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A review on phytochemistry and therapeutic uses of *Hibiscus sabdariffa* L.

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ABSTRACT

Hibiscus sabdariffa L. (roselle) belonging to the Malvaceae family is widely grown in many countries. This plant is often used in the traditional medicine being rich in phytochemicals like polyphenols especially anthocyanins, polysaccharides and organic acids thus having enormous prospective in modern therapeutic uses.

The study aimed to review and document all the available evidence and information about the calyces of *Hibiscus sabdariffa* (roselle) with the special focus on their nutritional composition, bioactive constituents and therapeutic uses. The electronic database was searched up to 2017, using keywords *Hibiscus sabdariffa*, chemical constituents of roselle, therapeutic uses of roselle. Journals, books and conference proceedings were also searched.

The review provides valuable information about the nutraceutical component of *Hibiscus sabdariffa* L. and their utilization for curing various degenerative diseases like hypertension, hyperlipidemia, cancer and other inflammatory diseases of liver and kidney. Their toxicological effects have also been discussed from a safety point of view.

Most studies supported and provided the scientific basis for the statement that *Hibiscus sabdariffa* and their active constituents play an important role in the prevention of chronic and degenerative diseases that are associated with oxidative stress. Our study suggests, that good research is needed, to establish a potential strategy that can balance the pharmacological and toxic effects of roselle and standardized fingerprint of *Hibiscus sabdariffa* is required internationally for quality control.

1. Introduction

Plants have played an important role in the life of human being as they provide the basic need of mankind that is food, clothing, shelter, and medicines. They have formed the basis of traditional medicine system among which are Ayurvedic, Unani etc. that have been in existence for many decades and continue to provide mankind with new remedies. In developing countries, a large section of the population relies on medicinal plants for primary health care requirements. The traditional medicines are becoming popular among most of the world population mainly because they are cheap, abundant with less adverse effect on health. In recent years, focus on plant research has increased globally to find out the immense potentials of medicinal plants used in various traditional systems. Various medicinal plants have been studied which could be used as potent phytochemical agents in the therapeutic treatment of various diseases; one among them is *Hibiscus sabdariffa*-known for its delicacy and medicinal properties which has several health benefits [1].

There are only a few reviews available on *Hibiscus sabdariffa.* Only two previous detailed reviews are available one focusing on phytochemical, pharmacological and toxicological properties [1] and another review, on the phytochemistry, pharmacological properties and economic-botanical aspects of roselle [2]. Other systematic reviews have investigated the effect of *Hibiscus sabdariffa* in the treatment of hypertension [3], hyperlipidemia, hypertension and apoptosis [4] and hyperlipidemia and hypertension [5]. In another systematic review of human clinical trial by Walton et al. [6] assessed the effectiveness of roselle in the treatment of hypertension. A recent review by Singh et al. [7] focused on the nutritional and health benefits of *Hibiscus sabdariffa.* In a another recent review, Herranz-López et al. [8] have focused on the multi-targeted molecular effect of roselle polyphenols on obesity management. In their review they mentioned that there is a need to understand the molecular mechanism of roselle polyphenols and metabolites involved, through virtual screening and epigenetic analysis.

The present review aims to document the detail information on the calyces of the flower of roselle (*Hibiscus sabdariffa* L.). It will also focus on the traditional uses, nutritional composition, bioactive constituents and the therapeutic uses of this plant. Most of the pharmacological

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investigations on the roselle plant has been summarised that provides a scientific basis for its use as functional food and to facilitate further investigations on the therapeutic uses of this plant.

2. Origin, distribution and morphology

Hibiscus sabdariffa, with an attractive flower, is widely grown in many developing countries. More than 300 species are distributed in tropical and subtropical regions around the world [9]. They are originally native from India, to Malaysia [10] where it is commonly cultivated and was carried at an early date to Africa. It is also cultivated in Sudan, Egypt, Nigeria, Mexico, Saudi Arabia, Taiwan, West Indies and Central America [11,12]. In India it is widely grown by the tribal in the villages of Madhya Pradesh, Maharashtra, Orissa, West Bengal, Assam, Meghalaya and Andhra Pradesh [13]. It is commonly known as roselle in English speaking regions, besides it is also known as Bissap in Senegal, Jamaica in Mexico and Spain, Congo in France, Wonjo in the Gambia, Zobo in Nigeria, Karkade in Egypt, Saudi Arabia and Sudan [14–17]. In the Indian subcontinent, it is known as Indian sorrel, mesta, lal ambari, patwa, amta and amti [18,13].

Hibiscus sabdariffa belongs to the family of Malvaceae. It is an annual or perennial herb or woody-based sub-shrub, growing to 2–2.5 m tall. The leaves are deeply 3-5 palmately lobed and 8–15 cm long, arranged alternately on the smooth, cylindrical red stems [19]. The flowers are auxiliary or terminal and 8–10 cm in diameter, white to pale yellow with a dark red spot at the base of each petal, and have a stout fleshy calyx at the base, 1–2 cm wide, enlarging to 3–3.5 cm, fleshy and bright red as the fruit matures (Figs. 1 and 2,). It takes about six months to mature. Roselle is cultivated at the beginning of the rainy season during mid-April and harvested for the calyces of fruits, about 3 weeks till the onset of flowering [13,18,20].

3. Uses of *Hibiscus sabdariffa*

Traditionally roselle is cultivated for its stem, leaves, calyces and seeds as all parts have industrial, medicinal and other applications [21].

3.1. Traditional culinary usage

The young leaves and tender stems of roselle are eaten raw in a salad or cooked alone or with meat or fish, while Sudanese cook it with onion or groundnut, eat it as green or dry it [11]. In India, the women folk use the tender leaves and stem for making chutney during rainy season, eaten as salad, used as vegetable and women folk dry it for use during off-season [13]. Seeds are rich in protein and after oil extraction, they are boiled and eaten in soups and are also used as a substitute for coffee in Africa [9]. The seeds are fermented to produce a meat substitute condiment [22]. The Chinese use the seeds for oil extraction [23].

Fig. 1. Roselle plant at flowering stage.

Fig. 2. Fresh roselle calyces.

The calyces are either frozen or dried in sun /artificially for out of season supply, [17].The dried calyces of roselle are utilized worldwide in the production of drinks (herbal/ice tea), jams, jellies, sauces, chutneys, wines, preserves, and a source of natural food colourant due to the presence of anthocyanins [11,24–26]. They are also used in fruit salads and in the preparation of syrup. These sauces or syrups are added to the puddings, cake frosting and in ice-cream. In Africa, they are frequently cooked as a side-dish eaten with pulverized peanuts while in Pakistan, their calyces have been recommended as a source of pectin for fruit-preserving industry [9]. In West Indies and tropical America, roselle is primarily used for cooling lemonade like beverages made from the calyces and is an important drink during Christmas [27]. Lo Shen is the processed drink, used by the Chinese [28]. In the Indian state of Madhya Pradesh, roselle calyces are sold in the local market as indigenous vegetables and the majority of females prepare beverages from the flowers of *Hibiscus sabdariffa* [13].

3.2. Traditional therapeutic usage

Various parts of the roselle plant have been used in traditional medicine to treat colds, toothaches, urinary tract infections and hangovers. It is claimed to be a Thai traditional medicine for kidney and urinary bladder stones [29]. However in India, traditionally the tribal utilizes roselle for curing diseases and use as ethnic food. They are used to relieve pain in urination and indigestion and the Mexicans, traditionally use the infusions of the calyces and leaves for curing hypertension and various other diseases [2]. The powder of dried calyx or fresh flowers is used for curing flatulence in cow, goat, and sheep. The extract of the calyces added with common salt is beneficial to cure diarrhoea and dysentery of animals and human. It is also used to cure waist pain and other gynaecological disorders in post-delivery cases [13]. The Calyx infusion (Sudan Tea) is taken to relieve coughs and remedy for biliousness [14,15,30] and are also used to lower the body temperature [31]. The drinks are also used to treat liver disease, fever, hypercholesterolemia, hypertension, antispasmodic and antimicrobial agent [32–34].

4. Nutritional composition

The calyces of roselle are rich in carbohydrate, dietary fibre,