

Review of Chemical Properties and Ethnomedicinal uses of *Acanthosicyos horridus* Welw. ex Hook. f.: An Indigenous Melon Species of South-West Coast of Africa

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Abstract: *Acanthosicyos horridus* Welw. ex Hook. f. is a perennial shrub collected from the wild for its edible fruits and is also used as a traditional medicine. This study is aimed at evaluating the chemical properties and ethnomedicinal uses of *A. horridus*. Results of the current study are based on data derived from several online databases such as Scopus, Google Scholar, PubMed and Science Direct, and pre-electronic sources such as scientific publications, books, dissertations, book chapters and journal articles. This study revealed that the fruit and root infusions and/or decoctions of *A. horridus* are used as traditional medicine for arteriosclerosis, chest pains, gastro-intestinal disorders, kidney problems, nausea and sexually transmitted infections. Phytochemical compounds identified from the species include cucurbitacins, fatty acids and sterols. Some of the compounds identified from the species have applications in food industry and health promoting products.

Keywords: *Acanthosicyos horridus*, Cucurbitaceae, indigenous pharmacopeia, traditional medicine.

INTRODUCTION

Acanthosicyos horridus Welw. ex Hook. f. is a perennial shrub belonging to the Cucurbitaceae family, often called cucurbits or the gourd family. The Cucurbitaceae family consist of 95 genera and 965 species [1] with species of *Cucumis* L., *Cucurbita* L., *Citrullus* Schrad., *Lagenaria* Ser., *Luffa* Mill. and *Momordica* L. widely grown around the tropics and temperate areas for their edible fruits [2,3]. The majority of edible species of Cucurbitaceae family have economic importance as leafy vegetables, cucumbers, honeydew melons, melons, muskmelons and watermelons [4,5]. The genus *Acanthosicyos* Welw. ex Hook. f. consists of a single species, *A. horridus* which is endemic to the Namib Desert of the south-west coast of Africa and occurs from southern Angola, through Namibia to South Africa [6,7]. *Acanthosicyos naudinianus* (Sond.) C. Jeffrey (a synonym of *Citrullus naudinianus* (Sond.) Hook. f.) was transferred to the genus *Acanthosicyos* by Jeffrey [8] based on biochemical and seed coat characters, a view not accepted by Fursa [9,10], and also contradicted by molecular data [7,8,11,12]. Such taxonomical problems have negative effect on ethnopharmacological research and conservation programmes targeting specific species and closely related species [13-17].

The genus name "*Acanthosicyos*" is a contraction of two terms, a Greek term "*acantha*" meaning "spine" or

"thorn" and a Latin term "*sicyoideus*" meaning "gourd-shaped", that is, swollen below with narrow neck above, in reference to the spines on the fruit [18]. The specific name "*horridus*" is from a Latin verb "horrere" in reference to sharp thorns and the plant's ability to grow into impenetrable spiky thickets [19]. The English common names of *A. horridus* include nara, nara bush and nara melon. The seeds of *A. horridus* are known as butternuts or butterpips [20]. *Acanthosicyos horridus* is a perennial, dioecious and strongly branched shrub growing up to one metre tall and 40.0 metres in diameter [20]. The longitudinally grooved, pale yellow to green stems with spines arising from a very long and woody taproot system. The leaves are reduced to minute scales. The flowers are unisexual and yellow in colour. The fruit is a subglobose berry covered with spines, ripening from green to pale yellow or pale orange-yellow with many seeds. The seeds are oblong to ovoid in shape, hard with a thick testa and cream in colour, embedded in yellow to orange-yellow pulp. *Acanthosicyos horridus* has been recorded in the sand dunes of mostly dry riverbeds where subsurface water is available at an altitude ranging from 25 m to 150 m above sea level [21-24].

Acanthosicyos horridus is protected in Namibia [25] and in South Africa, and the species is poorly known with the last collection of the species in the country made in 1925 [26]. *Acanthosicyos horridus* is regarded as an important medicinal plant species in South Africa that is threatened or is of conservation concern and currently categorized as Least Concern (Data Deficient due to insufficient information) [27] using the IUCN Red

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List Categories and Criteria version 3.1 of threatened species. Previous reports show that *A. horridus* occurs in small, severely fragmented subpopulations and is potentially threatened by habitat loss due to mining, agricultural expansion and urbanization [26], and such species are of conservation concern [28,29]. The fruits of *A. horridus* are regarded as an important food source in Namibia [30-32]. Mansfeld *et al.* [33] argued that *A. horridus* is an incipiently cultivated plant with great promise for cultivation in arid areas as a source of food, fodder and herbal medicines. Research by Van Wyk [34,35] and Van Wyk and Wink [36] revealed that the roots of *A. horridus* have commercial potential as traditional medicines while seed oil have commercial potential in the production of food products and cosmetics. Therefore, the aim of this review is to provide an integrated and detailed appraisal of the existing knowledge on the chemical properties, biological activities and ethnobotanical uses of *A. horridus* in an attempt to explore the therapeutic and functional potential of this species.

Traditional uses

Acanthosicyos horridus is an important food and medicinal plant species in the desert areas of Namibia and South Africa [37-46]. Before the introduction of maize (*Zea mays* L.) into southern Africa, *A. horridus* was a traditional staple food [47]. Archeological evidence indicates that it has been a staple food for desert dwellers in southern Africa for over 8000 years [48,49]. The seeds of *A. horridus* are eaten fresh or roasted as a snack food or ground into flour for cooking with other dishes or made into a traditional reserve or dried fruit pulp made into flat cakes. The seeds of *A. horridus* are a good substitute for almonds (*Prunus dulcis* (Mill.) D.A. Webb) and are collected from the wild

for use in the confectionery industry in South Africa [50-53]. Young stems of *A. horridus* are browsed by livestock and game [54,55] while the peels of fruits are fed to donkeys and goats and the pips to chicken [56-58]. Therefore, the fruit deserves consideration for a selection and breeding programme [59].

In Namibia, the fruit and root infusions and/or decoctions of *A. horridus* are used as a traditional medicine for arteriosclerosis, chest pains, gastrointestinal disorders such as diarrhoea, stomach ache and stomach problems, kidney problems, nausea, sexually transmitted infections and venereal diseases (Table 1). The roots of *A. horridus* are mixed with fat and applied topically against wounds [57,60,61] while seed oil of the species is applied topically as a skin moisturizer and against sunburn [20,57,60-62].

Nutritional and Phytochemical Composition

Several researchers such as Wilkins-Ellert [20], Joubert and Cooper [64], Tanaka [65], Wehmeyer [66], Eaton and Nelson [67], Klopatek and Stock [68], Velepini and Perkins [69], Yang and Keding [70] and Cheikhoussef *et al.* [71] investigated the nutritional properties of *A. horridus* flowers, fruits, roots, seeds, seed oil and stems (Table 2). A wide variety of nutrients associated with different plant parts of *A. horridus* (Table 2) imply that the species could be a source of health promoting nutrients such as calcium, carbohydrates, copper, crude fibre, fat, iron, magnesium, phosphorus, potassium, proteins, sodium, vitamin C and zinc [72-74]. These nutrients that were identified from different plant parts of *A. horridus* have applications in food industry and nutritive medicines. Based on these research findings, the fruits of *A. horridus* could serve as a good supplement for nutrients such as carbohydrates, crude fibre, fat

Table 1: Medicinal uses of *Acanthosicyos horridus* in Namibia

Medicinal use	Plant part	Reference
Arteriosclerosis	Root infusion and/or decoction taken orally	[57,60,61,62]
Chest pains	Root infusion and/or decoction taken orally	[57,60,61,62]
Gastro-intestinal disorders (diarrhoea, stomach ache and stomach problems)	Fruit and root infusion and/or decoction taken orally	[20,57,60-63]
Kidney problems	Root infusion and/or decoction taken orally	[57,60-62]
Nausea	Root infusion and/or decoction taken orally	[20,57,60-62]
Sexually transmitted infections and venereal diseases	Fruit infusion and/or decoction taken	[20,57,60-62]
Skin moisturizer	Seed oil applied topically	[20,57,60-62]
Sunburn	Seed oil applied topically	[20,57,60-62]
Wounds	Roots mixed with fat and applied topically	[57,60,61]

Table 2: Nutritional and Phytochemical Composition of *Acanthosicyos horridus*

Nutritional or phytochemical component	Value	Plant part	Reference
Nutritional component			
α -Tocopherol (%)	4.7 – 6.3	Seed oil	[71]
β -Tocopherol (%)	0.5 – 0.8	Seed oil	[71]
γ -Tocopherol (%)	35.5 – 45.1	Seed oil	[71]
δ -Tocopherol (%)	3.6 – 4.1	Seed oil	[71]
Total tocopherol (%)	44.5 – 46.1	Seed oil	[71]
β -carotene (mg/100g)	0.1	Fruits and stems	[20,66,70]
Ash (mg/100g)	1.6 – 3.4	Fruits and seeds	[66]
Calcium (mg/100g)	21.4 – 100.0	Fruits and seeds	[20,65-67]
Carbohydrate (g/100g)	2.3 - 11.7	Fruits and seeds	[20,66]
Copper (mg/100g)	0.3 – 3.9	Fruits and seeds	[66]
Crude fibre (g/100g)	1.0 – 1.3	Fruits and seeds	[20,66]
Dry matter (%)	16.0 – 94.7	Fruits and stems	[70]
Energy (kJ)	231.0 – 2709.0	Fruits and seeds	[20,65-67]
Fat (g/100g)	0.3 – 57.0	Fruits and seeds	[20,66]
Iron (mg/100g)	0.5 – 4.0	Fruits and seeds	[20,66]
Magnesium (mg/100g)	19.0 – 363.0	Fruits and seeds	[20,66]
Nicotinic acid (mg/100g)	2.2	Seeds	[20,66]
Nicotinic acid (mg/100g)	0.8 – 2.2	Fruits and seeds	[20,66]
Nitrogen (mg/g)	12.1 – 55.6	Flowers, fruits, roots, seeds and stems	[68]
Phosphorus (mg/100g)	22.4 – 811.0	Fruits and seeds	[20,66]
Potassium (mg/100g)	400.0 – 654.0	Fruits and seeds	[66]
Protein (g/100g)	1.4 – 30.7	Fruits and seeds	[20,64,66]
Riboflavin (mg/100g)	0.02	Fruits	[20,66]
Sodium (mg/100g)	3.0 – 14.1	Fruits and seeds	[66]
Thiamin (mg/100g)	0.01	Fruits	[20,66]
Vitamin C (mg)	-	Fruits and stems	[70]
Water (mg/100g)	5.3 - 84.0	Fruits and seeds	[20,66,69]
Zinc (mg/100g)	0.6 – 5.5	Fruits and seeds	[20,66,70]
Phytochemical component			
Stigmasterol (%)	20.5 – 24.6	Seed oil	[71]
β -Sitosterol (%)	19.8 – 26.8	Seed oil	[71]
Palmitic acid (%)	15.6	Seed oil	[71]
Stearic acid (%)	11.6 – 11.9	Seed oil	[71]
Oleic acid (%)	12.8 - 13.9	Seed oil	[71]
Linoleic acid (%)	53.1 – 54.5	Seed oil	[71]
Eicosenoic acid (%)	4.4	Seed oil	[71]
α -Eleostearic acid (%)	1.0	Seed oil	[71]
Total unsaturated fatty acids (%)	72.5 – 72.7	Seed oil	[71]
Total saturated fatty acids (%)	27.3 – 27.5	Seed oil	[71]
Cucurbitacin B	-	Fruits and roots	[75-77]

(Table 2). Continued.

Nutritional or phytochemical component	Value	Plant part	Reference
Cucurbitacin D	-	Fruits and roots	[75-77]
Cucurbitacin G	-	Fruits and roots	[75,77]
Cucurbitacin H	-	Fruits and roots	[75,77,78]
Dihydrocucurbitacin B	-	Roots	[76]
Dihydrocucurbitacin D	-	Roots	[76]
3-epi-iso-cucurbitacin D	-	Roots	[76]
tetrahydro-iso-cucurbitacin I	-	Roots	[76]
dihydro-epi-iso-cucurbitacin D	-	Roots	[76]
Diacetyldihydro-epi-iso-cucurbitacin D	-	Roots	[76]
tetrahydro-iso-elatericin B	-	Roots	[76]
Raffinoseoligosaccharides	-	Roots	[79]

proteins and vitamin C to complement the stipulated requirements for the recommended dietary allowance (RDA) values [72] as the species is a traditional staple food of communities in the Namib Desert of the south-west of Africa [20].

Phytochemical compounds identified from the fruits, roots and seed oil of *A. horridus* include cucurbitacins, fatty acids and sterols [71,75-78]. The triterpenoids such as cucurbitacin B, D, G and H, dihydrocucurbitacin B and D, 3-epi-iso-cucurbitacin D, tetrahydro-iso-cucurbitacin I, dihydro-epi-iso-cucurbitacin D, diacetyldihydro-epi-iso-cucurbitacin D, tetrahydro-iso-elatericin B and raffinoseoligosaccharides have been identified from the fruits, roots and seed oil of *A. horridus* [75-79]. The bitter taste associated with the fruits of *A. horridus* is attributed to cucurbitacins, the bitter-tasting triterpenoids that are highly cytotoxic as some of them block mitosis in metaphase by inhibiting microtubule formation [80] and have purgative properties [81]. Some of these phytochemical compounds may be responsible for the biological activities of the species.

FUTURE RESEARCH AND PERSPECTIVES

Research on *A. horridus* over the past decades showed that the species is an important food plant in the dry areas of the south-west coast of Angola, Namibia and South Africa. The species is currently collected from the wild but previous research showed that *A. horridus* has great promise for cultivation in arid areas as a source of food, fodder and herbal medicines.²⁰ Therefore, future research should focus on developing selection and breeding programmes aimed at developing a variety that can produce larger

and more palatable fruits. Future research should also focus on identifying the phytochemical compounds and pharmacological properties of both these compounds and crude extracts of the species. Such comprehensive chemical characterization of both crude and pure extracts, and evaluation of commercial potential and development of nutraceutical products based on traditional uses of *A. horridus* is important. Recent increase in research focusing on *A. horridus* revealed conservation concerns about the species, particularly in South Africa. Cultivation of *A. horridus* is, therefore, a solution to the sustainability problems associated with harvesting of the species from the wild, and this option is also necessary for establishing commercial scale medicinal production and processing and trade enterprises.

CONFLICT OF INTEREST

No conflict of interest is associated with this work.

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