

Devil's Claw—A review of the ethnobotany, phytochemistry and biological activity of Harpagophytum procumbens

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Abstract

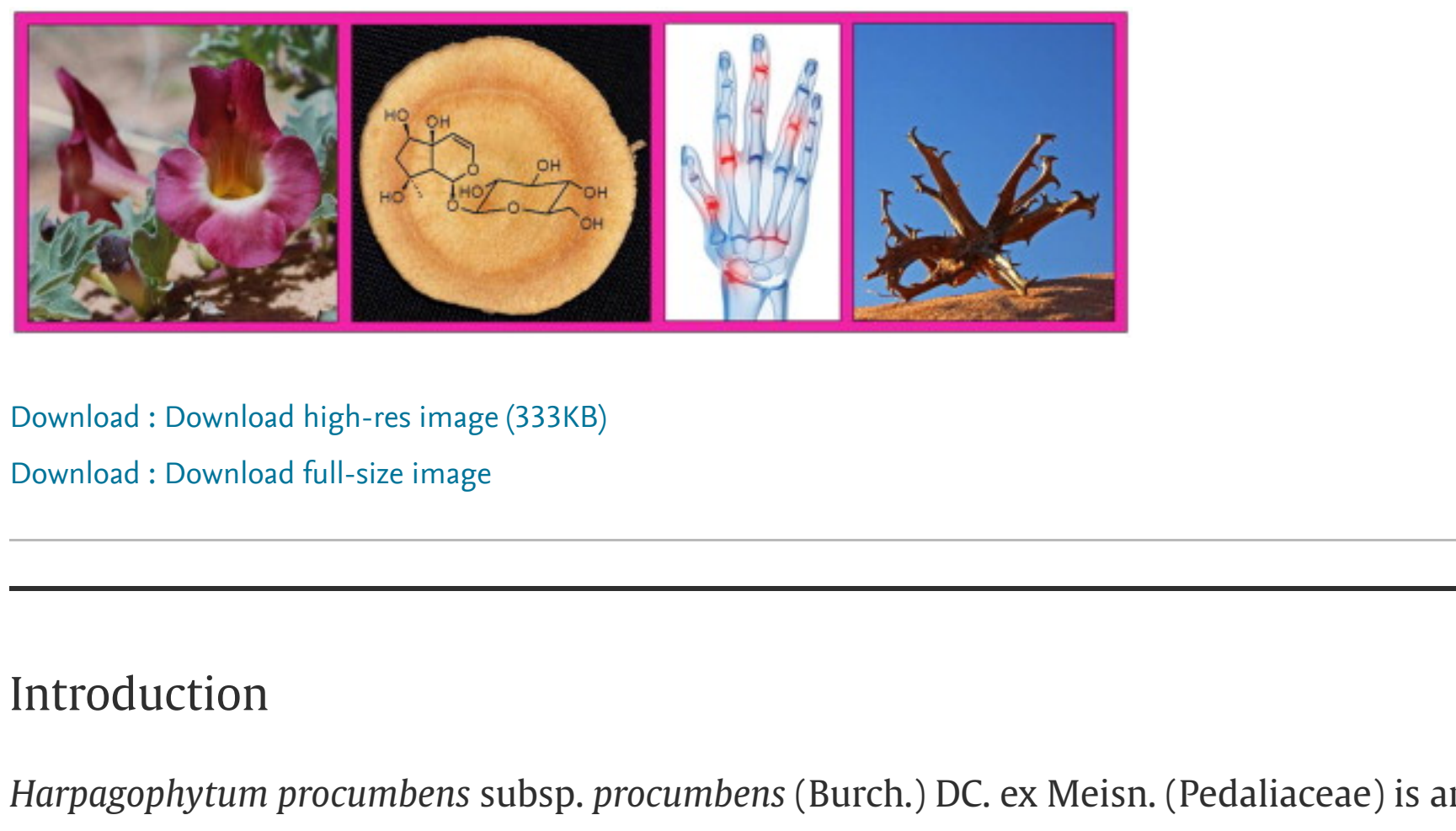
Ethnopharmacological relevance Harpagophytum procumbens subsp. procumbens (Burch.) DC. ex Meisn. (Pedaliaceae) is an important traditional medicine growing in the Kalahari region of southern Africa where it is consumed as a general health tonic and for treating diverse ailments including arthritis, pain, fever, ulcers and boils.

Aim of the review To provide a comprehensive overview of the ethnobotany, phytochemistry and biological activity of H. procumbens and possibly make recommendations for further research.

Materials and methods Peer-reviewed articles on H. procumbens were acquired on Scopus, ScienceDirect and SciFinder, there was no specific timeline set for the search. A focus group discussion was held with different communities in Botswana to further understand ethnobotanical uses of the plant.

Results Harpagophytum procumbens is used for a wide variety of health conditions in the form of infusions, decoctions, tinctures, powders and extracts. In addition to the common local use for arthritis and pain, other ethnomedicinal uses include dyspepsia, fever, blood diseases, urinary tract infections, postpartum pain, sprains, sores, ulcers and boils. Scientific studies revealed that H. procumbens exhibits analgesic, anti-oxidant, anti-diabetic, anti-epileptic, antimicrobial and antimalarial activities amongst others. Iridoid glycosides and phenylpropanoid glycosides have been the focus of phytochemical investigations as the biological activity has been ascribed to the iridoid glycosides (such as harpagoside and harpagide), which are common in nature and are known to possess anti-inflammatory activity. In addition, it has been shown that the hydrolysed products of harpagoside and harpagide have more pronounced anti-inflammatory activity when compared to the unhydrolysed compounds. Harpagophytum zeyheri is a close taxonomic ally of H. procumbens but H. procumbens is the favoured species of commerce, and contains higher levels of the pharmacologically active constituents. The two are used interchangeably and H. procumbens raw material is often intentionally adulterated with H. zeyheri and this may impact on the efficacy of inadequately controlled health products. The main exporter of this highly commercialised plant is Namibia. In 2009 alone, Harpagophytum exports were worth approximately €1.06 million. The high demand for health products based on this plant has led to over-harvesting, raising concerns about sustainability. Although only the secondary tubers are utilised commercially, the whole plant is often destroyed during harvesting.

Conclusions Harpagophytum procumbens is used to treat a wide range of ailments. Some of the ethnobotanical claims have been confirmed through in vitro studies, however, when the constituents deemed to be the biologically active compounds were isolated the efficacy was lower than that of the whole extract. This necessitates the use of a different approach where all the metabolites are considered using a robust method such as spectroscopy; the phytochemical data can then be superimposed on the biological activity. Furthermore, there is a need to develop rapid and efficient quality control methods for both raw materials and products because the orthodox methods in current use are time-consuming and labour intensive.



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Introduction

Harpagophytum procumbens subsp. procumbens (Burch.) DC. ex Meisn. (Pedaliaceae) is an important traditional medicinal plant growing in the Kalahari region of southern Africa (Van Wyk and Gericke, 2000). The use of H. procumbens was prominent amongst the indigenous San and Khoi people of South Africa; its use was further adopted by Bantu-speakers (Cole, 2003). Some of the ethnobotanical uses of H. procumbens include fever, diabetes, diarrhoea and blood disease, but there is a lack of written historical records. Suggestions to fix? Insert the treatment of before include. Recent scientific studies show that extracts of the secondary tubers of H. procumbens are effective in the treatment of degenerative rheumatoid arthritis, osteoarthritis, tendonitis, kidney inflammation, heart disease, dyspepsia and loss of appetite (Wichtl and Bisset, 2000, Stewart and Cole, 2005). The closely related H. zeyheri and H. procumbens are collectively known as Devil's Claw and are used interchangeably (Kemper, 1999). However, H. zeyheri has a lower concentration of the biologically active constituents. It is often included in raw materials and products as an adulterant of H. procumbens, the preferred species of commerce (McGregor et al., 2005). Harpagophytum procumbens is a commercially important plant species for the national income of Namibia for example, where it was an estimated €1.06 million in 2009 (Ridgway and Krugmann, 2011). Global sales are much more extensive, and a cumulative sale volume worth approximately €30 million was previously reported for Germany alone (Kathe et al., 2003).

The botany, ethnopharmacology, phytochemistry and biological activity of H. procumbens is herein reviewed. Furthermore, biopharmaceutical aspects and toxicity studies, which are essential parameters in drug delivery and drug action, are also discussed. Quality control (QC) forms an integral part of product development and production; thus robust and efficient methods used for the QC of H. procumbens were evaluated.

Section snippets

Description and classification

Harpagophytum procumbens (Pedaliaceae) is a weedy, perennial tuberous plant with visually striking fruits (Fig. 1A). The fruits have numerous characteristically long protrusions with sharp, grapple-like hooks, as well as two straight thorns on the upper surface, leading to the colloquial name of the genus Harpagophytum, Devil's Claw (Van Wyk et al., 2002, Wynberg et al., 2004). The flowers and leaves emerge from the...

Ethnopharmacology

In 1820, Devil's Claw was collected and described by European scientists. However, it was only much later that a German trader named G.H. Mehnert learned of the medicinal properties from the San and Nama people in Namibia and made these uses known in the early 1900s (Raimondo et al., 2005, Stewart and Cole, 2005). B. Zorn first studied the tubers after they were taken to Germany (University of Jena) in the 1950s (Wegener, 2000, Stewart and Cole, 2005). Tubers were also exported to Germany in...

Phytochemistry

Several phytochemical investigations have led to the isolation of constituents from H. procumbens including iridoids and other substances including harpagoquinones, amino acids, flavonoids, phytosterols and carbohydrates (Gruenwald, 2002). Iridoids represent a large group of cyclopenta[cl]pyran monoterpenoids occurring mainly in dicytyledonous plant families such as the Apocynaceae, Scrophulariaceae, Verbenaceae, Lamiaceae, Loganiaceae and Rubiaceae (Seeger, 1973). Phenylpropanoid glycosides are ...

Anti-inflammatory activity

In 1957, Zorn showed that subcutaneous injection and oral ingestion of an infusion of H. procumbens caused significant reduction in the swelling of arthritic joints of rats with formaldehyde-induced arthritis. It was concluded that H. procumbens contained a potent anti-inflammatory or anti-rheumatic substance and subsequent tests were undertaken by Eichler and Koch (1970) to determine whether the isolated constituent, harpagoside, yielded the same results. The results were positive but the...

Biopharmaceutical aspects

Biopharmaceutics is the study of the physicochemical properties of drugs and their proper dosage as related to the onset, duration and intensity of drug action. These are governed by pharmacokinetics which includes administration, distribution, metabolism and excretion. For each of those there are limiting factors that ultimately affect the bioavailability of drugs (Panchagnula and Thomas, 2000). The bioavailability of a drug injected directly into the bloodstream is 100%; however for orally...

Toxicity

An assessment report on H. procumbens and H. zeyheri secondary tuber for human use was prepared by the European Medicines Agency based on a review of available scientific studies (EMA (European Medicines Agency), 2009). Acute toxicity studies in mice revealed low toxicity. The LD50 values of aqueous, methanolic and butanolic extracts were greater than 4.6 g/kg and 1.0 g/kg for oral and intravenous administration, respectively. Intraperitoneal administration of harpagoside and harpagide to mice...

Quality control (QC) aspects

A plant species can usually be easily identified by taxonomists when the flowers and fruits are present, but the identification of leaf or root material is more challenging, especially when the plant material has been processed (e.g. powdered). Plant anatomy and phytochemistry have been used for many years by pharmacognosists as tools to authenticate plant material (Vieira et al., 2003). For Harpagophytum spp., it is said that the fruits of the plants are the only reliable method of...

Commercial aspects

Namibia has been the dominant producer and exporter of H. procumbens, accounting for between 85% and 99% of total exports (Stewart and Cole, 2005). Lesser amounts are sourced from South Africa and Botswana (Raimondo and Donaldson, 2002) and the majority of harvested dried secondary tubers are exported to Europe. Commercial harvesting and trade of H. procumbens in Namibia started in 1962 when the Namibian company Harpago Pty Ltd. began exporting dried secondary tubers to the German company Erwin ...

Conclusions

Harpagophytum procumbens has an ancient history of multiple indigenous uses and is one of the most highly commercialised indigenous traditional medicines from Africa, with bulk exports mainly to Europe where it is made into a large number of health products such as teas, tablets, capsules, and topical gels and patches.

While the phytochemistry of this plant has been well researched, there is a paucity of information on the additive or synergistic effects of the major compounds. These effects may ...

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