Food and Medicinal Values of Roselle (Hibiscus sabdariffa L. Linne Malvaceae) Plant Parts: A Review

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Abstract
Roselle/Mesta plant (Hibiscus sabdariffa L. Linne Malvaceae) was selected for its being large concentration point in relation to research advances on food and medicinal values. Data were collected from different print media like different annual reports and national and international journals during the year 2018 at Agronomy Division, Bangladesh Jute Research Institute (BIRI), Dhaka. So many Roselle crop varieties developed, released and used at farm level for commercial cultivation. All those varieties leaves and calyces have both vegetable and medicinal values. These are used fresh for making wine, juice, jam, jelly, syrup, gelatin, pudding, cakes, ice cream and flavors and also dried and brewed into tea, spice, and used for butter, pies, sauces, tarts, and other desserts. The roasted seeds can be used as a coffee substitute. The young root is edible, but very fibrous. The leaves are antiscorbutic, emollient, diuretic, refrigerant, and sedative. The fruits are antiscorbutic. The flowers contain gossypetin, anthocyanin, and the glycoside hibiscin. The ripe calyces are diuretic and antiscorbutic. The plant is also reported to be antiseptic, aphrodisiac, astringent, cholagogue, demulcent, digestive, purgative and resolvent. Medicinal plants as natural antimicrobial agents are gaining popularity. Roselle plant has been used in folk medicine as a diuretic, mild laxative, and treatment for cardiac and nerve diseases. In future, controlled studies are required to prove the effectiveness of different parts of Roselle under the various conditions.

Keywords: Roselle/Mesta; Leaf; Flower; Calices; Seed; Root; Food (Jam, Jelly, Syrup, Tea); Medicine (Antioxidant, Antihypertensive, Antimicrobial, Anticancer properties)

Introduction
Roselle is the most common name used specifically for Hibiscus sabdariffa var. Altissimo Hort, both for plant and fiber, although the edible Hibiscus sabdariffa L. is called Roselle. Other common names for the plant and fiber include: Kenaf in most countries; Mesta, Roselle, hemp, and pusa or pusa hemp in India; Kasi gogu in Andhra Pradesh, India; Roselle in Indonesia; Siam jute and paw keo in Thailand; voam bombazaha in Madagascar; azedinha, Curura-de-guine, and quiaoboroze in Brazil; and Oiselle-de-Guinee in West Africa. Roselle is a short day, annual herbaceous, bast fiber-bearing plant belonging to the Malvaceae family. The subspecies is the most economically important member of the genus Hibiscus in terms of fiber production. It is closely related to Kenaf (Hibiscus cannabinus L.) and okra (Hibiscus esculentus L.), young seed pods of the latter being widely used for food in many temperate, subtropical and tropical continuous. The plant reaches to about two meters in height, has beautiful bright white to pale yellow flowers and a stout fleshy and bright red as the fruit matures. Roselle is famous for producing edible calyx that can be used in beverages. The calyx is the red colored pointed pods found on the hibiscus that protect and support the hibiscus plant. It tastes sweet and should be picked 10 to 15 days after they lose its blooms, or else it will taste more tart [1,2].

Roselle plant, with an attractive flower believed to be native to Africa, is cultivated in Sudan, India, Malaysia and Taiwan. It is an annual or perennial herb or woody-based sub-shrub, growing to 2 m to 2.5 m tall. The leaves are deeply 3 to 5 lobed, 8 cm to 15 cm long, arranged alternately on the stems. The flowers are 8 cm to 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 cm to 2 cm wide, enlarging to 3 cm to 3.5 cm, fleshy and bright red as the fruit matures. It takes about six months to mature. In some places, the plant is primarily cultivated for the production of bast fiber from the stem of the plant. The fiber may be used as a substitute for jute in making burlap. The red calyces of the plant are used as food colorings and dyes [3]. Today, Roselle is attracting the attention of food and beverage manufacturers and pharmaceutical concerns who feel it may have exploitable possibilities as a natural food product for herbal medicine and as a colorant to replace some synthetic dyes.

The most scientifically studied claim is the use of Roselle tea to positively affect blood pressures and cholesterol and prevent cardiovascular disease. Some of the other less-researched health benefits of Roselle tea include assisting in digestion, strengthening immunity, working as an anti-inflammatory agent, and reducing the risk of cancer. Roselle tea is also rich in vitamin-C, minerals and various antioxidants, while also helping in the treatment of hypertension and anxiety. Roselle tea can be made by steeping parts of the hibiscus plant in boiling water, particularly the calyx. It has distinct maroon color along with sweet and tart flavor similar to that of cranberries. It can be enjoyed both hot and cold depending on your preferences like most other teas [4].
Kenaf/Mesta Cultivation: Area under Mesta & Kenaf in Bangladesh: 34,000 ha (Kenaf - 19,611 ha & Mesta - 14,489 ha) (Figure 1).

**Origin of Hibiscus sabdariffa**

There is a big argument about the origin of Roselle among different scholars. Cobley [1], suggested Roselle is a native plant of West Africa and from there it was carried to other parts of the world such as Asia and America, whereas in others opinion, Roselle was originated from India [5].

**Description of Hibiscus sabdariffa**

Hibiscus has more than three hundred species distributed in tropical and subtropical regions around the world and are used as ornamental plants. Research on have shown that some species of Hibiscus possess certain medicinal properties of which Hibiscus sabdariffa is one [6]. H. sabdariffa is commonly named as “red sorrel” or “Roselle”. Even though permeable soil is the best, Roselle can adapt to a variety of soil in a warmer and more humid climate [7,8]

H. sabdariffa, a member of Malvaceae family, is a known medicinal plant with a worldwide fame [9] and the plant can be found in almost all warm countries such as India, Saudi Arabia, Malaysia, Indonesia, Thailand, Philippines, Vietnam, Sudan, Egypt and Mexico [3,7,10]. Roselle is mainly cultivated to be consumed and the main producers Thailand, Philippines, Vietnam, Sudan, Egypt and Mexico [3,7,10]. Roselle is cultivated in tropical and subtropical regions around the world and are used as ornamental plants. Roselle is a native plant of West Africa and from there it was carried to other parts of the world such as Asia and America, whereas in others opinion, Roselle was originated from India [5].

**Materials and Methods**

The study was based on secondary information. The secondary data used were collected from different studies of the Library of Bangladesh Jute Research Institute, Dhaka during from January to November 2018. These secondary data were BJRI annual reports, different thesis, Books, Bangladesh Journal of Jute and Fiber Research, Jute and Jute Fabrics, Bangladesh (News letter) of BJRI and other national and international journals.

**Results and Discussion**

**Taxonomy**

A morphological description of the Roselle/Mesta is as follows: Stems are erect, solid, cylindrical, unbranched, mostly bristled, rarely glabrous, green, red, or regimented in various shades, reaching a height of 1 m to 5 m.

Leaves are simple on young plants, later becoming lobed alternate, stipulate, stipules free lateral, 0.5 cm to 1.0 cm long, green or red. Petiole 4 cm to 14 cm long, green to red, pubescent on the abaxial surface and densely bristled or sparsely hairy on the abaxial surface, green to deep and red, scabrous or smooth. Lamina are mostly 3 to 5, deeply palmately lobed, each lose ovate to oblong lanceolate, margin serrulose, apex-acute, pubescent and bristled along the veins on both the surface, scabrous or scaberulous, green to red, one green gland present in the mid vein on the undersurface. Flowers solitary, axillary, pedunculate, peduncle 0.2 cm to 0.4 cm long, bristled, pentameros, completely yellow or yellow with red center, when open 3.0 cm to 5.0 cm in diameter, bracteoles (epicalyx) 8 to 10, short ovate, bristled, 0.5 cm to 0.7 cm long, green or red, persistent, attached to the base of the calyx [4].

Calyx, sepal 5, lanceolate, connate bellow the middle in to a cup, 1.5 cm to 2.0 cm lobes 1.5, 1.5 to 2.0 times the length of the cup, bristled slightly tomentose, gland not prominent, persistent.

Corolla large, preading, bell-shaped, full-yellow or yellow with deep red center, petals 5, free, twisted, outside pubescent and with glandular hairs in the inner portion, 3 cm to 5 cm long.

Stamens many, monadelphous, staminal column epipetrous, truncate, 1.0 cm long, with glandular hairs, yellow or red, filaments 0.1 cm to 0.2 cm long, yellow to red anthers reinform, pollen spiny. Carpels 5, ovary ovoid 0.3 cm to 0.4 cm long, broadly globular ovoid, with dense silky hairs, 5 chambered with many ovules in each chamber arranged in 2 to 3 rows, stigma 5, hairy, capitate, red or yellow exerted.

Capsule ovoid, pointed densely villose with about 30 to 40 seeds. Seeds reinform, smaller than those of Kenaf reddish brown with many small yellowish brown warty spots. Hilum reddish brown, relatively long seed average, 60000 per kg (Figure 2) [4].

**Propagation of Roselle**

Seed sow early spring in a warm greenhouse. Germination is usually fairly rapid. Prick out the seedlings into individual pots when they are large enough to handle. If growing them as annuals, plant them out into their permanent positions in early summer and protect them with a frame or cloche until they are growing away well. If hoping to grow them as perennials, then it is better to grow them on in the greenhouse for their first year and to plant them out in early summer of the following year. Cuttings of half-ripe wood, July/August in a frame. Overwinter them in a warm greenhouse and plant out after the last expected frosts (Figure 3).

**Identifying characters of different Mesta varieties developed by BJRI**

**Mesta variety (Hibiscus sabdariffa L.):**

Variety HS-24 (Tani mesta): Variety HS-24 was released
in 1977 developed by pure line selection. Its stem green with nods purple, pigmented leaves fine lobed, petiole is smaller than lamina. Leaves 5 lobed with lanceolate segments which are serrated, central lobe longest, leaf lobed dark green with veins and margins purple, rough, sepals light green with purple spots at maturity, petals yellow with crimson red at the inner basal portion, fruits capsule ovoil hairy, dehiscent seeds dull brown reniform. High land (Less fertile) is suitable for cultivation. Seed sowing time mid February to mid May. Seed rate 12 to 18 kg/ha. Plant height 4.00 m to 6.00 m. Fiber recovery 6.23%. Time of flowering 190 to 210 days after sowing. Time of harvest 120 to 130 days after harvest or as per need. Yield 2.00 to 2.70 t/ha at Research station. This variety is suitable for high, less fertile and drought affected land. After harvest T. aman can be grown. Resistant to root-knot nematodes (Figure 4) [4].

**BJRI Mesta-2 (VM-1):** BJRI Mesta-2 (VM-1) was released in 2010 developed by pure line selection. Its stem red with nods purple, pigmented leaves fine lobed, Long petiole similar as lamina. Leaves 3 lobed with lanceolate segments which are serrated, central lobe longest, leaf lobed dark green with veins and margins purple, rough, sepals light green with purple spots at maturity, petals yellow with crimson red at the inner basal portion, fruits red and cone type. Plants are bushy in type. High land (Less fertile) is suitable for cultivation. Seed sowing time 15th April to 30th June. Seed rate 12 to 18 kg/ha. Plant height 1.00 m to 1.50 m. Time of flowering 180 to 200 days after sowing. Time of harvest from 60 days to onward for fruit or as per need. Red colored fruit yield 2.00 to 2.50 t/ha and leaf 6.0 to 7.0 t/ha at Research station. This variety is suitable for high, less fertile and drought affected land. Could produced 20% edible oil from seeds, Resistant to draught and root-knot nematodes (Figure 5) [4].

**BJRI Mesta-3 (SAMU’93):** BJRI Mesta-3 (SAMU’93) was released in 2017 developed by pure line selection. Its stem green with nods purple, leaves green and fine lobed, long petiole than lamina. Leaves 5 lobed with lanceolate segments which are serrated, central lobe longest, leaf lobed dark green with veins, fine, sepals light green with purple spots at maturity, petals yellow with crimson red at the inner basal portion, fruits capsule ovoil hairy, dehiscent seeds dull brown reniform. High land (Less fertile) is suitable for cultivation. Seed sowing time 15th March to 15th May. Seed rate 12 to 18 kg/ha. Plant height 4.00 m to 5.00 m. Time of flowering 180 to 210 days after sowing. Time of flowering 190 to 210 days after sowing. Time of harvest 120 to 130 days after harvest or as per need. Yield 2.50 to 2.80 t/ha at Research station. This variety is suitable for high, less fertile and drought affected land. Quick growing and resistant to root-knot nematodes (Figure 6) [4].
Different uses of Mesta/Roselle

**Nutritional uses of Roselle:** The fresh calyx (the outer whorl of the flower) is eaten raw in salads, is cooked and used as a flavoring in cakes etc and is also used in making jellies, soups, sauces, pickles, puddings etc. The calyx is rich in citric acid and pectin and so is useful for making jams, jellies etc. It is also used to add a red color and to flavor to herb teas, and can be roasted and used as a coffee substitute. A refreshing and very popular beverage can be made by boiling the calyx, sweetening it with sugar and adding ginger. Tender young leaves and stems - raw or cooked. Used in salads, as a potherb and as a seasoning in curries, they have an acid, rhubarb-like flavor. Seed - the dried and make into a powder then can use in oily soups and sauces. The oven dried seeds have been used as a coffee substitute as aphrodisiac properties. Root- also edible however very fibrous. Mucilaginous, without flavor. The seed has 20% oil content [12].

**Nutritional value:** Many parts of Roselle including seeds, leaves, fruits and roots are used in various foods. Among them, the fleshy red calyces are the most popular. They are used fresh for making wine, juice, jam, jelly, syrup, gelatin, pudding, cakes, ice cream and flavors and also dried and brewed into tea, spice, and used for butter, pies, sauces, tarts, and other desserts. The calyces possess pectin that makes a firm jelly. The young leaves and tender stems of Roselle are eaten raw in salads or cooked as greens alone or in combination with other vegetables and/or with meat. They are also added to curries as seasoning. They have an acid, rhubarb-like flavor. The seeds, are high in protein, can be roasted and ground into a powder then used in soups and sauces. The roasted seeds can be used as a coffee substitute. The young root is edible, but very fibrous (Table 1) [12].

The nutritional analysis of Roselle plant by proximate method found the carbohydrate content (68.7%) was highest followed by crude fiber (14.6%) and ash content (12.2%) and others [13]. The plant is also found to be rich in minerals especially potassium and magnesium. Vitamins (ascorbic acid, niacin and pyridoxine) were also present in appreciable amounts. Various workers reported variable content suggesting that the type of soil influences its ash and mineral content causing variations within the same species [14-18]. It has long been used in herbal tea to treat hypertension, pyrexia and liver damage although the pharmaceutical components are poorly defined [19]. Choi and Mason [20], reported that nutritional studies have indicated that low consumption of fruits and vegetables is consistently related to an increased incidence of cancer reflecting dietary habits (Figure 7).

**Medicinal use of Roselle:** Roselle is an aromatic, astringent, cooling herb that is much used in the Tropics. It is said to have diuretic effects, to help lower feeders and is antiscorbutic. The leaves showed antiscorbutic, diuretic, emollient, sedative and refrigerant. The leaves tastes very mucilaginous and used as emollient and use to cough remedy. The fruits showed antiscorbutic effect. The flowers contain gossypetin, glycoside hibiscin and anthocyanin. These might to cough remedy. The fruits showed antiscorbutic effect. The flowers showed antiscorbutic, diuretic, emollient, sedative and refrigerant. The leaves, are rich in minerals, amino acids, organic acids, carotene, vitamin C and total sugar in its calyx, seeds and leaves at different levels depending on the variety and geographical area. Roselle has flavonoids, anthocyanidins, triterpernoids, steroids and alkaloids. Nutrient contents of different part of H. sabdariffa per 100 g are as follows in Table 2.

**Different medicinal properties:**

**Antimicrobial properties:** Roselle is widely used for the treatment of diseases. Olaleye [28] used the aqueousmethanolic extract of Roselle and reported that the extract contained cardiac glycosides, flavonoids, saponins and alkaloids. It exhibited antibacterial activities against Staphylococcus aureus, Bacillus steatheromorphus, Micrococcus luteus, Serratia massences, Clostridium sporogones, Escherichia coli, Klebsiella, pneumoni, Bacillus cereus, Pseudomonas fluorosence. The results agreed the use of Roselle plant in the treatment of abscesses, bilious conditions, cancer and coughs in traditional medicine, and also suggested for possibility of isolating antibacterial and anticancer agents while the antimicrobial activity on Escherichia coli O157:H7. Salmonella enterica and Listeria monocytogenes isolates from food, veterinary, and clinical samples by Fullerton [29] indicated that Roselle extract was effective and suggested for application of extracts as potential antimicrobials in foods. The antibacterial effects of

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**Table 1:** Nutritional value per 100 g of Roselle.

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Roselle (Mesta) (raw)</th>
<th>Nutritional value per 100 g (3.5 oz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g)</td>
<td>2</td>
<td>28.9 mg (0%)</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>0.1</td>
<td>21.4 mg (1%)</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>10.2</td>
<td>25.5 mg (2%)</td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A (μg)</td>
<td>14 μg (2%)</td>
<td></td>
</tr>
<tr>
<td>Niacin (μg)</td>
<td>0.31 mg (2%)</td>
<td></td>
</tr>
<tr>
<td>Riboflavin (μg)</td>
<td>0.028 mg (2%)</td>
<td></td>
</tr>
<tr>
<td>Thiamine (mg)</td>
<td>0.011 mg (1%)</td>
<td></td>
</tr>
<tr>
<td>Trace metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>215 mg (22%)</td>
<td></td>
</tr>
<tr>
<td>Magnesium (mg)</td>
<td>51 mg (14%)</td>
<td></td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>37 mg (5%)</td>
<td></td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>6 mg (0%)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2:** Biochemical values of different parts of Roselle plant [10].

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Calyxes</th>
<th>Seeds</th>
<th>Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g)</td>
<td>0.07</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>0.1</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>10.2</td>
<td>25.5</td>
<td>25.5</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>17</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Thiamine (mg)</td>
<td>0.05</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>0.07</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Niacin (mg)</td>
<td>0.06</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>150</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>9</td>
<td>2.3</td>
<td>2.3</td>
</tr>
</tbody>
</table>
Roselle calyx aqueous and ethanol extracts and protocatechuic acid against food spoilage bacteria Salmonella Typhimurium DT104, E. coli O157:H7, Listeria monocytogenes, Staphylococcus aureus and Bacillus cereus were estimated by Chau et al. [30], and shown that the inhibitory activity in dose-dependent behavior against test bacteria in ground beef and apple juice and suggested that it might be potent agents as food additives for preventing contamination from those bacteria.

Antioxidant properties: Roselle-Hibiscus anthocyanins (HAs) which are a group of natural pigments existing in the dried calyx exhibited antioxidant activity and liver protection manner. HA antioxidant bioactivity in rat primary hepatocytes and hepatotoxicity was studied by [31]. The results revealed that HA’s, at the concentrations of 0.10 mg/ml and 0.20 mg/ml, significantly decreased the leakage of lactate dehydrogenase and the formation of malondialdehyde and the serum levels of hepatic enzyme markers (alanine and aspartate aminotransferase) significantly decreased and reduced oxidative liver damage. An antioxidant activity was also reported in cancerous cell lines [32]. McKay et al. [33], reported in his animal models that extracts of Roselle’s calyces have demonstrated hypcholesterolemic and antihypertensive properties. The antioxidant potential of three fractions of the ethanol crude extract (HS-C: chloroform soluble fraction; HS-E: ethyl acetate soluble fraction; HS-R: residual fraction) found from the dried flowers were evaluated for their capacity to quench free radicals and inhibiting xanthine oxidase (XO) activity [34]. HS-E showed the greatest capacity of scavenging free radical, and HS-C showed the strongest inhibitory effect on XO activity. Furthermore, antioxidant bioactivities of these crude extracts were investigated on rat primary hepatocytes. All fractions were found to inhibit significantly the Unscheduled DNA Synthesis (UDS). These results revealed that the dried flower extracts (HS-C and HS-E) protect rat hepatocytes from t-BHP-induced cytotoxicity and genotoxicity. The study on hepatoprotective and antioxidant effects on the Carbon rat hepatocytes from t-BHP-induced cytotoxicity and genotoxicity. Results revealed that the dried flower extracts protect significantly the Unscheduled DNA Synthesis (UDS). These studies showed that HS-C and HS-E showed the strongest inhibitory effect on XO activity. The study on hepatoprotective and antioxidant effects on the Carbon rat hepatocytes from t-BHP-induced cytotoxicity and genotoxicity. Results revealed that the dried flower extracts protect significantly the Unscheduled DNA Synthesis (UDS). These studies showed that HS-C and HS-E showed the strongest inhibitory effect on XO activity.

Anticancerous properties: Akim et al. [32], evaluated the antiproliferative activities of Roselle juice by using different cell lines like ovarian (Caov-3), breast (MCF-7, MDA-MB-231) and cervical (HeLa) cancer cell lines and found that it exhibited the strongest anti-proliferative potentiality towards the MCF-7 cancer cells. Using Roselle-antiochyanins (HA), the effects on human cancer cells (HL-60) studied and showed apoptosis of cells in a dose and time-dependent manner [36]. Hou et al. [19], reported the apoptosis of leukemia cells induced by anthocyanin was through reactive oxygen species mediated mitochondrial pathways. Protocatechuic Acid (PCA), a phenolic compound isolated from the dried flower, was found to inhibit the survival of human promyelocytic leukemia (HL-60) in a concentration and time dependent manner [34], and apoptosis was induced via reduction of retinoblastoma phosphorylation and down regulation of Bcl-2 protein expression [37]. The study revealed that cells underwent intranucleosomal DNA fragmentation and morphological changes characteristics of apoptosis while the action against gastric carcinoma cells by inducing apoptosis was through JNK/MAPK signaling pathways [38]. The methanolic extract of Roselle on seven cancer lines implied the AGS cancer cells being most susceptible in concentration-dependant form affecting both the intrinsic and extrinsic apoptotic routes [39].

Mohamed et al. [40], reported that the antioxidant potential of Roselle (Hibiscus sabdariffa L.) extracts was studied. Different plant organs, including seeds, stems, leaves, and sepals, were analyzed with respect to their water-soluble antioxidant capacity, lipid-soluble antioxidant capacity, and tocopherol content. The Roselle seeds are a good source of lipidsoluble antioxidants, particularly γ-tocopherol. Its seed oil was extracted and characterized, and its physicochemical parameters were reported: acidity, 2.24%; plopxide index, 8.63 meq/ kg; extinction coefficients at 232 (k232) and 270 nm (k270), 3.19 and 1.46, respectively. Oxidative stability, 15.53 h; refractive index, 1.477; density, 0.92 kg/L; and viscosity, 15.9 CP. Roselle seed oil belongs to linoleic/oelcic category, most abundant fatty acids being C18:2 (40.1%), C18:1 (28%), C16:0 (20%), C18:0 (5.3%), and C19:1 (1.7%). Sterols include β-sitosterol (71.9%), campesterol (13.6%), Δ-5-avenasterol (5.9%), cholesterol (1.35%), and clerosterol (0.6%). Total tocopherols were detected as an average concentration of 2000 mg/kg, including α-tocopherol (25%), γ-tocopherol (74.5%), and δ-tocopherol (0.5%). The global characteristics of Roselle seed oil suggest that it could have important industrial applications, adding to the traditional use of Roselle sepals in the elaboration of karkade drink.

Different physiological effect:

Effect on lipid metabolism: In a studied on hypertensive patients, the effect of Roselle on lipid profile, creatinine and serum electrolytes reported that the upward trend of total cholesterol and High Density Lipid (HDL) which is significant since HDL-Cholesterol is a protective factor for coronary heart diseases [41]. After consuming Roselle juice in different concentrations and durations, the changes of urine in normal patients which may help the treatment and prevention of renal stone disease, reported that a decrease of creatinine, uric acid, citrate, tartrate, sodium, calcium, phosphate and potassium however not oxalate in urinary excretion [42].

Antihypertensive effect: The consequence of hypertension is implicated in the development of cerebrovascular diseases, cardiac ischemia as well as cardiac and renal failure, and is now considered a global health problem. Faraji et al. [43], reported that the efficacy of aqueous extract in hypertensive human showed significant reduced pressure difference in both systolic and diastolic compared to control group. In another report found the decrease in systolic pressure significant, the diastolic pressure remained unchanged [33]. Studies were also conducted on rats and findings were supported the popular belief that Roselle extract contains antihypertensive constituents [44,45]. The anthocyanins extract investigated for its therapeutic efficacy, safety and tolerability along with antihypertensive drug captopril [46], lisinopril in humans found the results were comparable and suggested that the synergistic mechanism of diuretic and ACE inhibition results in exerting hypotensive effects [47,48].

Other uses of Roselle/Mesta: A strong fiber obtained from the stem (called rosella hemp) is used for various household purposes including making sackcloth, twine and cord. A yellow dye obtained from the petals of the flowers. The Roselle seed has 20% oil content.

Use as domestic animals' food for medicinal effect: A few studies were found in animals. In post weaning pig, Roselle extract as acidifiers has been found the ability to increase trypsin activity, improve feed conversion ratio (FCR) and fat digestibility [49]. The
effect of Roselle calyx in layer diets on egg production performance in the poultry, egg quality and Thiobarbituric Acid Reactive Substances (TBARS) value in plasma and yolk was studied to check the lipid per oxidation as a result of degradation of fats. Storage time of extract was found as an important factor to decrease egg quality and increase TBARS value in yolk. [50].

**Roselle’s Drink**

Roselle drink is caffeine free herbal drink from a special type of hibiscus, called *H. sabdariffa*. Specifically, the drink is made out of the dried fruit part, called calyx. It’s color is red and tastes like berries [51].

**Steps in preparation of Calyx Drink:**

a. First, collect the fruits and wash those clean, and then dry in air or dry in an oven with 70°C for 3 days.

b. Then peel off the calyx and store those in air-tight containers.

c. To make drink, simply take 2 g of the dried calyx, and crash them into small pieces using a wooden roller.

d. Then put those in a bag like tea bag or a net, bring out mug and then add 8 oz of boiling water and steep it for 2 to 4 min, if desired add sugar, or add other flavors of choice such as few drops of lemon juice.

e. We can also refrigerate the dried calyx and make Roselle iced drink.

**Future Approach**

Among the properties reported to date, its effect on lipid metabolism, antihypertensive action and apoptosis are largely studied. Some studies on its antimicrobial effects were also documented. The calyx of Roselle is rich in citric acid and pectin and so is useful for making jams, jellies etc. It is also used to add a red color and to flavor herb drinks, and could be roasted and used as a coffee substitute. It is found aromatic, astringent, cooling herb that much used in the Tropics. The leaves found antiscorbutic, emollient, diuretic, refrigerant, and sedative. The plant also reported to be antiseptic, aphrodisiac, astringent, cholagogue, demulcent, digestive, purgative and resolvent. It used as a folk remedy in the treatment of abscesses, urinary difficulties and strangury. Therefore, with many enriching chemical-biological knowledge from animal and human models using plant extracts, future studies with greater scientific robustness in terms of standardization of dose for its effectiveness, safety and tolerability will permit the formulation of safe, effective therapeutic herbal formulations which can be used as an acceptable source for curing many food and health issues and restoring general health.

**Conclusion**

There are so many Roselle crops varieties developed, released and used at farmer’s level for commercial cultivation. All those varieties leaves and calyces have both vegetable and medicinal values. The fleshy red calyces are the most popular. They are fresh used for making wine, juice, jam, jelly, syrup, gelatin, puddings, cakes, ice cream and flavors and also dried and brewed into tea, spice, and used for butter, pies, sauces, tarts, and other desserts. The roasted seeds can be used as a coffee substitute. The young root is edible, but very fibrous. Roselle is an aromatic, astrigent, cooling herb that is much used in the Tropics. The leaves are antiscorbutic, emollient, diuretic, refrigerant, and sedative. The fruits are antiscorbutic. The flowers contain gossypetin, anthocyanin, and the glycoside hibiscin. These may have diuretic and choleric effects, decreasing the viscosity of the blood, reducing blood pressure and stimulating intestinal peristalsis. The ripe calyces are diuretic and antiscorbutic. The plant is also reported to be antiseptic, aphrodisiac, astringent, cholagogue, demulcent, digestive, purgative and resolvent. It may reduce risk of cancer. Therefore Roselle leaves, fleshy red calyces, roots have great importance in terms of human nutrition and health care. In future, controlled studies are required to prove the effectiveness of different parts of Roselle under the various conditions.

**References**

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