Food Chemistry 165 (2014) 424–443

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Review

Hibiscus sabdariffa L. – A phytochemical and pharmacological review

Inês Da-Costa-Rocha [a], Bernd Bonnlaender [b], Hartwig Sievers [c], Ivo Pischel [a,c], Michael Heinrich [a,*]

[a] Centre for Pharmacognosy and Phytotherapy, UCL School of Pharmacy, University of London, 29-39 Brunswick Square, London WC1N 1AX, UK
[b] Plantextrakt GmbH & Co. KG, Dutendorfer Str. 5–7, D-91487 Vestenbergsgreuth, Germany
[c] Phytolab GmbH & Co. KG, Dutendorfer Str. 5–7, D-91487 Vestenbergsgreuth, Germany

ARTICLE INFO

Article history:
Received 24 November 2013
Received in revised form 26 March 2014
Accepted 1 May 2014
Available online 27 May 2014

Keywords:
Roselle
Malvaceae
Lipid metabolism (anti-cholesterol)
Nephro- and hepato-protective
Renal/diuretic effect
Anti-diabetic
Anti-oxidant
Hydroxycitric acid
Hibiscus acid
Protocatechuic acid
Anthocyanins

ABSTRACT

Hibiscus sabdariffa L. (Hs, roselle; Malvaceae) has been used traditionally as a food, in herbal drinks, in hot and cold beverages, as a flavouring agent in the food industry and as a herbal medicine. *In vitro* and *in vivo* studies as well as some clinical trials provide some evidence mostly for phytochemically poorly characterised Hs extracts. Extracts showed antibacterial, anti-oxidant, nephro- and hepato-protective, renal/diuretic effect, effects on lipid metabolism (anti-cholesterol), anti-diabetic and anti-hypertensive effects among others. This might be linked to strong antioxidant activities, inhibition of α-glucosidase and α-amylase, inhibition of angiotensin-converting enzymes (ACE), and direct vaso-relaxant effect or calcium channel modulation. Phenolic acids (esp. protocatechuic acid), organic acid (hydroxycitric acid and hibiscus acid) and anthocyanins (delphinidin-3-sambubioside and cyanidin-3-sambubioside) are likely to contribute to the reported effects.

More well designed controlled clinical trials are needed which use phytochemically characterised preparations. Hs has an excellent safety and tolerability record.

Contents

* Corresponding author. Tel.: +44 20 7753 5844.
E-mail address: m.heinrich@ucl.ac.uk (M. Heinrich).

http://dx.doi.org/10.1016/j.foodchem.2014.05.002
0308-8146/

1. Introduction

Hibiscus sabdariffa L. (*Hs*), also known as roselle, is an ideal crop for developing countries as it is relatively easy to grow, can be grown as part of multi-cropping systems and can be used as food and fibre. In China the seeds are used for their oil and the plant is used for its medicinal properties, while in West Africa the leaves and powdered seeds are used in meals. Additionally, it is used in the pharmaceutical and food industries.

A limited number of reviews on Hs have been conducted. Only one detailed review on the phytochemical, pharmacological and toxicological properties of *Hs* (Ali, Al Wabel, & Blunden, 2005) and two more focused, later reviews are available: One on the effectiveness of *Hs* in the treatment of hypertension (Wahabi, Alansary, Al-Sabban, & Glasziuo, 2010) and another on the treatment of hypertension and hyperlipidemia (Hopkins, Lamm, Funk, & Ritenbaugh, 2013). This review will focus not only on the phytochemistry and pharmacological properties of Hs in more detail, but also on economic-botanical aspects of *Hs,* its scientific applications and translational research.

2. Botanical description

The genus *Hibiscus* (Malvaceae) includes more than 300 species of annual or perennial herbs, shrubs or trees (Wang, Morris, Tonnis, Davis, & Pederson, 2012). *Hs* (syn.: *Abelmoschus cruentus* (Bertol.) Walp., *Furcaria sabdariffa* Ulbr., *Hibiscus cruentus* Bertol., *Hibiscus fraternus* L., *Hibiscus palmatilobus* Baill. and *Sabdariffa rubra* Kostel (The Plant list, 2010) is commonly known as roselle, hibiscus, Jamaica sorrel or red sorrel (English) and in Arabic, karkadeh (Ali et al., 2005; Ross, 2003). Its native distribution is uncertain, some believe that is from India or Saudi Arabia (Ismail, Ikram, & Nazri, 2008), while Murdock (Murdock, 1959) showed evidence that *Hs* was domesticated by the black populations of western Sudan (Africa) sometime before 4000 BC. Nowadays, it is widely cultivated in both tropical and subtropical regions (Morton, 1987; USDA, 2007) including India, Saudi Arabia, China, Malaysia, Indonesia, The Philippines, Vietnam, Sudan, Egypt, Nigeria and México (Chewonarin et al., 1999; Dung et al., 1999; Eslaminejad & Zakaria, 2011; Ismail, Ikram, & Nazri, 2008; Mahran, El-Hossary, & El-Labban, 1979; Rao, 1996; Sharaf, 1962; Yagoub Ael, Mohamed, Ahmed, & El Tinay, 2004).

There are two main varieties of *Hs*, the first being *Hs* var. *altissima* Wester, cultivated for its jute-like fibre and the second is *Hs* var. *sabdariffa.* The second variety includes shorter bushy forms, which have been described as races: *bhagalpuriensi*, *intermedius*, *albus* and *ruber*. The first variety has green, red-streaked, inedible calyces, while the second and third race have yellow-green edible calyces (var. *ruber*) and also yield fibre (Morton, 1987).

2.1. Morphology

Hs var. sabdariffa ruber is an annual, erect, bushy, herbaceous subshrub that can grow up to 8 ft (2.4 m) tall, with smooth or nearly smooth, cylindrical, typically red stems. The leaves are alternate, 3 to 5 in (7.5–12.5 cm) long, green with reddish veins and long or short petioles. The leaves of young seedlings and upper leaves of older plants are simple; lower leaves are deeply 3 to 5 or even 7 lobed; the margins are toothed. Flowers, borne singly in the leaf axils, are up to 5 in (12.5 cm) wide, yellow or buff with a rose or maroon eye, and turn pink as they wither at the end of the day. At this time, the typically red calyx, consisting of 5 large sepals with a collar (epicalyx) of 8 to 12 slim, pointed bracts (or bracteoles) around the base, begins to enlarge, becomes fleshy, crisp but juicy, 1 1/4 to 2 1/4