Journal of Herbal Medicine 6 (2016) 163–170

Contents lists available at ScienceDirect

Journal of Herbal Medicine

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

Review article

Boswellic acid – Medicinal use of an ancient herbal remedy

Parameswara Rao Vuddanda[a,b], Sanjay Singh[b], Sitaram Velaga[a,*]

[a] Department of Health Sciences, Luleå University of Technology, Luleå 97187, Sweden
[b] Department of Pharmaceutics, Indian Institute of Technology (Banaras Hindu University), Varanasi 221005, India

ARTICLE INFO

Article history:
Received 21 September 2015
Received in revised form 5 November 2015
Accepted 3 August 2016
Available online 4 August 2016

Keywords:
Boswellic acid
Shallaki
Acetyl keto boswellic acid
Keto boswellic acid
Phyto chemical
Nanoparticles

ABSTRACT

Boswellic acid (BA) is an ancient herbal drug prescribed in the Indian traditional medicine systems (Ayurveda) for treatment of coughs, colds, hoarseness, bronchitis, asthma, dyspnea and diarrhea. Current research suggests it also has therapeutic potential in modern medical practice. Therefore, it is of interest to the research community to consolidate the preclinical and clinical findings on BA. The aim of this review was to comprehensively cover the plant sources, phytochemistry and physicochemical properties of BA along with its medicinal properties, safety, toxicity, and regulatory status. The review also discussed the challenges associated with drug delivery and some feasible approaches for addressing these. Four electronic databases (Scifinder, Unbound Medline, PubMed and Science Direct) and two internet search engines (Scirus and Google Scholar) were extensively searched without any time constraint.

The many studies discussed in the review indicated therapeutic potential for BA in the treatment of a range of chronic diseases including arthritis, cancer, asthma and diabetes. It is hoped that this review will help researchers identify relevant research questions leading to the development of effective formulations and a better understanding of the safety of BA, with the aim of promoting it as a mainstream treatment for various diseases in clinical practice.

Contents

Abbreviations: BA, boswellic acid; AKBA, acetyl keto boswellic acid;; KBA, keto boswellic acid; αTNF, tumor necrosis factor; NSAID, non-steroidal anti-inflammatory drug; G-CSF, granulocyte colony stimulating factor; GM-CSF, granulocyte/macrophage colony stimulating factor; VEGF, vascular endothelial growth factor; PAE, post antibiotic effect; ROS, reactive oxygen species; APTT, activated partial thromboplastin time; LOX, lipooxygenase; OVA, ovalbumin.

* Corresponding author at: Department of Health Sciences, Division of Medical Sciences, Luleå University of Technology, Luleå, 97187, Sweden.
E-mail address: sitaram.velaga@ltu.se (S. Velaga).

http://dx.doi.org/10.1016/j.hermed.2016.08.002
2210-8033/

1. Introduction

Interest in herbalism, the study and use of plants for medicinal purposes, has recently been renewed with respect to modern healthcare systems. Before the current scientific era, humans treated diseases with medicines of natural origin, particularly from plants and herbs. Information about medicinal plants and their therapeutic uses has been preserved in the great Indian Ayurveda and traditional Chinese herbal medicine compendia (Dohling, 2008; The Ayurvedic Pharmacopoeia of India, 2007; Yang, 2002). This ancient knowledge has served as a basis for the development of many modern drugs, for instance aspirin (from willow bark), digoxin (from foxglove), quinine (from cinchona bark), and morphine (from the opium poppy). In recent decades, the popularity of herbal drugs has been growing as a result of potentially better safety, availability and economic benefits. The World Health Organization also encourages developing countries to use herbal drugs as an alternative to modern systems (Vuddanda et al., 2010). Drug regulatory authorities and official public health departments in various countries are actively involved in checking the authentication and safe use of herbal remedies. It has been forecasted that the global market for herbal remedies and dietary supplements will reach US$107 billion by the year 2017 (Jose March 19, 2012). In addition to the Asia-Pacific region, Japan and Europe account for a large share of the herbal medicine market. Thus, there seems to be a thrust for the development of herbal products/medicines in the treatment and management of various diseases.

With this motivation, an attempt has been made in this contribution to review and summarize recent activities and developments in the modern medicinal use of the ancient Ayurvedic herbal remedy – Boswellic acid (BA).

2. Methodology

A literature search was conducted between 2014 and 2015 by using the following key words: 'Boswellic acids and its medicinal use'; 'Shallaki'; 'Acetyl keto boswellic acid' and 'Keto boswellic acid'. Four electronic databases were searched: Scifinder; Unbound Medline; PubMed and Science Direct and two internet search engines: Scirus and Google Scholar were used to collate the available literature on BA without any time constraints. The following journals: Planta Medica; Phytotherapy Research; Fitoterapia; Phytomedicine and Ethnopharmacology and International Pharmacognosy text books were consulted. Traditional and historical information was extracted from Indian Ayurvedic books; i.e. Charaka Samhita; 1^{st} – 2^{nd} century AD; Astangahrdaya Samhita; 7^{th} century AD and The Ayurvedic Pharmacopoeia of India; Volume-I; Part -IV which were accessed from the faculty of Ayurveda; Institute of Medical Sciences; Banaras Hindu University; Varanasi; India.

Few reviews however are available in the literature in regard to the sources, geographical distribution, phytochemistry, physicochemical properties and specific pharmacology (including anti-inflammatory effects) of the remedy. Thus, this review focuses on the available recent studies of its various pharmacological properties, safety, toxicity and regulatory status. The challenges associated with formulation development and drug delivery are also discussed, and feasible solutions are reviewed, with the aim of obtaining maximum potential from this unique herbal remedy.

3. Botany and phytochemistry of boswellic acids

BAs are extracted from the trunks of various Boswellia species trees. They are moderate to large branched trees that grow in the dry mountainous regions of India, Northern Africa and the Middle East (Leung and Foster 1996; Strappaghetti et al., 1982). The genus Boswellia belongs to the family Burseraceae and more than 600 species are widespread in all tropical regions (Siddiqui, 2011). These widely recognized species are listed in Table 1. Oleo gum resin is extracted from the trunk and processed in a specially made bamboo basket until it turns into an aromatic, hard glass like amorphous solid. The yield and chemical constituents of the oleo gum resin is dependent on many factors, including the geographical region, the season during which collection took place, the age of the tree, the wound surface area, the collection procedure and the storage conditions. Boswellia trees can produce good quality exudates for only three years.

The oleo gum contains resins (30–60%), essential oils (5–10%) and water-soluble polysaccharides (~65% arabinose, galactose, xylose) (Boswellia Serrata monograph 2008). The resinous part contains monoterpenes (α-thujene), diterpenes (incensole, incensole oxide, iso-incensole oxide, and the diterpene alcohol serratol), triterpenes (α- and β-amyrins), tetracyclic triterpenes (tirucall-8, 24-dien-21-oic acids) and pentacyclic triterpenes. Among these, the pentacyclic triterpenes are mainly accountable for the multiple pharmacological effects (El-Khadem et al., 1972; Kumar et al., 2012). Buchele et al. has identified 12 pentacyclic triterpenes from boswellia species from India and Africa. The chemical structures and characteristics of four major pentacyclic triterpenic acids, namely αBA, βBA, keto-BA (KBA) and 11 keto acetyl BA (AKBA) are presented in Figure 1 and Table 2, respectively (Ammon et al., 1991; Buchele and Simmet, 2003; Buchele et al., 2003).

4. Medicinal uses

4.1. Traditional uses

Boswellia is called *Ashvamutri, Kundara* and *Shallaki* in Sanskrit. Ayurveda (Indian traditional medicine practice) describes boswellia as an active ingredient in decoctions used for the treatment of gastrointestinal diseases such as diarrhea, constipation, flatulence and vomiting. It has also been stated that the extract is useful in the treatment of respiratory complications including cough, cold, hoarseness, bronchitis, asthma and dyspnea (Ammon, 2006; Sionneau and Flaws, 1995; Sionneau and Dui Yao, 1997; The Ayurvedic Pharmacopoeia of India, 2007; Wichtl, 2004).

Table 1
Widely recognized species of Boswellia (Ammon, 2006).

S. No	Species	Geographical Place
1.	*B. cateri* Birdw	Somalia
2.	*B. sacra* Flueck	Nubia, South Arabia
3.	*B. frereana* Birdw	Somalia
4.	*B. bhau-dajiana* Birdw	North Somalia
5.	*B.papyrifera* Hocst	Ethiopia
6.	*B. neglecta* S. Moore	Somalia
7.	*B.odorata* Hutch	Tropical Africa
8.	*B.dalzielli* Hutch	Tropical Africa
9.	*B.serrata* Roxeb	India