phytochemical constituents. Therefore, this study was undertaken to evaluate the proximate, phytochemical, vitamin and mineral compositions of fresh leaves of both species collected from local farms in 4 different Local Government Areas of Cross River State, Nigeria. Both species were found to be rich in nutrients and phytochemicals. However, *E. polysperma* was significantly ($P<0.05$) richer in calcium, phosphorus, magnesium, vitamins B_1 and B_2, and crude protein while *E. speciosa* had higher carbohydrate, potassium, iron, zinc, vitamins A, B_3, C and E, contents. *E. polysperma* had significantly higher ($P<0.05$) saponin, flavonoid, phenol and alkaloid contents than *E. speciosa* which in turn was significantly richer in tannins and sterols. The abundance of a wide variety of bioactive compounds in both species of *Eremomastax* justifies their use in traditional healthcare. In addition, their uncovered rich nutrient base explains why the natives sometimes refer to them as 'blood tonic'.

Keywords: Eremomastax; vitamins; minerals; phytochemicals; proximate composition; traditional healthcare.

Introduction

Eremomastax speciosa (Hochst.) Cufod and *Eremomastax polysperma* (Benth.) Dandy represent some of the understudied species of medicinal plants that form part of the natural herbal remedy base commonly used by local communities in some African countries. In southern Nigeria where the plants predominate, there are wide claims by locals that these species are effective against infertility, diabetes, anaemia and internal heat (Pandey, 2006; Mboso et al., 2013). They are sometimes referred to locally as 'blood tonic'. Scientific evidence that corroborates the medicinal potential of these species avail from studies reported by Uyoh et al. (2013a) on their antioxidant health benefits; Okokon et al. (2007) on the significant antimicrobial and anti-anaemic activities of different extracts of *E. speciosa*. Oben et al. (2006) reported that aqueous leaf extract of *E. speciosa* significantly reduced castor oil-induced diarrhea in experimental animals while Tan et al. (1996) reported that aqueous leaf extract of *E. speciosa* inhibited HCl/EtOH and pylorus ligation-induced gastric ulceration in rats. Mboso et al. (2013) reported the presence of tannins, phenols, flavonoids, alkaloids, saponins and terpenes in the leaves of these plants. Despite the extensive use of these plants in traditional medicine, little information is available on their nutrient and anti-nutrient constituents. Against this backdrop, the present study was meant to evaluate the proximate, phytochemical, vitamin and mineral constituents of *E. polysperma* and *E. speciosa*, to further unravel the basis for their usage in traditional medicine.

Materials and methods

Plant material

Fresh leaves of *E. speciosa* and *E. polysperma* were obtained from local farms in four different local government areas - Calabar South and Calabar Municipality (4º57ʹN 8º19ʹE), Akpabuyo (4º56ʹN 8º24ʹE) and Akamkpa (5º16ʹN 8º34ʹE) in Cross River State of Nigeria. They were air-dried for three weeks and ground into uniform powder using a Thomas Willey milling machine.

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Proximate analysis

Moisture, ash, fibre and crude fat were determined using the methods of Udo et al. (2009); crude protein was determined by macro-Kjedahl method (Onwuka, 2005; Udo et al., 2009); nitrogen free extract (NFE) referred to as soluble carbohydrate was obtained by subtracting all the other components (except fat and dry matter) from 100%. NFE = 100 – (% ash + % crude fibre + % crude protein + % moisture).

Phytochemical analysis

Alkaloids, flavonoids, saponins, phenols, tannins and sterols were estimated by the methods described by Harborne (1973) and Edeoga et al. (2006) while hydrogen cyanide was estimated using the alkaline extraction method described by Onwuka (2005).

Vitamin and mineral analysis

Vitamins A and E contents were estimated by the methods described by Pearson (1976); vitamin C was estimated as described by Kirk and Sawyer (1998), B-complex vitamins (thiamine, riboflavin and niacin), zinc and iron were estimated as described by James (1995). Phosphorus, Calcium, Potassium, Sodium and Magnesium were estimated by AOAC methods (AOAC, 2000).

Data analysis

Data for each sample in every experiment were obtained in triplicates and used to compute mean and standard errors. The Students' t-test was used for comparison between the two species in all the parameters estimated, using the SPSS version 11 software.

Results and discussion

Proximate composition

E. polysperma was significantly ($P<0.05$) richer in moisture, ash, crude fiber, ether extract and crude protein while *E. speciosa* had higher dry matter and carbohydrate contents (Table 1). The fairly high moisture content (8.14-8.99%) provides for greater activity of water soluble enzymes and co-enzymes needed for metabolic activities (Iheanacho and Udebuani, 2009). Both species had reasonably high ash contents (24.93% in *E. polysperma* and 23.42% in *E. speciosa*), confirming the rich mineral contents in this report for these species (Table 3).The values reported here for ash are higher than earlier reports in *Vitis vinifera* (0.1%) (Aina et al., 2012), *Rhinacanthus nasutus* (11.4%) (Bukke et al., 2013) and *Tetrapeura tetraptera* (2.86 - 4.81) (Uyoh et al., 2013b), but comparable to those of *Afrofittonia sylvestries* (24.5%) and (Odoemena et al., 2002). Crude fibre contents of 11.64% and 12.06% (*E. polysperma* and *E. speciosa* respectively) were similar to 13.24% reported in *Rhinacanthus nasutus* (Bukke et al., 2013). Dietary fibre has some physiological effects in the gastrointestinal tract such as variation in faecal water, faecal bulk, transit time, and elimination of bile acids. It also affects nutritional sterols, which lower the body cholesterol pool, thereby reducing the incidence of coronary and breast cancer (Lintas, 1992; Effiong et al., 2005; Akpabio and Akpakpan, 2012.). Fat contents of 0.16% and 0.25% reported for *E. polysperma* and *E. speciosa* respectively, are less than the 0.74% in *Rhinacanthus nasutus* (Bukke et al., 2013) but similar to the 0.18% in *Vitis vinifera* (Aina et al., 2012). Both *Eremomastax* species were rich in crude protein with values ranging from18.85% to 20.57%.The total carbohydrate content was also high ranging from 33.19%-37.81%. Carbohydrates provide energy to the cells in the body and spare the body protein from being so used. The values obtained for carbohydrates in both species were far higher than those obtained in other members of the family Acanthaceae namely, *Afrofittonia sylvestris* (8.5%) (Odoemena et al., 2002) and *Vitis vinifera* (16.72%) (Aina et al., 2012). Thus, both species of *Eremomastax* are good sources of energy in addition to their medicinal benefits.

Phytochemical composition

E. polysperma had significantly higher ($P<0.05$) saponin, flavonoid, phenol and alkaloid contents than *E. speciosa* which in turn was significantly richer in tannins and sterols (Table 2). The detected phytochemicals are potent bioactive compounds which serve as precursors for the synthesis of useful drugs (Sofowora, 1993; Okigbo et al., 2009).

Table 1: Proximate composition in *Eremomastax polysperma* and *Eremomastax speciosa*.

Species	Moisture (%)	Dry matter (%)	Ash (%)	Crude fibre (%)	Ether extract (%)	Crude protein (%)	Carbohydrate (%)
E. polysperma	$8.99^{a} \pm 0.17$	$91.00^{b} \pm 0.17$	$24.93^{a} \pm 0.33$	$12.06^{a} \pm 0.08$	$0.25^{a} \pm 0.01$	$20.57^{a} \pm 0.27$	$33.19^{b} \pm 0.17$
E. speciosa	$8.14^{b} \pm 0.17$	$91.86^{a} \pm 0.17$	$23.42^{b} \pm 0.44$	$11.64^{a} \pm 0.23$	$0.16^{b} \pm 0.01$	$16.85^{b} \pm 0.10$	$37.81^{a} \pm 0.57$

*Results are expressed as mean ± standard error of mean
**Means with same superscript along each vertical array do not differ significantly (p>0.05) from each other

Table 2: Phytochemical composition in *Eremomastax polysperma* and *Eremomastax speciosa*.

Species	Saponin (%)	Tannin (%)	Flavonoid (%)	Sterol (%)	Phenol (%)	Alkaloid (%)
E. polysperma	$2.56^{a} \pm 0.05$	$1.64^{b} \pm 0.02$	$3.60^{a} \pm 0.05$	$0.17^{b} \pm 0.01$	$0.31^{a} \pm 0.01$	$3.61^{a} \pm 0.06$
E. speciosa	$2.13^{b} \pm 0.03$	$2.00^{a} \pm 0.02$	$2.67^{b} \pm 0.03$	$0.24^{a} \pm 0.01$	$0.23^{b} \pm 0.01$	$2.87^{b} \pm 0.02$

*Results are expressed as mean ± standard error of mean
**Means with same superscript along each vertical array did not differ significantly (p>0.05) from each other

Mean percent saponin contents of 2.56 and 2.13 were recorded in the present study for *E. polysperma* and *E. speciosa* respectively. Saponins are bitter phenolic compounds produced by plants as deterrence mechanisms to stop attacks by foreign pathogens, thus saponins are natural antimicrobials (Okwu and Emenike, 2006). They enhance the penetration of proteins through cell membranes (Sule et al., 2011). They are also useful cholesterol lowering agents (Skene and Sutton, 2006) and help in the relief of cough (Kee, 1998). Saponins also have the ability to kill or inhibit cancer cells (Harisaranraj et al., 2009).

Tannins are dietary anti-nutrients and their presence in reasonable amounts (1.64 and 2.00 % respectively for *E. polysperma* and *E. speciosa)* give both of them their characteristic astringent taste. This poor palatability probably explains why these plants are not very popular as diet components. Tannins are useful in the treatment of intestinal disorders such as diarrhea and dysentery, as well as urinary tract infections (Fahey, 2005; Akinpelu and Onakoya, 2006).

Flavonoid contents of 2.67% and 3.60% reported for *E. polysperma* and *E. speciosa* respectively are higher than the 0.98% obtained from the methanol extract of leaves from *Justicia spicigera* (Gabriela et al., 2009). They enhance the effect of vitamin C and function as antioxidants. They are also known to be biologically active against liver toxins, tumours, viruses and other microbes, allergies and inflammation. They protect blood vessels especially the tiny capillaries that carry oxygen and nutrients to cells (Okwu, 2004; Harisaranraj et al., 2009).

Phenols are the largest group of phytochemicals known and act as antioxidants (Aliyu et al., 2009) and free radical scavengers which prevent oxidative cell damage (Del-Rio et al., 1997, Okwu, 2004). They also play beneficial roles in human diets by acting as anti-carcinogens and in reducing the risks of heart diseases as well as diabetes (Holloway and Bradbury, 1999). Mean Phenolic contents of 0.23 and 0.31% were obtained from this study and this was lower than the 3.91% reported from the methanol extract of leaf from *Justicia spicigera* (Gabriela et al., 2009).

Mean alkaloid contents of 2.87 and 3.61% were obtained respectively for *E. speciosa* and *E. polysperma* in the present study. Alkaloids are endowed with analgesic, anti-spasmodic and anti-bacterial properties and are the most significant plant substances medicinally (Stay, 1998; Harisaranraj et al., 2009).

The presence of sterols in a plant is beneficial because steroidal compounds are potent precursors for the synthesis of sex hormones (Edeoga et al., 2005). Sterol content was, however, quite low in the two *Eremomastax* species in this study.

The presence of different phytochemicals in significant amounts in the two species of

Eremomastax studied, justifies their wide usage in traditional medicine.

Mineral composition

Appreciable amounts of both macro (K, P, Mg,Ca) and micro (Fe, Zn) elements were represented in both species with higher calcium, phosphorus and magnesium contents expressed in *E. polysperma* while *E. speciosa* had higher potassium, iron and zinc, ($P<0.05$), Table 3. Mean calcium contents of 271.79mg/100g and 261.21 mg/100g in *E. polysperma* and *E. speciosa* respectively, are higher than what were reported by Aliyu et al., 2008 in medicinal plants like *A. difformis* and *Pavetta crassipes* (120.60mg/100g and 32.30mg/100g respectively) and Uyoh et al., 2013b in *Tetrapleura tetraptera* (175.69mg/100g). Potassium contents of *E. polysperma* and *E. speciosa* (226.30mg/100g and 234.35mg/100g respectively) are however similar to values reported by Aliyu et al., 2008 in *Vernonia blumeoides* (230.00mg/100g) and Uyoh et al., 2013b in *Tetrapleura tetraptera* (240.00mg/100g). *E. polysperma* and *E. speciosa* have phosphorus contents (194.40mg/100g and 186.96mg/100g respectively) higher than the 172.10mg/100g reported for *Tetrapleura tetraptera* (Osagie and Eka, 1998) but lower than report by Dike (2010) in *Xylopia aethiopica*. Values for Iron (112.00mg/100g and 99.00mg/100g) recorded by Dike (2010) for *Monodora myristica* and *Xylopia aethiopica* respectively, are higher than the values reported in this study for *E. polysperma* and *E. speciosa* (3.25mg/100g and 3.65mg/100g). The zinc contents reported in this study for *E. polysperma* and *E. speciosa* (2.10mg/100g and 2.73mg/100g respectively) are comparable to that of *Pavetta crassipies* (2.64mg/100g) (Aliyu et al., 2008). Magnesium contents of 157.40mg/100g and 152mg/100g reported in this study for *E. polysperma* and *E. speciosa* respectively are comparable to that of *Anchomanes difformis* (145.07mg/100g) (Aliyu et al., 2008). The roles of these elements in the well-being of humans have been well documented by previous workers (Merck, 2005; Oluyemi *et al*., 2006).

Vitamins

E. polysperma had relatively higher vitamins B_1 and B_2 contents while *E. speciosa* was richer in vitamins A, B_3, C and E ($P<0.05$) (Table 4). These vitamins, particularly A, C and E are rich antioxidant sources (Yeh et al., 2003). The high vitamin contents of these species further corroborates reports of Uyoh et al. (2013a) on the rich antioxidant potentials of these plants and further explains their importance in traditional medicine.

Table 3: Mineral composition in *Eremomastax polysperma* and *Eremomastax speciosa.*

Species	**K (mg/100g)**	**Ca (mg/100g)**	**P (mg/100g)**	**Fe (mg/100g)**	**Mg (mg/100g)**	**Zn (mg/100g)**
E. polysperma	$226.30^b \pm 2.10$	$271.79^a \pm 1.86$	$194.40^a \pm 0.57$	$3.25^b \pm 0.08$	$157.40^a \pm 0.65$	$2.10^b \pm 0.38$
E. speciosa	$234.35^a \pm 0.310$	$261.21^b \pm 0.443$	$186.96^b \pm 0.076$	$3.68^a \pm 0.027$	$152.48^b \pm 0.101$	$2.73^a \pm 0.024$

*Results are expressed as mean ± standard error of mean
**Means with same superscript along each vertical array did not differ significantly ($p>0.05$) from each other

Table 4: Vitamin composition in *Eremomastax polysperma* and *Eremomastax speciosa.*

Species	**B_1 (%)**	**B_2 (%)**	**B_3 (%)**	**A (µg/g)**	**C (mg/100g)**	**E (mg/100g)**
E. polysperma	$1.29^a \pm 0.01$	$0.74^a \pm 0.10$	$1.19^b \pm 0.01$	$341.50^b \pm 2.25$	$276.70^b \pm 0.35$	$25.91^b \pm 0.07$
E. speciosa	$1.23^b \pm 0.005$	$0.65^b \pm 0.003$	$1.21^a \pm 0.008$	$353.25^a \pm 0.367$	$285.37^a \pm 0.109$	$26.57^a \pm 0.078$

*Results are expressed as mean ± standard error of mean
**Means with same superscript along each vertical arrays did not differ significantly ($p>0.05$) from each other.

Conclusion

The abundance of phytochemicals as reported in this study for *E. polysperma* and *E. speciosa* justifies their various roles in folk medicine. In addition, their rich nutrient values confirm their local name of ‘blood tonic’.

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