



Health Benefits & Therapeutic Potential Of Roselle

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ABSTRACT

Hibiscus sabdariffa (HS), sometimes referred to as Roselle, has a long history of traditional applications and is well-known for a wide range of pharmacological characteristics, such as antibacterial, antihypertensive, and anti-inflammatory effects. This thorough analysis summarizes the body of research on the advantages of consuming HS or its constituents for health. Crucial domains of concentration encompass metabolic well-being, glucose regulation, and cholesterol management. Research has indicated diverse impacts on metrics like insulin sensitivity, lipid profiles, and fasting blood glucose. Additionally, Roselle demonstrates anti-inflammatory qualities, as demonstrated by its influence on inflammatory markers like MCP-1 and TNF- α . Furthermore, HS extracts have demonstrated strong antibacterial activity against a range of strains, suggesting a possible use in the treatment of urinary tract infections. Studies have also shown improvements in indicators such as blood urea nitrogen and creatinine levels, which may have positive effects on renal function. Our goal in writing this essay is to review the body of research regarding HS's health advantages.

INTRODUCTION

Since they offer humans their basic needs—food, clothing, shelter, and medicine—plants have played a significant part in human history. They serve as the cornerstone of the traditional medical system, which includes practices like Ayurvedic, Unani, and others that have been around for many years and continue to develop innovative treatments for humanity. For their basic medical needs, a sizable portion of the populace in developing nations uses medicinal herbs. The majority of people on the planet are starting to use traditional medicines because they are affordable, widely available, and have fewer negative health effects. To fully understand the enormous potential of medicinal plants employed in many traditional systems, there has been a global surge in concentration on plant study in recent years. Hibiscus sabdariffa, which is prized for its delicacy and medicinal qualities and offers numerous health benefits, is one of the many medicinal plants that have been researched and found to be effective phytochemical agents for treating a range of diseases(1). Two previous thorough reviews are available: [1] and (2) which emphasize Roselle's phytochemistry, medicinal characteristics, and ecological-botanical features. The impact of Hibiscus sabdariffa on hypertension (Wahabi et al. 2010) (3), hyperlipidemia, hypertension, and apoptosis (Nolasco-Hipolito et al. n.d.)(4), and hyperlipidemia and hypertension (Hopkins et al. 2013)(5) have all been the subject of additional systematic reviews. The usefulness of roselle in the management of hypertension was evaluated in a different systematic analysis of human clinical trials conducted by Walton et al. (Walton, Whitten, and Hawrelak 2016a) (6) (Morton, Miami, and Dowling Jr n.d.). Singh et al.'s (Khan 2017) review(7) concentrated on the dietary and medicinal advantages of Hibiscus sabdariffa. Herranz-López et al. (8) have conducted a new review that centres discusses how roselle polyphenols' multitargeted molecular effects affect the treatment of obesity. In their review, they pointed out that Virtual screening and epigenetic analysis are necessary to comprehend the

molecular mechanism of roselle polyphenols and the metabolites involved. The current review makes an effort to document the precise information on the roselle flower's calyces. It will also concentrate on the plant's medicinal applications, nutritional makeup, bioactive components, and traditional usage. To assist future research on the therapeutic applications of this plant and In order to provide evidence for its potential use as a functional food, the majority of pharmacological research on the roselle plant has been summarized.

BOTANICAL DESCRIPTION

Origin, dispersion, and physical features

Hibiscus is a popular flowering plant prevalent throughout many underdeveloped nations. Worldwide, tropical and subtropical regions are home to more than 300 species (Morton, Miami, and Dowling Jr., n.d.) (9). They originated in Malaysia (Mahadevan and Shivali, n.d.) (10), where they are widely cultivated and were initially brought to Africa. According to Ismail, Ikram, and Nazri (2008), it is grown in Sudan, Egypt, Nigeria, Saudi Arabia, Taiwan, the West Indies, and Central America (11, 12). Tribal people grow it extensively in the Indian states of Madhya Pradesh, Maharashtra, Orissa, West Bengal, Assam, Meghalaya, and Andhra Pradesh (Singh, Sureja, and Singh 2006)(13). In areas where English is the primary language, it is commonly referred to as "roselle." It goes by such names as "Bissap" in Senegal, "Jamaica in Mexico and Spain," "Congo" in France, "Wonjo" in the Gambia, "Zobo" in Nigeria, and "Karkade" in Egypt, Saudi Arabia, and Sudan(14, 15). On the Indian subcontinent, it is known as Indian sorrel, mesta, lal ambari, patwa, and amti (13, 16).

Hibiscus belongs to the family Malvaceae. It can grow up to 2.5 meters tall and is a woody-based sub-shrub or annual or perennial herb. The smooth, cylindrical red stems have alternating arrangements of strongly lobed, 5 palmately lobed, 15 cm long leaves (17). The auxiliary or terminal flowers have a 10 cm diameter, are white to pale yellow, and have a dark red spot at the base of each petal. At the base of the flowers is a sturdy, meaty calyx that is 1-2 cm wide at first, but grows to a 3-3.5 cm diameter as the fruit ripens. It takes about six months for maturation. Mid-April marks the start of the rainy season, and roselle is grown. It is picked for the fruit calyces approximately three weeks before the flowers begin to bloom (Gautam 2004; Singh, Sureja, and Singh 2006; El Naim and Ahmed 2010) (13, 16, 18).

PROXIMATE AND PHYTOCHEMICAL COMPOSITION OF HIBISCUS SABDARIFFA

Nutritional composition

As to Aurelio, Edgardo, and Navarro-Galindo (2008) (19), the calories of Carbohydrates, dietary fibre, protein, vitamins, minerals, and bioactive compounds are all rich in roselle. Research on the nutritional analysis of roselle plants (20) noted that the largest amount was that of carbohydrates (68.7%), followed by crude fibre and ash. The dry weight basis measurement of the roselle calyces' proximate makeup, was published by (21), and it included protein, fat, carbohydrates, fiber, and ash. Similar findings were observed by Adenipeku in a previous investigation. However, according to them, the normal literature values for fat, protein, and carbohydrates are (1.01%), (6.71%), and (68.75%), respectively. These variations were ascribed to the calyces' origins. More recently, Jabeur et al. (Jabeur et al. 2017) (22) revealed that Hibiscus sabdariffa included fructose, glucose, and fatty acids for the first time. Additionally, they reported that the most prevalent macronutrient was carbohydrate, followed by protein and fat. However, (Sáyago-Ayerdi et al. 2007) (23) found that the majority of the dietary fiber in roselle flowers was made up of insoluble substances, It accounts for the total amount of dietary fiber as soluble dietary fiber. This soluble dietary fiber has been linked to polyphenols, which have antioxidant properties and benefit colon health. Nutritionists have discovered that ascorbic acid, riboflavin, and niacin are among the vitamins that are abundant in roselle calyces (Morton, Miami, and Dowling Jr n.d.) (9). Niacin and pyridoxine are found in considerable amounts in the calyces of Hibiscus sabdariffa (Luvonga et al. 2010)(20). Roselle also contains α - and β -tocopherols, with the most prevalent isoform being α -tocopherol (22). There is also a significant concentration of minerals, including calcium, iron, potassium, and magnesium. Different ash and mineral content values were reported by various workers(24, 25). (Nolasco-Hipolito et al., n.d.)[4] proposed that the reason for these variations in values was that The kind of soil has an impact on the ash and mineral content within the same species.

According to Fernández-Arroyo et al. (2011) (26), Polyphenols abound in the calyces of roselle, especially anthocyanins, which are powerful antioxidants with hydrophilic qualities, such as cyanidin-3-sambubioside and delphi-nidin-3-sambubioside. (27), Additionally abundant in organic acids and polyphenolic acids (protocatechuic acid and hibiscus acid) are the roselle calyces. (citric, tartaric, malic, and malic acid). Because roselle calyces have a high nutritional content, They are suitable as an ingredient in functional foods as well as a standalone functional food.

According to Duke and Atchley (1984)(28), roselle leaves are an excellent source of protein, lipids, carbs, riboflavin, and iron. They are rich in polyphenolic chemicals, primarily in quercetin and kaempferol glycosides, which are isomers of chlorogenic acid and contribute to their anti-inflammatory and antioxidant

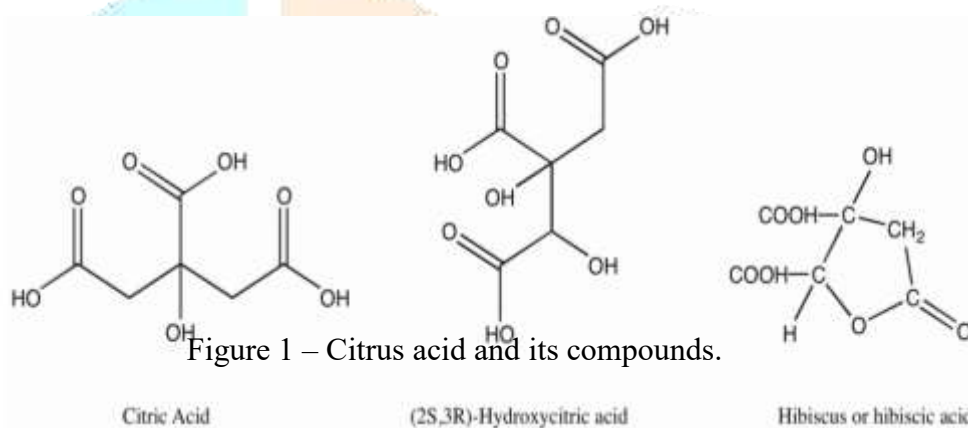
properties (29). Crude fatty oil, crude protein, carbohydrates, crude fiber, and ash can all be found in good amounts in roselle seeds. When it comes to minerals, potassium is the most common, followed by sodium, calcium, magnesium, and phosphorus. Oleic acid and linoleic acid are the main unsaturated fatty acids found in the seed oil, while palmitic acid and stearic acid are the predominant saturated fatty acids(30).

Bioactive components

Regarding the medicinal value of roselle, its main constituents are polysaccharides, flavonoids, mainly anthocyanins(31, 32). Phytosterols, polyphenols, anthocyanins, and other water-soluble antioxidants have been found in dried calyces extracts in addition to acidic organic substances (tartaric, oxalic, maleic, ascorbic, and citric acids) (Mahadevan and Shivali n.d.)(10). The organic acids' free radical scavenging activity and bioactive components (Luvonga et al. 2010)(20). The positive impacts on health are mostly caused by these bioactive substances.

Organic acid

According to (33), roselle extracts have a high percentage of organic acids in the calyces, such as citric acid and malic acid. In addition, (21) revealed that ascorbic acid is also present in the calyces. The ascorbic acid content in the calyces has also been demonstrated by prior research (J A Duke and Atchley 1984; Salama and Ibrahim 1979; James A. Duke 1983)(34). High concentrations of organic acids, including citric acid, succinic acid, tartaric acid and oxalic acid, have been observed by several writers. Recently, Jabeur et al. (Jabeur et al. 2017) (22) showed that The main organic acids found in the roselle calyces were fumaric, shikimic, and oxalic acids, with malic acid being the most common.



Flavonoids and polyphenols

Many of the therapeutic chemicals found in plants originate from their secondary metabolisms. Potential bioactive compounds with anti-inflammatory, antibacterial, hypocholesterolemic, antihypertensive, anticarcinogenic, and Roselle calyces are interesting sources of these compounds, which have antioxidant qualities. The calyces of roselle are rich in flavonoids and polyphenols, which have been connected to the nutritional value of roselle due to their antioxidant qualities, as numerous scientific investigations have shown. The majority of the plant's phenolic content is composed of anthocyanins, including cyanidin-3-sambubioside, sambubioside, and delphinidin-3-glucoside (22), as well as other flavonoids, including hibiscetin and gossypetine, and their corresponding glycosides; Eugenol, protocatechuic acid, and sterols as β -sitosterol and ergosterol (10, 35).

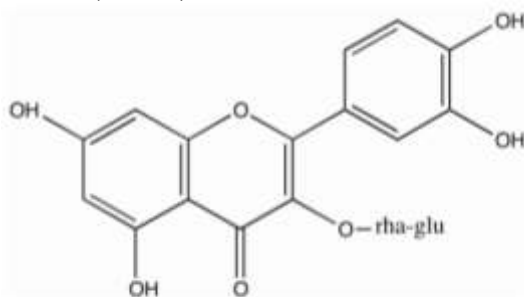


Figure 2 - Quercetin-3-rutinoside

The phytochemicals that give the vibrant anthocyanins their colour are called flavonoids. Anthocyanins are made up of molecules that easily break down. According to Idham et al. (2012) (36), the stability of flavonoids is contingent upon various elements including metals, other flavonoids, phenolic acids, light, pH, temperature, and the presence of enzymes.

Anthocyanins of *Hibiscus sabdariffa* L

The calyces of roselle include two major anthocyanin chemicals, namely cyanide-3-sambubioside and delphinidin-3-sambubioside, and two minor compounds, namely cyanide-3-glucoside and delphinidin-3-glucoside. These have been documented by (37) and (38). Research by Tsai et al. (P. J. Tsai et al. 2002) (39) states that delphinidine-3-sambubioside, which makes up 85% of anthocyanins, is the main source of the roselle extract. Aurelio et al. (Aurelio, Edgardo, and Navarro-Galindo 2008) found that The abundance of anthocyanins found in roselle calyces, including cyanidin-3-sambubioside, sambubioside, and delphinidin-3-glucoside, is what gives the extracts their antioxidant properties. It is challenging to compare because different *Hibiscus sab-dariffa* cultivars and extraction methods were employed in different research. According to Luvonga et al. (Luvonga et al. 2010), roselle extract has a total phenolic content. Total anthocyanins were found in dried roselle as measured by total phenolic content in the dry weight sample (Abou-Arab, Abu-Salem, and Abou-Arab 2011) and cyanidine 3-glu-coside. In their inquiry, recently discovered delphinidin-3-o glucoside, cyanidin-3-o sambubioside, and delphinedine-3-o-sambubioside.

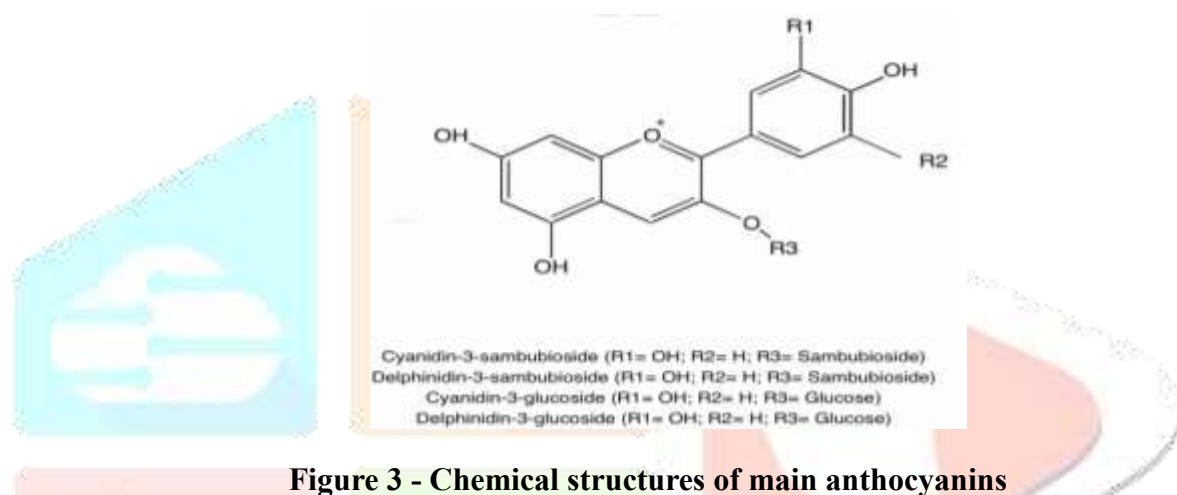
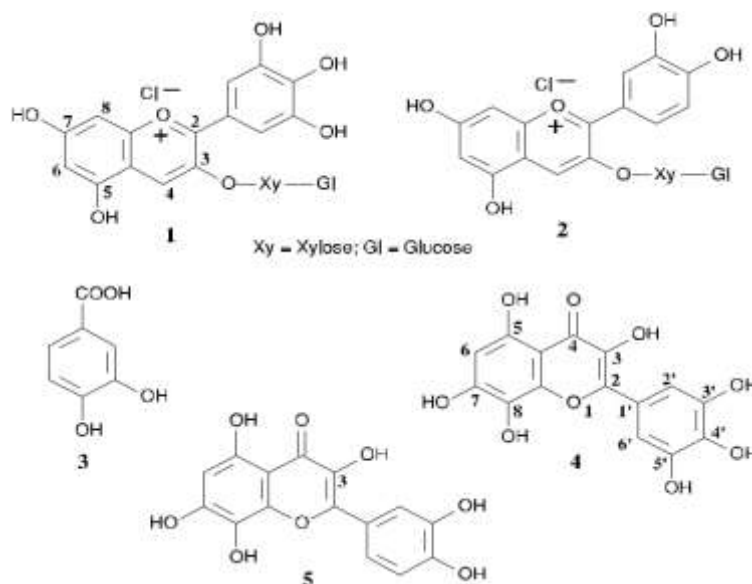


Figure 3 - Chemical structures of main anthocyanins

CONSTITUENTS

Numerous studies on the components of various *H. sabdariffa* plant parts have been published; Ross (2003) provides a concise summary of studies. Citric and malic acids have been identified as the main organic acids in flower aqueous extracts. Tartaric acid, on the other hand, was only found as a trace component by Indovina, even though it was detected by paper chromatography in Taiwan flower extracts along with citric and oxalic acids (Lin, 1975). High amounts of organic acids were found in the calyx, according to Kerharo (1971), which contains tartaric and malic acids present but citric acid predominating. Khafaga and Koch (1980a) discovered tartaric, malic, hibiscus, and citric acids in the calyces of five distinct strains of *H. sabdariffa* var. *sabdariffa*. The concentration of acids rose in all strains during the calyces' development but decreased after they were fully ripe. Buogo and Picchinenna and Reaubourg and Monceaux reported finding ascorbic acid in aqueous extracts, but Indovina and Capotummino did not detect it. The chemical composition of a few key components of *Hibiscus sabdariffa* blooms The majority of chemical studies conducted on the components of flowers have focused on the characterization of their pigments. Anthocyanin was isolated by Yamamoto and Oshima (1932), who also gave it the structural name cyanidin-3-glucoside. Eventually, delphinidin-pentoside-glucoside was substituted for this (Yamamoto and Oshima, 1936). Forsyth and Simmonds (1954) found that plants growing in Trinidad contained delphinidin and cyanidin. In their study, Shibata and Furukawa discovered delphinidin-3-sambubioside in Taiwanese roselle pigments, as well as trace levels of delphinidin, cyanidin-3-monoglucoside, and delphinidin. They also isolated the major component, delphinidin-3-sambubioside, as well as the secondary anthocyanins, cyanidin-3-monoglucoside.

Furthermore, The predominant pigment was cyanidin-3-sambubioside, which was followed by cyanidin-3-glucoside. The Senegalese strain had no delphinidin glycosides, but the other four strains had them. All strains had anthocyanin concentration between 1.7% and 2.5% of their dry weight throughout calyx growth.



isolated the hibiscitrin flavonol glycoside from *H. sabdariffa* flowers. The aglycone hibiscetin was created by the hydrolysis of this flavonoid(40). In a subsequent article, Rao and Seshadri (1942b) reported that hibiscitrin, gossypitrin, and sabdaritrin were isolated from the flower petals of the same species. After being hydrolyzed in an acid, the final one produced a hydroxyflavone that was given the name sabdaretin. Previous research had demonstrated that gossypitrin was the 7-glucoside of gossypetin, from the flower petals of *H. sabdariffa*, Seshadri and Thakur extracted gastrin in 1961, which they later identified as gossypetin-3-glucoside. Gossypetin-8-glucoside, gossypetin-7-glucoside, and gossypetin-3-glucoside were isolated, according to Subramanian and Nair's 1972 publication. Neelakantam and Seshadri isolated the 8-glucoside gossypin from *Gossypium indicum* first (1936). It was demonstrated by Rao and Seshadri (1942a) that flavonol glycosides were mostly prevalent in flower petals and that the calyces had relatively little of these substances.

Diuretic, uricosuric effect and hyperuricemia

In a study conducted on conscious rats, Ribeiro et al. (de A. Ribeiro et al. 1988) (41) examined the aqueous infusion of *Hibiscus sabdariffa* (HS) has diuretic effects. Urine collected increased after consuming the 6-hour HS extract; this was significantly greater than the urine collected from a water placebo and hydrochlorothiazide at a dose of 25 mg/kg. In addition, uric acid, salt, and potassium levels rose in comparison to placebo and hydrochlorothiazide-treated individuals. According to Prasongawatana et al. (Prasongwatana et al. 2008)(42), roselle tea has uricosuric effects on humans that are dose-dependent (3 g/day) and may be utilized to treat hyperuricemia in gout patients.

It has no diuretic or antilithiatic effects at this dosage. Two groups of the human model were used in the study: one group had kidney stones, while the other group did not. At baseline, while drinking tea, and 15 days after quitting, blood and urine samples were taken and analyzed. There was no discernible difference between the two groups in any of the serum measures; they were all within range. The baseline urine parameters were the same for every group. Oxalate and citrate levels increased, and both groups' fractional uric acid excretion and uric acid excretion reverted to baseline during the washout period. Kuo et al. (Kuo et al. 2012) investigated the effect of *Hibiscus sabdariffa* extract (HSE) on oxonic acid (OA)-induced hyperuricemia in rats. The rats were given normal saline and oxonate solution for one week, and then allopurinol or HSE for five weeks. The results showed that HSE was more effective than allopurinol in inhibiting OA-caused hyperuricemia and lowering uric acid concentrations. This research offer proof that using HSE to treat hyperuricemia could be effective on a scientific level. Roselle's diuretic impact has generated debate because some researchers (de A. Ribeiro et al. 1988) (41) reported an increase in urine volume, whereas (Prasongwatana et al. 2008) (42) reported no increase in urine volume. In their study,(43) proved that the aqueous extract of *Hibiscus sabdariffa* had natriuretic, diuretic, and potassium-sparing qualities. Rat diuresis and renal filtration rate in the kidney "in situ" were the two experimental parameters. models they employed, and the doses that produced a consistent diuretic effect ranged from 500 to 2500 mg/kg. They emphasized the aqueous HSE's dose-dependent behaviour (500–2500 mg/kg) and suggested that endothelium-dependent nitric oxide release could be the mechanism through which roselle's diuretic effect is mediated.

Treatment of anaemia

Because *Hibiscus sabdariffa* (Hs) is high in iron and ascorbic acid, it was the most frequently mentioned species against anaemia. In ethnomedicine, their potential as anti-anaemic is justified by the fact that This ascorbic acid facilitates non-heme iron absorption. The evaluation of *Hibiscus sabdariffa* (HS) extract pharmacologically showed increased hematocrit and haemoglobin in both animal and human models (Peter et al. 2014)(44). In their evaluation of the effects of *Hibiscus sabdariffa*'s aqueous extract on haematological indices as total and differential white blood cell count, haemoglobin, haematocrit, and Adigun et al. (Adigun et al. 2006)(45) suggested that 200 mg/kg be beneficial.

Rats were given oral doses ranging from mg/kg body weight for a maximum of 2 weeks. After 14 days, the animals in the 200 mg per kg dosage group showed a considerable increase in their haemoglobin and hematocrit levels.

Higher doses, however, resulted in a notable drop in the haemoglobin level but not in the hematocrit. Emelike and Dapper carried out a similar investigation on rats over 28 days, suggesting that the administration of an aqueous extract of *Hibiscus sabdariffa* is beneficial to the hematopoietic system. Anaemia is a disorder of low red blood cells (RBCs) in the blood, caused by an iron deficiency.

Red blood cells (RBCs) supply oxygen to the body's cells. Due to its extremely low pH and high ascorbic acid concentration, which have been demonstrated to improve mineral bioavailability (Da-Costa-Rocha et al. 2014b), the roselle extract may have anti-anaemic effects.

In contrast to the first two studies, a 30-day clinical trial on people with mild to severe anaemia discovered that consuming the standardized aqueous extract of *Hibiscus sapdariffa* did not improve the iron status of anaemic adults in a malaria-endemic location. However, during a 30-day oral course of treatment, no adverse effects were reported, suggesting that roselle is safe for human consumption (Peter et al. 2017)(46).

ferritin in serum, According to their research, the test group did not experience a substantial increase in an effective biomarker of response to iron intervention, whereas the control group did. Neither the test group nor the control group experienced a significant change in haemoglobin or CRP. Every group had cases of malaria, with the control group having the highest rate, and the group receiving 2000 millilitres of roselle extract coming in second. They cited the effects of iron supplementation on ferritin levels, haemoglobin levels, and infection risk as support for their conclusions. Ultimately, they concluded that other vitamin deficiencies and everyday food deficits that they were unable to control may have contributed to the groups' lack of a dose-dependent response and the participants' non-responsiveness to the iron intervention.

The anti-anaemic effect of roselle extract has not received much attention in the literature. The promise of roselle in the treatment of anaemia and its emerging mechanism of action requires more high-quality research with larger sample numbers and reliable study methods.

Anti-carcinogenic

According to a study released by(12), The chemopreventive effect of roselle methanolic extract was studied in rats whose aberrant crypt foci (ACF) formation was brought on by 2-amino-1-methyl-6-phenylimidazo[4,5-b] pyridine (PhIP) and azoxymethane (AOM). The significant reductions in AOM and PhIP-induced ACF of 17% and 22%, respectively, at the early stage showed the antimutagenic qualities against PhIP-induced ACF and methylazoxymethanol acetate. On the other hand, there were more ACFs during the post-initiation phase. Thus, further investigation into the processes behind the modulative impact of the roselle is recommended.

The phosphorylation of target protein C-Jun by *Hibiscus sabdariffa* anthocyanins induced apoptosis in HL-60 cancer cells by activating apoptotic protein cascades containing Fas-mediated signalling, according to a different investigation into the effects of *Hibiscus sabdariffa* anthocyanins on human tumour cells. This finally led to the cleavage of caspase-3 and the release of cytochrome C from mitochondria(47).

Human promyelocytic leukaemia cells undergo a dose-dependent program of apoptosis when exposed to delphinidin 3-sambubioside from *Hibiscus sabdariffa*. Reactive oxygen species (ROS) and mitochondrial dysfunction mediate this programme(48). The two outcomes that were previously discussed concurred. On cervical (HeLa), ovarian (Caov-3), and breast (MCF-7 and MAD-MB-231) cancer cells, roselle juice has an anti-proliferative impact (49). cytotoxic effects The effects of *Hibiscus sabdariffa* aqueous extract on human breast cancer cell line (MCF-7) and fetal foreskin fibroblast (HF) were investigated by (Khaghani et al. 2011)(50).

Researchers discovered that at a level of 0.5 mg/ml, the extract caused apoptosis in MCF-7 cells, which led to a sharp decrease to less than 50%, even while it did not harm normal HF cells. Furthermore, the impairment of histology, morphology, and haematology was improved by the hibiscus anthocyanins.

However, aspartate aminotransferase (AST), uric acid, myeloperoxidase (MPO), and alanine transaminase (ALT) were all reduced (T. C. Tsai et al. 2014). This report is the first example of antileukemic action observed

in vivo. (Wu et al. 2016) (51) have demonstrated for the first time that the Hibiscus sabdariffa anthocyanins changed mitochondrial activity and triggered autophagy and necrosis in MCF-7 cells rather than programmed cell death. The results indicated above indicate that Hibiscus sapdariffa anthocyanins have anticarcinogenic qualities; nevertheless, more in vivo studies are needed to validate the anticarcinogenic qualities of roselle anthocyanin extract.

employed to stop the toxicity of cadmium According to a study on male Wistar rats, pre-treating the rats with Hibiscus sabdariffa extract significantly reduced the toxicity of cadmium in the liver. It also protected rats against hepatic and testicular lipoperoxidation. A unique pharmacologic function of the plant's anthocyanin-rich extract has been demonstrated: immunoprotection. The extract has improved the viability of cadmium-suppressed cells and reduced cadmium-mediated production of macrophage activation markers in a dose-dependent manner when compared to quercetin dihydrate (Okoko and Ere 2012)(52).

Reproductive ability

Hibiscus sabdariffa extract increased sperm motility via antioxidant capacity and decreased how much sperm abnormalities are caused by cisplatin in a study (53) on rats. This suggests that Hibiscus extract may be used to treat fertility disorders. To validate the potential of roselle extract to improve the reproductive issue, more preclinical and clinical investigations are needed. The Toxicology of Saprophyllum corneum Roselle has the potential to modify the risk factors associated with metabolic syndrome; however, It is crucial to take into account its toxicological and safety implications as well.

Hibiscus is a common component of herbal tea and may be found in many brands on the market. It can occasionally make up 50% of the overall ingredient content (Nunes et al. 2017)(54). In various regions of the world, roselle tea is a commonly consumed food item since it is thought to be natural, harmless, and may have some health advantages. However, because of the potential for the herbs to interact with synthetic medications, The natural product might not be suitable for fragile groups or those on medication (Nunes et al. 2017)(54). In various regions of the world, roselle tea is a commonly consumed food item since it is thought to be natural, harmless, and may have some health advantages. However, because of the potential for the herbs to interact with synthetic medications, The natural item might not be secure for those taking medication or for vulnerable populations (children and expectant mothers) (Nunes et al. 2017)(54). Herb-drug interactions happen when either product's pharmacokinetics profile is noticeably changed as a result of their concurrent administration, which raises the risk of toxicity, adverse effects, or treatment failure (Johnson et al. 2013) (55). Acetaminophen, diclofenac, and hydrochlorothiazide were less likely to be eliminated when Hibiscus sabdariffa was dissolved in water (56, 57).

On the other hand, (Johnson et al. 2013) observed that there might not be a substantial herb-drug interaction in their in vitro studies on roselle extract's ability to inhibit cytochrome P450 (CYP). More clinical research is needed in this area to ensure that Hibiscus sabdariffa aqueous extract can be used safely in conjunction with other medications. The European Union's (EU) food legislation should be followed when labelling herbal products so that consumers may better understand the unique benefits of each product. health claims must satisfy methodologically sound scientific criteria, be supported by relevant human intervention studies, and be acceptable concerning the connection between intervention research and outcomes (effects, frequency, dose, and placebo). A few pre-clinical investigations have documented Hibiscus sabdariffa's low level of acute toxicity.

Hibiscus saccharine extract has been shown to cause liver damage when used at higher dosages for extended periods; however, Akindahunsi and Olaleye (2016)(58) found that serum levels of albumin, alanine aminotransferase (ALT), and aspartate aminotransferase (AST) were significantly elevated in Wistar albino rats following doses of 250 mg/kg; lactate dehydrogenase (LDH) and alkaline phosphatase (ALP) were not significantly affected. No histologically significant effects were seen in the liver or heart.

used large dosages of Hibiscus sabdariffa extract in their three-month study with albino rats and discovered that while 50% alcohol increased the levels of plasma creatinine and had more detrimental effects on liver function enzymes, the aqueous extract increased the levels of serum creatinine. At doses up, there were no adverse effects on the liver, kidney, blood system, electrolytes, lipid and carbohydrate metabolism, or other essential organ systems (59). The phase 1 hepatic CYPs implicated in drug metabolism and carcinogenic/mutagenic bioactivation were found to be unaffected by doses of 250 mg/kg/day in ex vivo research using male Wistar rats.

Conversely,(60) discovered that the liver enzymes (AST, ALT, and ALP) increased at a dose of 2000 mg/kg and above, whereas urea and uric acid increased significantly at 1000 mg/kg. Their research led them to recommend a safe dosage of less than 1000 mg/kg, which won't affect kidney or liver function. The research cited above suggests that roselle extract should be used carefully because higher quantities may

be hazardous. Further research is required in this area to discover the optimal dosage that balances the pharmacological and toxicological effects of roselle.

CONCLUSIONS

Extensive documentation has been presented regarding the several advantageous impacts of *Hibiscus sabdariffa* as well as its suggested mode of action. This paper reviews the majority of prior research on the phytochemical composition and medicinal applications of *Hibiscus sabdariffa* in order to determine its current state. Numerous traditional uses of this plant have been confirmed by phytochemical and phytopharmacological research. Studies on the phytochemical makeup of roselle have shown that it contains bioactive substances that can effectively treat a number of degenerative illnesses. Research has shown that consuming roselle at modest levels does not have any negative effects on the kidneys or liver. Roselle can therefore be utilized as a functional food or as an active ingredient in food that functions to treat a variety of degenerative illnesses. To develop a potential plan that can counteract roselle's harmful and pharmacological effects, more research is advised. Another issue that needs to be addressed is the roselle extract's bioavailability and dose. As a result, *Hibiscus sabdariffa*'s standardized fingerprint is required globally for quality control.

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