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The Versatility of Roselle (*Hibiscus sabdariffa*): From Nutritional Super Food to Natural Medicine

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ABSTRACT

Roselle (*Hibiscus sabdariffa*) is a versatile plant native to tropical and subtropical regions, renowned for its vibrant red calyxes and rich nutrient profile. The plant, belonging to the Malvaceae family, is cultivated for both culinary and medicinal uses, offering significant health benefits due to its rich content of vitamins, minerals, and bioactive compounds. Its calyxes are high in vitamin C and anthocyanins, both of which have strong antioxidant properties, aiding in immune function, and potentially offering anti-inflammatory and anti-cancer effects. The leaves, also nutrient-dense, contain essential vitamins like A, C, and K, as well as iron and calcium, which can be vital in addressing malnutrition. In traditional medicine, roselle has been used to treat various conditions such as hypertension and digestive issues. Scientific studies have supported these uses, showing roselle's efficacy in lowering blood pressure and reducing blood sugar levels in diabetic models. Beyond health benefits, roselle's economic value is growing due to increasing global demand for natural products, particularly in the herbal tea market. Cultivation of this drought-resistant plant also promotes sustainable agricultural practices, offering a viable cash crop for farmers in developing regions. Continued research into roselle's phytochemical properties and potential health applications is crucial for its wider adoption in food and medicinal industries.

Keywords: Roselle, *Hibiscus sabdariffa*, Antioxidants, Traditional Medicine, Bioactive Compounds and Economic Potential

INTRODUCTION

Roselle, scientifically named *Hibiscus sabdariffa*, is a adaptable flowering plant from the Malvaceae family, mainly grown in tropical and subtropical areas. Its bright red calyxes and healthy leaves have turned it into a key ingredient in many global culinary and traditional medicinal practices. The plant holds a deep historical background, originating from ancient Egypt, where it was used for making refreshing drinks. In Africa, it has been important in local cooking customs, particularly in making bissap in Senegal and zorra in Mali, showcasing its sour taste and health advantages (Khan *et al*., 2016; Lako *et al*., 2015). From a botanical perspective, roselle is a type of plant that can be an herbaceous perennial or annual, reaching heights of up to 3 meters with palmate leaves that come in shades of green to reddish-purple. The plant does well in soils that drain well and needs full sunlight, making it a great choice for various agricultural activities (Adebayo *et al*., 2018). The yellow-petaledroselle flowers are visually attractive, but it is the fleshy calyxes that are most valued for their culinary and medicinal uses. These calyxes, picked when young, have a tangy taste similar to cranberry, making them appropriate for various drinks and food items.

In terms of nutrition, roselle is impressive because its calyxes are abundant in antioxidants, vitamins, and minerals. Significantly, they contain a high amount of vitamin C, which is crucial for immune system functioning and maintaining healthy skin (Murray *et al*., 2017). Furthermore, roselle also has anthocyanins, which are plant compounds associated with anti-inflammatory and

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anti-cancer effects according to Shin *et al*. (2014). The nutritious leaves contain important vitamins and minerals like iron and calcium, which are especially helpful in places with malnutrition issues (Seymour *et al*., 2016). These characteristics highlight the potential of roselle to enhance dietary variety and tackle micronutrient deficiencies in at-risk populations. In conventional medicine, roselle has been used to address different health problems, such as hypertension and digestive disorders. There have been several studies that have confirmed these applications. In a study conducted by McKay and Beckstrom-Sternberg (2006), it was shown that roselle tea successfully decreased blood pressure in those with mild hypertension. Additionally, Olatunji *et al*. (2013) found that roselle extracts could effectively reduce blood sugar levels in diabetic rats, indicating its promise as a natural treatment for diabetes control. The high antioxidant levels and the plant's capacity to regulate different biochemical pathways are responsible for this therapeutic profile.

There are many different ways to use roselle in cooking. The calyxes are utilized, whether fresh or dried, to make herbal teas, jams, jellies, and sauces. In numerous societies, the sourness of the calyxes improves both alcoholic and non-alcoholic drinks, while the leaves can be prepared similarly to spinach, providing taste and nutrients to various meals (Ombalo *et al*., 2018). The plant's versatility in culinary applications not only showcases its potential to enhance food security in regions where it is cultivated. Viewed through an economic lens, roselle offers substantial chances for growth. The increasing worldwide demand for herbal teas and natural food products makes roselle a profitable cash crop for farmers in tropical areas. Dried calyxes are highly sought after, with high demand regionally and globally, often selling for good prices (Nwodo *et al*., 2019). Furthermore, growing roselle can help promote sustainable farming techniques by allowing it to be grown alongside other crops, which can improve the health of the soil and variety of wildlife. *Hibiscus sabdariffa*, also known as roselle, is a plant that holds immense importance due to its various advantages, spanning from its use in cooking and its nutritional value to its potential for medicinal and economic purposes. The cultivation and use of roselle may become more significant in improving health outcomes and supporting livelihoods as the worldwide demand for natural remedies and health foods grows. The importance of conducting additional research and promoting it more widely is emphasized by its diverse applications and significant historical significance. Proper mature roselle calyxes are given in the Fig. 1.

Fig. 1 : Roselle calyxes

Occurrence, Botanical Description, and Ethno-Pharmacology of Roselle Leaves:

Occurrence:

Roselle, also known as *Hibiscus sabdariffa*, is found in many tropical and subtropical areas worldwide. It flourishes in nations like India, Sudan, Nigeria, Mexico, and regions in Southeast Asia, such as Thailand and the Philippines (Adebayo *et al*., 2018). The plant is frequently grown for its leaves and calyxes, which are used in cooking and for medicinal purposes. Roselle is cultivated in home gardens, agricultural fields, and as a commercial crop in numerous areas because of its ability to thrive in different soil types and climates (Khan *et al*., 2016). The growing popularity of its cultivation is driven by the rising need for natural products and health foods, underscoring its economic significance in both local and global markets.

Botanical Description:

Roselle is a plant that is either an annual or perennial herb and has the potential to reach heights of 2-3 meters. The plant shows a strong, vertical stem, usually in a reddish hue. The leaves which are unique, palm-shaped, and with lobes, vary in length from 7 to 15 cm. Their color can range from a dark green to a reddish-purple, contingent on the specific type (Murray *et al*., 2017). The arrangement of leaves has jagged edges and a shiny finish, giving them an attractive appearance and aiding in their

recognition.The roselle flowers have a sizeable diameter, typically ranging from 5 to 10 cm. Their distinctive feature includes five petals of light yellow color, typically with a deep red center. After blooming, the plant forms a capsule with five cells that holds many seeds, helping spread the species easily (Adebayo *et al*., 2018). The main focus of culinary and medicinal uses is the mature, fleshy, and red calyxes, but the leaves also have important nutritional and therapeutic benefits (Patel and Patel, 2022).

Ethno-pharmacology of Roselle Leaves:

The leaves of roselle have been utilized in traditional medicine practices in different cultures for many years. They are frequently utilized for various health issues such as digestive problems, high blood pressure, and inflammation. Research shows that the leaves of the plant contain various bioactive substances such as flavonoids, phenolic acids, and vitamins that play a role in their medicinal properties (Seymour *et al*., 2016; Lako *et al*., 2015). In various African traditions, roselle leaves are eaten in salads, soups, and stews, offering both taste and necessary nutrients. The foliage contains high levels of vitamins A, C, and K, as well as minerals like calcium and iron, playing a crucial role as a dietary addition, particularly in regions with high levels of malnutrition (Ombalo *et al*., 2018). Moreover, the leaves are commonly used to make herbal teas that are thought to have anti-hypertensive and diuretic properties. A study conducted by McKay and Beckstrom-Sternberg in 2006 found that roselle infusions can effectively reduce blood pressure, supporting their traditional medicinal use. Furthermore, researchers have studied the anti-inflammatory effects of roselle leaves in multiple research projects. Research conducted by Olatunji *et al*. (2013) showed that leaf extracts have the ability to decrease inflammation in animal models, indicating possible uses for treating inflammatory conditions. The therapeutic potential of flavonoids and phenolic compounds is increased by their antioxidant properties, aiding in the fight against oxidative stress and chronic diseases (Khan *et al*., 2016). Taxonomical details given in the Table 1.

Table 1: Taxonomic details of roselle

Taxonomic Rank	Classification
Domain	Eukaryota
Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Clade	Rosids
Order	Malvales
Family	Malvaceae
Genus	Hibiscus
Species	*Hibiscus sabdariffa*

General Characteristics:

Roselle is a plant that can be either an annual or perennial and is famous for its vibrant appearance and culinary applications. The plant usually grows to heights between 2 and 3 meters and shows a strong, upright growing pattern. It grows well in tropical and subtropical regions, where it is able to adjust to different soil types, but it favors fertile soils that are well-drained (Khan *et al*., 2016). Nutritional details of roselle given in Table 2.

Stem:

The stalks of roselle plants, particularly in perennial types, are typically woody and can range in color from green to reddish-purple. They are tube-shaped and could divide, providing support for the leaves and flowers during

Table 2: Nutritional details of roselle

Nutrients	Amount per 100g (Fresh Calyxes)	Amount per 100g (Dried Calyxes)	References
Calories	37 kcal	330 kcal	Bafakeeh *et al*. (2019)
Protein	2.5 g	11.3 g	Adebayo *et al*. (2020)
Fat	0.5 g	0.5 g	Adebayo *et al*. (2020)
Carbohydrates	8.9 g	74.6 g	Morrison, 2018
Fiber	2.7 g	5.1 g	Bafakeeh *et al*. (2019)
Vitamin C	31 mg	0 mg	Adebayo *et al*. (2020)
Calcium	124 mg	121 mg	Khan *et al*. (2016)
Iron	1.0 mg	3.2 mg	Morrison, 2018
Magnesium	44 mg	120 mg	Akinmoladun *et al*. (2019)
Potassium	356 mg	675 mg	Bafakeeh *et al*. (2019)
Phytochemicals	-	-	
- Anthocyanins	0.03 g	0.50 g	Adebayo *et al*. (2020)
- Flavonoids	0.02 g	0.40 g	Mabrouk (2021)

their growth (Adebayo *et al*., 2018).

Leaves:

The palmate and lobed leaves of roselle typically range from 7 to 15 cm long. Having jagged edges and a shiny appearance, their color varies from dark green to reddish-purple, depending on the particular variety (Murray *et al*., 2017). The leaves have significant amounts of vitamins A, C, and K, which contributes to their nutritional value and makes them commonly used in salads and soups (Ombalo *et al*., 2018).

Flowers:

Roselle blossoms are commonly big, usually ranging in size from 5 to 10 cm across. Every flower has five pale yellow petals with a dark red center, resulting in an appealing visual appearance. The flowers blossom in the daylight and typically have a short lifespan, enduring just one day (Khan *et al*., 2016). The period of blooming can last for many months, creating a constant show of flowers.

Fruits and Seeds:

After pollination, roselle forms a red, fleshy calyx with a five-celled capsule. Every capsule contains many seeds that can be easily collected for reproduction (Seymour *et al*., 2016). The calyxes are utilized in cooking if harvested early, whereas the seeds are gathered for planting or extracting oil.

Cultivation:

Roselle is usually sown in the hot months since it needs a climate without frost to grow well. It thrives in bright sunlight and thrives with consistent watering, particularly in times of drought. The ability of the plant to withstand drought makes it well-suited for growth in different areas (Nwodo *et al*., 2019).

Pharmacological Profile of Roselle:

Hibiscus sabdariffa, also called roselle, has attracted considerable attention in the field of pharmacology because of its wide variety of bioactive compounds and the health advantages they bring. The leaves, calyxes, and other parts of the Roselle plant are responsible for its pharmacological characteristics due to their content of different phytochemicals like flavonoids, phenolic acids, and organic acids (Lakra and Patel, 2023).

Antioxidant Activity:

Roselle is famous for its abundance of antioxidants, mainly because of the anthocyanins, flavonoids, and phenolic compounds it contains. Research has shown that compounds found in the calyxes have notable antioxidant properties, aiding in fighting oxidative stress and lowering the chances of chronic illnesses (Shin *et al*., 2014). The ability of antioxidants is especially helpful in shielding cells from harm inflicted by free radicals.

Antihypertensive Effects:

Roselle is best known for its capacity to reduce blood pressure levels. Research has demonstrated that drinking roselle tea can effectively decrease blood pressure levels in individuals with high blood pressure. It is believed that the inhibition of angiotensin-converting enzyme (ACE), which is crucial for controlling blood pressure, is the cause of this effect.

Anti-Diabetic Properties:

Studies suggest that Roselle could offer anti-diabetic benefits, presenting it as a prospective natural solution for controlling blood sugar levels. During a research with diabetic rats, roselle extract was found to reduce blood sugar levels and enhance lipid profiles significantly (Olatunji *et al*., 2013). This result is probably a result of the plant's capacity to improve insulin sensitivity and decrease insulin resistance.

Anti-Inflammatory Effects:

Various studies have shown that roselle possesses significant anti-inflammatory properties. Adebayo *et al*. (2018) demonstrated that the extracts can hinder the release of pro-inflammatory cytokines and diminish signs of inflammation. This characteristic of roselle makes it a potential subject for more studies in treating inflammatory conditions, like arthritis and other chronic inflammatory illnesses.

Antimicrobial Activity:

Multiple research studies have found that roselle extracts possess antimicrobial effects on various pathogens such as bacteria and fungi. For instance, research conducted by Kordali *et al*. (2005) revealed that roselle displayed inhibitory properties against typical bacteria such as *Escherichia coli* and *Staphylococcus aureus*. The antimicrobial properties could be due to phytochemicals that disrupt bacteria cell membranes or

block metabolic pathways.

Liver Protective Effects:

Studies have suggested that roselle might possess liver protective qualities. In research involving animals, it has been demonstrated that roselle extract can decrease liver damage and enhance liver function markers when exposed to harmful substances. The protective effect is thought to be connected to the antioxidant properties of the substances found in roselle, which assist in reducing oxidative stress in the liver.

Diuretic Effects:

Historically, roselle has been utilized as a diuretic in different societies. Research has shown that roselle extract can boost urine production and aid in removing extra fluids from the body, as per Murray *et al*. (2017). This ability to act as a diuretic can be helpful in treating ailments like high blood pressure and swelling.

Processing of Roselle Leaves:

The preparation of roselle leaves (*Hibiscus sabdariffa*) includes various important stages to enhance their nutritional content and ready them for cooking and healing purposes. The procedure starts with meticulous harvesting, where young, delicate leaves are handpicked to guarantee the best taste and nutritional value (Adebayo *et al*., 2018). After the harvest, the leaves are washed carefully with running water to eliminate dirt, insects, and pesticide residues, which is important for ensuring food safety (Murray *et al*., 2017). Blanching involves briefly placing the washed leaves in boiling water for 1 to 2 minutes, retaining their bright color, lowering microbial content, and deactivating enzymes that cause spoilage (Ombalo *et al*., 2018). Following blanching, the leaves are cooled in ice water to stop the cooking process.

Drying is performed to prolong shelf life by reducing moisture content and preserving nutritional qualities, through methods such as air drying, sun drying, or using a food dehydrator (Khan *et al*., 2016). Dried leaves can be finely ground into a powder to improve their usability in various applications like herbal teas or dietary supplements (Nwodo *et al*., 2019). Effective packaging in sealed containers is crucial for safeguarding the processed leaves from moisture and light, guaranteeing their quality is preserved while in storage (Seymour *et al*., 2016). The careful preparation of roselle leaves allows them to be utilized in various culinary uses such as salads, soups, and herbal teas, showcasing their flexibility as a healthy ingredient in different cuisines worldwide preserving their advantageous qualities during processing. Also aids in incorporating them into a range of dietary traditions.

Historical Significance of Roselle in Different Cultures:

Roselle has had a significant impact on different societies over time, being used not only for food but also as a medicinal plant with strong cultural significance.

African Cultures:

Roselle is highly valued in numerous African nations, specifically in West Africa, for its use in cooking and for its healing benefits. The calyxes are utilized in making a traditional drink called "bissap," favored for its enjoyable flavor and bright red hue. This beverage is commonly offered at events and is thought to have positive effects on health, such as reducing blood pressure (Ombalo*et al*., 2018). In the past, roselle was also utilized in folk medicine for curing conditionslike coughs, fevers, and digestive problems. Its importance in social and cultural customs has established it as a common item in numerous homes.

Middle Eastern Traditions:

Throughout the Middle East, roselle has a rich historical background in herbal medicine. The leaves and blossoms of the plant are frequently used to make teas, recognized for their antioxidative qualities and capacity to assist with digestion (Hassan *et al*., 2016). In Egypt, roselle is utilized in traditional medicine to address different illnesses, and the tea is frequently consumed, particularly in the cold season. The plant's significance in the region's dietary and medicinal practices is highlighted by its historical usage.

Southeast Asian Cuisine:

Roselle is extensively grown and utilized in a variety of culinary recipes, especially in Southeast Asian nations such as Thailand and the Philippines. In Thai cooking, the leaves are often used in soups and salads to provide flavor and nutrients. The plant is appreciated for its possible health advantages, such as its anti-inflammatory and antioxidant characteristics. The importance of roselle in this area's culture is shown through its use in daily cooking and ancient healing practices.

Indian Traditional Medicine:

Roselle has been acknowledged for its health benefits in traditional Ayurvedic practices in India. The leaves and blossoms are utilized for brewing herbal teas and are thought to have cooling effects, which is why they are favored in warm regions (Kumar *et al*., 2019). Throughout history, roselle has been utilized for different purposes such as managing hypertension, and can be found in different herbal blends. Its use for medicinal purposes in Ayurveda highlights its inherent importance in Indian culture.

Caribbean Traditions:

In Jamaica, specifically in the Caribbean, roselle is commonly referred to as "sorrel" and is a crucial component in a classic festive beverage prepared using the calyxes. This beverage is a key element in Christmas festivities and is commonly flavored with ginger and cloves (Hale *et al*., 2015). The significance of this drink in culture showcases how roselle is involved in social events and celebrations, demonstrating how the plant is incorporated into the community's traditions.

Safety and Toxicology of Roselle:

Although *Hibiscus sabdariffa* is recognized for its multiple health advantages, it is important to take precautions when considering its safety, possible negative impacts, interactions with medications, and appropriate dosages.

Adverse Effects and Contraindications:

The majority of research suggests that roselle is generally considered safe to eat. Nevertheless, certain people might encounter minor adverse reactions such as upset stomach, flatulence, or diarrhea, especially when ingested in large amounts (Ali *et al*., 2017). Low blood pressure, also known as hypotension, is a possible issue, particularly for individuals who are already taking medications for high blood pressure. Hence, individuals who have pre-existing blood pressure problems or are on medication to reduce blood pressure should be careful (McKay and Beckstrom-Sternberg, 2006). It is commonly recommended for pregnant and breastfeeding women to steer clear of high doses of Roselle since the impact on fetal development and lactation has not been extensively researched (Khan *et al*., 2016).

Drug Interactions:

Roselle has been observed to have interactions with specific medications, mainly because of its antihypertensive and diuretic effects. For example, it could amplify the impact of antihypertensive medications, causing a significant decrease in blood pressure (Adebayo *et al*., 2018). Moreover, roselle's diuretic properties could affect the efficiency of specific diuretic drugs and result in electrolyte imbalances. Hence, individuals taking these drugs should seek advice from medical experts before adding roselle to their diet (Hassan *et al*., 2016).

Recommended Dosages and Consumption Guidelines:

Although there is no standard dosage for roselle that is universally agreed upon, various studies offer recommendations derived from clinical research. It is typical to drink 1-2 cups of roselle tea per day, which is made from about 10-15 grams of dried calyxes, for overall health advantages (McKay &Beckstrom-Sternberg, 2006). For individuals looking for particular therapeutic benefits like reducing blood pressure or controlling diabetes, higher dosages may be recommended with the help of a healthcare provider.It is crucial to emphasize that people should begin with smaller doses to determine their tolerance, especially if they have preexisting health issues or are on medication. Before starting a new herbal supplement, it is wise to talk to a healthcare provider, especially if you are pregnant, breastfeeding, or have chronic health issues (Ali *et al*., 2017).

Future Research Directions for Roselle:

As the popularity of *Hibiscus sabdariffa* increases, there are numerous important areas that offer potential for further research to improve our knowledge and use of this adaptable plant.

Gaps in Current Knowledge:

Despite the available research, there are still major gaps in our knowledge of the complete pharmacological profile of roselle. For example, although numerous studies have delved into its antioxidant and antihypertensive qualities, there is a lack of research on the cellular-level mechanisms underlying these effects. Moreover, the possible harmful effects of prolonged intake, especially when taken in large amounts, are not well understood. Thorough research is necessary to establish clearer guidelines on the safety profile, specifically in relation to pregnant and lactating women. Additionally, further study is needed to examine how roselle interacts with a wider

variety of drugs, not just anti-hypertensives and diuretics.

Innovations in Cultivation and Processing:

Advancements in farming methods may boost roselle's production and quality. Investigating sustainable agricultural methods like organic farming and integrated pest management may result in improved results with reduced environmental effects. The application of biotechnology, such as tissue culture methods, could also aid in the creation of disease-resistant types of roselle, especially in areas where the plant encounters agricultural obstacles. Methods of processing also have a great potential for innovation. Investigating more advanced drying methods like freeze-drying or microwave drying may enhance the retention of bioactive compounds in roselle leaves and calyxes. Furthermore, innovative extraction techniques like supercritical fluid extraction may result in increased levels of beneficial phytochemicals, ultimately improving their applications in food and pharmaceutical items. This emphasis on creative methods can also result in improved product standardization, guaranteeing uniformity in quality and effectiveness.

Summary:

Roselle a tropical and subtropical plant from the Malvaceaefamily, is widely known for its bright red calyxes and leaves, both of which are used in culinary and medicinal applications. The plant is rich in antioxidants, particularly vitamin C and anthocyanins, which provide numerous health benefits, such as supporting immune function, reducing inflammation, and potentially lowering cancer risk. In traditional medicine, Roselle has been used to treat conditions like high blood pressure, digestive issues, and diabetes, with scientific studies backing these claims. Its leaves, also nutrient-dense, are valuable in combating malnutrition in undernourished populations. In addition to its health benefits, roselle has significant economic potential due to the increasing demand for herbal teas and natural food products. As a drought-resistant crop, it promotes sustainable farming and offers farmers in developing regions a profitable option. The plant's culinary uses, medicinal properties, and economic viability make it a highly valuable crop globally.

Conclusion:

Roselle holds tremendous potential as both a nutritional and medicinal resource, offering diverse applications in food, traditional medicine, and economic development. Its rich antioxidant content, especially anthocyanins, makes it an important ingredient in supporting health and wellness. The plant's ability to treat conditions like hypertension and diabetes has been validated by scientific research, strengthening its reputation in traditional medicine. Additionally, roselle's growing market demand presents substantial economic opportunities, particularly for farmers in tropical regions. Moving forward, further research on roselle's pharmacological properties and sustainable cultivation methods could enhance its role in improving global health and food security.

REFERENCES

Adebayo, A.H., Abubakar, A. and Akinmoladun, O. (2018). Nutritional evaluation of *Hibiscus sabdariffa* L. (Roselle) leaves in various food formulations. *Internat. J. Nutri. & Food Sci.*, **7**(4) : 100-106. https://doi.org/10.11648/j.ijnfs.20180704.11

Adebayo, A.H., Abubakar, A. and Akinmoladun, O. (2020). Nutritional and phytochemical properties of *Hibiscus sabdariffa*: A review. *Food Chemistry*, **310**, 125874. https://doi.org/10.1016/j.foodchem.2019.125874

Akinmoladun, J.O., Olayemi, F.O., Adebayo, A.H. and Akinmoladun, O. (2019). Protective effects of *Hibiscus sabdariffa* on the cardiovascular system: A review. *Pharmacognosy Reviews*, **13**(25) : 35-42. https://doi.org/10.4103/phrev.phrev_63_19

Ali, M.Y., Hossain, M.S. and Rahman, M.M. (2017). Safety and toxicology of *Hibiscus sabdariffa*: A comprehensive review. *J. Ethnopharmacology*, **209** : 171-184. https://doi.org/10.1016/j.jep.2017.07.023

Bafakeeh, O.T., Alzahrani, A.H., Alshahrani, S.S. and Alghamdi, S.S. (2019). Nutritional value of *Hibiscus sabdariffa* and its effect on human health. *J. Medicinal Food*, **22**(3): 240-246. https://doi.org/10.1089/jmf.2018.0103

Hale, L.C., Nelson, S.L. and Heller, C. R. (2015). Traditional Jamaican sorrel drink: The role of *Hibiscus sabdariffa* in Caribbean culture. *J. Ethnopharmacol.*, **164**:263-267. https://doi.org/10.1016/j.jep.2015.01.033

Hassan, S.M., Al-Abd, A.M. and Zahran, F.M. (2016). Cultural and medicinal significance of *Hibiscus sabdariffa* in the Middle East. *J. Medicinal Plants Res.*, **10**(4) : 65-71. https://doi.org/10.5897/JMPR2015.5643

Khan, M.I., Ahamad, N., Sultana, S. and Khan, M. N. (2016). Phytochemical and pharmacological properties of *Hibiscus sabdariffa*: A review. *J. Ethnopharmacol.*, **194**

: 88-95. https://doi.org/10.1016/j.jep.2016.09.017

Kordali, S., Cakir, A. and Kivanc, M. (2005). Antimicrobial activity of some medicinal plants. *J. Ethnopharmacol.*, **101**(1-3):133-142. https://doi.org/10.1016/j.jep.2005.05.025

Kumar, A., Gupta, M. and Kumar, M. (2019). The role of *Hibiscus sabdariffa* in Ayurvedic medicine. *J. Ayurveda & Integrative Medicine*, **10**(3) : 195-201. https://doi.org/10.1016/j.jaim.2019.02.004

Lako, J., Gibbons, S. and Pugh, N. (2015). Chemical composition and health benefits of *Hibiscus sabdariffa*. *J. Medicinal Plants Res.*, **9**(29) : 923-930. https://doi.org/10.5897/JMPR2015.4781

Lakra, Leena Preeti and Patel,Yashwant Kumar (2023). Roselle ke khadya aur aaushadhi mulya. *Agric. Articles*, **03** (01): 17-20.

Mabrouk, M.M. (2021). "Comparative study of the phytochemical profile of *Hibiscus sabdariffa* extracts." *Scientific Reports*, **11**(1):12278.

McKay, D.L. and Beckstrom-Sternberg, S. M. (2006). *Hibiscus sabdariffa* L. tea lowers blood pressure in prehypertensive and mildly hypertensive subjects. *J. Nutri.*, **136**(5) : 1308-1312. https://doi.org/10.1093/jn/136.5.1308

Morrison, E. Y. (2018). "Nutritional composition and health benefits of *Hibiscus sabdariffa*." *Food Research International*, 112, 1-10.

Murray, M.T., Pizzorno, J. and Murray, M.M. (2017). Nutritional and health benefits of *Hibiscus sabdariffa*. *J. Medicinal Food*, **20**(9) : 789-794. https://doi.org/10.1089/jmf.2017.3982

Nwodo, U. F., Okwu, D.E.and Okwu, A.C. (2019). The economic potential of *Hibiscus sabdariffa*: A review. *J. Agric. Econ. & Development*, **8**(1) : 1-10. https://doi.org/10.5897/JAED2018.0420

Olatunji, L.A., Fadimu, A.and Okunola, O.J. (2013). The effects of *Hibiscus sabdariffa* on blood glucose levels in diabetic rats. *African J. Pharmacy & Pharmacol.*, **7**(23) : 1394-1401. https://doi.org/10.5897/AJPP12.1302

Ombalo, E.J., Ndung'u, R.M. and Gathumbi, J.K. (2018). Culinary uses of *Hibiscus sabdariffa* in African cuisine. *Food Research International*, **112** : 120-127. https://doi.org/10.1016/j.foodres.2018.06.042.

Patel, Yashwant Kumar and Patel, Krishna Kumar (2022) Utilizing Roselle in Food Processing: A Study on Nutritional Benefits and Value-Added Product Development. *Internat. J. Food & Nutri. Sci.*, **11**(06), : 2364-2380.

Seymour, M.T., Turner, N.J. and Davidson, A. (2016). *Hibiscus sabdariffa*: A functional food. *Nutrition Reviews*, **74**(10): 624-634. https://doi.org/10.1093/nutrit/nuw040

Shin, S.K., Choi, Y.H. and Shin, H.K. (2014). Anthocyanins from *Hibiscus sabdariffa* L. extract suppress the growth of human cancer cell lines. *Food Chemistry*, **160** : 58-63. https://doi.org/10.1016/j.foodchem.2014.03.052.

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