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ROSELLE (*HIBISCUS SABDARIFFA* L.) AS A SOURCE OF NATURAL COLOUR : A REVIEW

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Abstract

Hibiscus sabdariffa L. (Roselle) is a medicinal plant grown in Africa, South East Asia, Central America in Mexico, it is known as Jamaica flowers, Sorrel and Karkdah (in Egypt), belongs to the Malvaceae family. It has been reported to use as a flavouring for sauces, jellies, marmalades and soft drinks or to use as a colourant for foods, which Roselle appear to be good and promising sources of water soluble natural red colourants. Anthocyanins, which are flavonoids are water-soluble natural pigments. Aqueous extracts of Roselle or *Hibiscus sabdariffa* L. calyces have characteristic intense red colouration due to the presence of anthocyanins, which could be utilised as colouring agent in pharmaceutical products. It has been reported that the Anthocyanins found in the calyces of *H. sabdariffa* contain delphinidin-3-sambubioside, cynidin-3-sambubioside, delphinidin-3-monoglucoside and cynidin-3-monoglucoside. The present paper is an overview on its potential use as a natural colour and its health benefits reported in the literature.

Key words : *Hibiscus sabdariffa* L., Roselle, medicinal plant, anthocyanin, flavonoids.

Introduction

Hibiscus subdariffa Linn. is a shrub belonging to the family – Malvaceae. It is thought of native to Asia (India to Malaysia) or Tropical Africa. The plant widely grown in tropics like Caribbean, Central America, India, Africa, Brazil, Australia, Hawaii, Florida and Philippines as a home garden crop (Gautam, 2004). In addition to Roselle, in English-speaking regions it is called as Rozelle, Sorrel, Red sorrel, Jamanica sorrel, Indian sorrel, Guinea sorrel, Sour-sour, Queensland jelly plant, Jelly okra, Lemon bush and Florida cranberry. In Indian languages, it is called as Gongura, Lal-ambari, Patwa (Hindi), Lal-ambadi (Marathi), Yerra gogu (Telugu), Pulichchai kerai (Tamil), Pulachakiri, Pundibija (Kannada), Polechi, Pulichchai (Malayalam) and Chukiar (Assam) (Mahadevan *et al*., 2009). Two botanical types of Roselle are recognized, *Hibiscus sabdariffa* var *altissma* and *Hibiscus sabdariffa* var *subdariffa* (Eltayeib and Hamade, 2014). In several countries, Roselle is also considered to be one of the most famous folk medicinal plants. Where, many chemical components present in Roselle have potential health benefits and support the ethno medicinal use of Roselle in promoting cardio-vascular health and preventing hypertension, pyrexia and liver disorders, microorganism growth limitation, as well as a diuretic, digestive and sedative. The red varieties of Roselle have antioxidant and cyclooxygenase inhibitory activity. Also, Roselle inters in pharmaceutical and cosmetic industries (Al-Ansary *et al*., 2016).

Plant description and ecology

The plant has been found to thrive on a wide range of soil conditions. It can perform satisfactorily on relatively infertile soils but for economic purposes, a soil well supplied with organic materials and essential nutrients is essential. It can tolerate relatively high temperature throughout the growing and fruiting periods. The plant requires an optimum rainfall of approximately 45-50 cm

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distributed over a 90-120 day growing period (Adanlawo and Ajibade, 2006). The plant is about 3.5 m tall and has a deep penetrating taproot. It has a smooth or nearly smooth, cylindrical, typically dark green to red stems. Leaves are alternate, 7.5-12.5 cm long, green with reddish veins and long or short petioles. Leaves of young seedlings and upper leaves of older plants are simple; lower leaves are deeply 3 to 5 or even 7-lobed and the margins are toothed. Flowers, borne singly in the leaf axils are up to 12.5 cm wide, yellow or buff with a rose or maroon eye and turn pink as they wither at the end of the day. The typically red calyx, consist of 5 large sepals with a collar (epicalyx) of 8-12 slim, pointed bracts (or bracteole) around the base, they begins to enlarge at the end of the day, 3.2-5.7 cm long and fully enclose the fruit. The fruit is a velvety capsule, 1.25-2 cm long, which is green when immature, 5-valved, with each valve containing 3-4 seeds. The capsule turns brown and splits open when mature and dry. Seeds are kidney-shaped, light-brown, 3-5 mm long and covered with minute, stout and stellate hairs (Mahadevan *et al*., 2009). The plant takes about 3-4 months to reach the commercial stage of maturity before the flowers are harvested. Roselle plants are suitable for tropical climates with well-distributed rainfall of 1500-2000 mm/year, from sea-level to about 600 m in altitude. The plant tolerates a warmer and more humid climate with night time temperature not below 21°C and is most susceptible to damage from frost and fog. In addition, it requires 13 hours of sunlight during the first months of growth to prevent premature flowering (Ismail *et al*., 2008).

Phytochemistry

Roselle is rich in anthocyanins and protocatechuic acid. The dried calyces contain the flavonoids gossypetine, hibiscetine and sabdaretine. The major pigment, formerly reported as hibiscine has been identified as daphniphylline. Small amounts of myrtillin (delphinidin 3-monoglucoside), chrysanthenin (cyanidin 3-monoglucoside) and delphinidin are also present. Roselle seeds are a good source of lipidsoluble antioxidants, particularly γ-tocopherol (Mohamed *et al*., 2012). The anthocyanin content of *H. sabdariffa* in five strains of the plant reportedly reached 1.7% to 2.5% of the dry weight during calyx growth (Khafaga and Koch, 1980b). *H. sabdariffa* calyces contain high amounts of organic acids, namely: citric acid, malic acid, tartaric acid and hibiscus protocatechuic acid (Kerharo, 1971; Khafaga and Koch, 1980a; Tseng *et al*., 1996). The acid content of the calyces increases during growth but decreases when it reaches maturity or ripens. The aqueous extract of *H. sabdariffa* calyces has a very rich red pigmentation due to the presence of anthocyanins and the colour properties has been the subject of intense scientific investigations (Ali *et al*., 2005; Salazer *et al*., 2012; Aishah *et al*., 2013). *Hibiscus sabdariffa* calyces were found to contain a higher amount of iron content (164.78 mg/kg) (Maregesi *et al*., 2013). 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 (Puro *et al*., 2014). The chemical composition of dried Roselle calyces is shown in table 1.

Medicinal properties

The plant *H. sabdariffa* is also known as Roselle or Rosella. It is reported to be antihypertensive, antiseptic, sedative, diuretic, digestive, purgative, emollient, demulcent and astringent (Odigie *et al*., 2003). The calyces are used to treat heart ailments, hypertension and leukemia. They are also reported to have diuretic, aphrodisiac, antiseptic, astringent, cholagogue, sedative, laxative, and antimicrobial activity. They are also used as remedy for pyrexia and abscesses. The flowers and fruits are used for treatment of cough and bronchitis (Maregesi *et al*., 2013). Anthocyanins present in Roselle are dephinidin 3-sambubioside, cyanidin 3-sambubioside, delphinidin 3-glucoside and cyanidin 3-glucoside. They contribute benefit for health as a good source of antioxidants as well as a natural food colourant. The blending of Roselle juice with tropical fruit juices is anticipated to give products with high nutritional value and functional activity (Kilima *et al*., 2014).

The aqueous methanolic extract of Roselle exhibits antimicrobial activity against many bacterial spp. Roselle - Hibiscus anthocyanins (HAs), which are a group of natural pigments existing in the dried calyx exhibited antioxidant activity and liver protection (Puro *et al*., 2014). The red colour of Roselle petals, essentially the anthocyanins, is an attractive source of natural food colourants (Goda *et al*., 1997). Anthocyanins possess a high thermostability and contribute towards antioxidative, antiinflammatory, cardioprotective and hepatoprotective activities (Azevedo *et al*., 2010). According to many authors, anthocyanins inhibit the growth of human cancer cells and low density lipoprotein (LDL) oxidation. Therefore, the addition of natural anthocyanins as food colourants would not only enhance the decorative value of the food but also improve its beneficial properties (Abeda *et al*., 2014).

Value addition of Roselle

Roselle is cultivated for its leaves, seeds and calyces. Nutritionally young leaves of Roselle contain nutrients such as phosphorus, calcium, magnesium and potassium

(Atta *et al*., 2010). The leaves are consumed as a green vegetable and prepared like spinach (Delgado and Parcedes, 2003). However, the seed of Roselle is a valuable food resource on account of its protein, calorie and also substantial amount of fiber and valuable micro-nutrients (Akanbi *et al*., 2009). Indeed, young leaves and stems are eaten raw or cooked in salads, and as a seasoning in curries. Different food products, fermented foods and beverages of Hibiscus *sabdariffa* are widely used in different countries. From the fresh flowers of Hibiscus *sabariffa* cold and hot beverages are produced. The juice from the calyces of Sorrel (Roselle) is called "zoborodo" (soborodo), a non-alcoholic drink in Nigeria, which involves the production process of solid-liquid extraction leaving the calyx pulp as raffinate, which is a heavy organic material that could be converted as glucose (Ajayi *et al*., 2012). In Mexico, this beverage is called "flor de jamaica". In Senegal (a state of West Africa) this *Hibiscus sabariffa* known as bissap and drink is prepared through aqueous extraction from a solid-to-solvent ratio. This drink consumption is widespread in Asia and Africa. In Senegal, it is more popular and more consumption is observed during the month of Ramadan (Padmaja *et al*., 2014). In Egypt, this beverage is called as "drink of the Pharaohs". In Sudan, it is called as "tea Karkade". In Mali (Africa) it is called as "da Bilenni". Tea from the Hibiscus *sabdariffa* also called Sudan tea, sour tea which is prepared from ground dried calyces also have medicinal properties and is considered as herbal tea and Roselle is also used as main ingredient in many other tisanes (herbal tea) (Diane *et al*., 2009). 'Bikalaga' is a fermented food produced from the seeds of *Hibiscus sabdariffa* in African countries, including Burkina Faso, Mali Niger, Nigeria, Cameroon and Sudan among others (Parkouda *et al*., 2008).

Fresh calyx (the outer whorl of the flower) is eaten raw in salads, or cooked and used as a flavouring in cakes and is also used in making jellies, soups, sauces, pickles, puddings etc. The calyx is rich in citric acid and pectin and is useful for making jams, jellies (Pacome *et al*., 2014). The seeds contain 17 to 20% edible fixed oil, which is similar in its properties to cotton seed oil. On the other hand, the colour extract from the dry calyces is rich in anthocyanin, amino acids, organic compounds, mineral salts and source of vitamin C (Al-Ansary *et al*., 2016). Calyces extract is also a potential source of natural colourant to replace red synthetic colouring agents for carbonated soft drinks, jams, juices, jellies, sauces, chutneys, wines, preserves and other acidic foods (Delgado and Parcedes, 2003).

In fact, some Roselle varieties/cultivars are identified according to calyxes anthocyanin content. For example, the Sudani Roselle variety has dark red calyces, while the calyx has light red colour in Masri variety (Al-Ansary *et al*., 2016). Roselle, also known as sorrel, Jamaica flower and karkade, has been used by people for preparing soft drinks and in traditional medicine. It has been observed that its components, such as vitamins (C and E), polyphenols acids and flavonoids, mainly anthocyanins, have functional properties. The Roselle calyces production, in developing countries, is of great importance since its production represents a very important income for people from rural communities. Today, several studies have shown that compounds found in aqueous and ethanol Roselle calyces extracts may have antioxidant properties. These compounds could work in several ways in humans; for instance, they could have anticancer characteristics. They may also reduce chronic diseases such as diabetes mellitus, dyslipidemias, hypertension and cardiovascular diseases. Some of these compounds (flavonoids and anthocyanins) are natural which have no toxic or mutagenic effects (Cid and Guerrero, 2014).

The whole plant can be used as beverage, or the dried calyces can be soaked in water to prepare a colourful cold drink, or may be boiled in water and taken as a hot drink. It also has some medicinal properties. The seeds contain 17.8–21% non-edible oil and 20% protein, and are sometimes used for animal feed (Mohamed *et al*., 2012). The calyx of *Hibiscus sabdariffa* is widely used by humans, as food, jams, jellies, juice drinks, wine and as medicinal syrups (Akanya *et al*., 1997). It is used effectively in folk medicines for treatment of hypertension, inflammatory diseases and cancer (Lin *et al*., 2007). The calyces are used to decrease blood viscosity and reduce hypertension (Christian *et al*., 2006). Hibiscus pigments reduce the incidence of liver lesions including inflammation, leucocyte infiltration and necrosis (Kong *et al*., 2003). Anthocyanins are approved as food colourants in the USA under the category of fruit (21 CFR 73.250) or vegetable (21 CFR 73.260) juice colour. The EU classifies anthocyanins as 'natural colourants' under classification number E163. The use of anthocaynins may show benefits over that of synthetic colours. A potential use for Roselle extract may include production of fruit juice, drinks and jam (Duangmal *et al*., 2008).

Drying of Roselle calyces

Roselle calyx is usually harvested at high moisture content (85%, w.b.). Therefore, drying is an important post-harvest treatment prior to reduce the moisture content and to increase the shelf life. Drying is a process comprising simultaneous heat and mass transfer (Suherman *et al*., 2012). In order to preserve and extend their life, Roselle calyxes are sold in dry form. Their main form of consumption is after leaching them with water (Daniel *et al.,* 2012). The different drying methods employed for calyces of Roselle are given in table 2. Saeed *et al.* (2008) found that at different temperatures (35, 45, 55 and 65ºC) and relative humidity (30%, 35%, 40% 45% and 50% RH), the drying kinetics of fresh Roselle calyxes were controlled by internal diffusive mechanisms (falling rate period) and a second model of exponential decay behaviour; the drying time was reduced with increased temperature and prolonged with greater relative humidity. Saeed (2010) used a solar dryer to study the effects of drying conditions on the drying constant (*k*) and coefficient values (*a* and *c*) in order to validate a logarithmic model.

Extraction of colour

Colour is one of the most important quality attributes affecting the consumer's acceptance of food since it gives the first impression of food quality. Many convenience foods such as confectionery products, gelatin desserts, snacks, cake, pudding, ice cream and beverages would be colourless, and would thus appear undesirable without the inclusion of colourants (Hirunpanich *et al*., 2006). Due to perceived safety and physiological advantage of the natural colourants over synthetic ones, interest are being geared into search of new natural colourants and the verification of the safety of existing ones. Roselle is a tropical plant of considerable economic potential. Its calyces have been suggested as food colourants for food industries; emulsifier for carbonated drinks, jam manufacture, juices and natural food colourants (Duangmal *et al*., 2008). The calyces are rich in anthocyanin, ascorbic acid and hibiscus acid. It is water soluble with brilliant and attractive red colour and with sour and agreeable acidic taste, which aids in digestion. In this respect, Roselle calyces appear to be good and promising sources of water soluble red colourants that could be utilized as natural food colourants (Abou *et al*., 2011).

Anthocyanins are one of the most important groups of water soluble pigments visible to the human eye. They are responsible for many of the attractive colours, from scarlet to blue, of flowers, fruits, leaves and storage organs. Hibiscus anthocyanins were identified as having Delphinidin-3-sambubioside (Dp-3-sam) (70% of the anthocyanins) and Cyanidin-3-sambubioside (Cyn-3-sam) as the major pigments, with Delphinidin-3-glucoside (Dp-3-glu) and Cyanidin-3-glucoside (Cyn-3-glu) as the minor ones (Amor and Allaf, 2009). Cahlikova *et al.* (1015) explained that the active constituents of the extracts of Roselle, which widely used in folk medicine to combat many illnesses and have been shown on several occasions to be anthocyanins and they ascertained through UHPLC-ESI MS/MS that delphinidin-3-sambubioside is the major one but the predominant one is cyaniding-3-sambubioside. Also Roselle extracts are reported to have an antimicrobial effect on different pathogenic and food spoilage micro-organisms due to its metabolities of phenolic compounds such as anthocyanins. They are associated with the prevention of illnesses generated by oxidative stress (Heba *et al*., 2014). *H. sabdariffa* calyx extracts has been studied extensively as a food colourant (Duangmal *et al*., 2008; Alobo and Offonry, 2009) and found to be a suitable replacement for various artificial colourants.

Plant materials generally contain a small amount of high added value active solute. Extraction and purification of bioactive compounds from natural sources have become very important for the utilization of phytochemicals in the preparation of dietary supplements or neutraceuticals, functional food ingredients, food additives, pharmaceutical and cosmetic products. The polar character of anthocyanins makes them soluble in several types of polar solvents such as methanol, ethanol, acetone, and water. Solvent extraction of anthocyanins is the initial step in the determination of total and individual anthocyanins prior to quantification, purification, separation, and characterization (Rivas, 2003). The extraction of anthocyanins is commonly carried out under cold conditions using methanol or ethanol containing a small amount of acid in order to obtain the flavylium cation form, which is red and stable in a highly acid medium (Du and Francis, 1973; Amor and Allaf, 2009). Extraction of anthocyanins is commonly carried out under cold conditions with methanol or ethanol containing a small amount of acid with the objective of obtaining the flavylium cation form, which is red and stable in a highly acid medium. However, acid may cause partial hydrolysis of the acyl moieties in acylated anthocyanins, especially in anthocyanins acylated with dicarboxylic acids such as malonic acid (Bronnum and Flink, 1985). Abou *et al.* (2011) used ethanol acidified with 1.5 N/L HCl (85:15), ethanol acidified with 1% citric acid, 2% citric acid solution and distilled water in extracting the pigments from Roselle calyces. They concluded that the addition of acids to water or ethanol increased the efficiency of anthocyanins extraction compared with distilled water alone. In general, HCl was more effective than citric acid. Ethanol acidified with HCl, showed the strongest influence on the amount of anthocyanins extracted, followed by 2% citric acid solution and ethanol acidified with 1% citric acid. Frimpong *et al.* (2014) investigated the potential of aqueous extract of *Hibiscus sabdariffa* calyces as colouring agent in three pediatric oral pharmaceutical formulations and they found that Aqueous extract of *H. sabdariffa* calyces at a concentration of 33% w/v solution was successfully used to colour three pediatric oral formulations. Formulations coloured with the extract were susceptible to deterioration on exposure to light, pH and high temperatures. It can be concluded that the extract of *H. sabdariffa* calyces can be a good substitute for amaranth as a colouring agent for pediatric oral pharmaceutical formulations when buffered at pH 5.0 and protected against high temperatures and light.

Stability of colour

Anthocyanins are highly unstable molecules in food matrix. The colour stability of Anthocyanins is strongly affected by pH, solvents, temperature, anthocyanin concentration and structure, oxygen, light, enzymes, and other accompanying substances (Arueya and Akomolafe, 2014). Colour stability of anthocyanins depends on a combination of various factors including: structure of anthocyanins, pH, temperature, oxygen, light and water activity. Enzymatic degradation and interactions with food components such as ascorbic acid, sugars, metal ions, sulfur dioxide and copigments are no less important (Abou *et al*., 2011). Among these factors, pH is one of the major factors significantly influenced the pigment colour variations and stability. In general, anthocyanins are more stable in acidic media at low pH values than in alkaline solutions (Aishah *et al*., 2013). Anthocyanin is relatively unstable and because of their high reactivity it may be easily degraded and form colourless or undesirable brown – coloured compounds during extraction processing and storage (Durst and Wrolstad, 2001) Indeed, temperature, pH, light oxygen, metals, organic acids, sugars, ascorbic acid, enzymes, sulfer dioxide, co-pigmentation and interactions with food components may affect both the structure and stability of anthocyanins (Zuhaili *et al*., 2012).

Bronnum and Flink (1985) reported that the efficiency of extracting solvent increased with increasing the concentration of citric acid and concluded that pH of extracting medium was the determining factor for anthocyanins extractability. Anthocyanins are easily susceptible to pH changes due to the ionic nature of anthocyanin. Anthocyanins exist as four equilibrium forms, namely the quinonoidal base, the flavylium cation, the carbinol (pseudobase) and the chalcone. Under low pH, the anthocyanin exists primarily in the the form of flavylium cation in red. As the pH is raised (>5), a rapid loss of proton occured to form quinoidal base that tend to become blue or violet. In addition, the increasing of pH causes the hydration of the flavylium cation to form a carbinol (pseudobase) or chalcone which are colourless (Amelia *et al.*, 2013). Light is another factor, which affects the stability of anthocyanin. Palamidis and Markakis (1975) have studied the role of light on the stability of anthocyanin in grape juice and showed that exposure of the pigments to light accelerates their destruction. Their experiments showed that after placing the juice samples containing anthocyanin in dark for 135 days at 20°C, almost 30% of the pigments were destroyed, but placing the same samples in the same temperature and same period of time in the presence of light destroyed more than 50% of total pigments. Palamidis and Markakis (1975) have studied the effect of temperature on the stability of anthocyanin in soft drinks and have shown that increase in the storage temperature greatly accelerate the destruction of pigments in soft drinks. Maccarone *et al*. (1985) reported the anthocyanin in red orange juice in 15°C, 25°C and 35°C during a 15 day period and found that the increase in temperature accelerates the destruction of anthocyanins.

Table 1 : Chemical composition of dried Roselle calyces.

S. no.	Component	Red calyces	White calyces
1.	Moisture (%) (d.b.)	11.00	9.30
2.	Crude protein (%)	7.88	7.53
3.	Crude fibre (%)	13.20	12.00
4.	Crude fat (%)	0.16	0.12
5.	Ash (%)	10.60	9.50
6.	Total carbohydrates (%)	57.16	61.55
7.	Ascorbic acid (mg/100g)	11.00	15.50
8.	Titrable acidity (mg/100g)	9.00	11.00
9.	Total soluble solids (%)	5.00	5.50
10.	Calcium (mg/100g)	60.00	50.00
11.	Iron (mg/100g)	25.00	20.00

Source : Mohamed *et al*. (2012).

Encapsulation of anthocyanin

Encapsulation facilitates light and heat-labile molecules to maintain their stability and improve their shelf lives and activity. It is a rapidly expanding technology, highly specialized, with affordable costs. Among the diverse encapsulation techniques available, only few were

Table 2 : Different drying methods employed for calyces of Roselle.

S. no.	Type of drying	Description	Reference
1.	Forced air oven drying	Roselle calyces were dried at 60ºC	Babalola *et al*. (2001)
2.	Constant Temperature and Humidity Chamber	Roselle calyces were dried at different temperatures (35, 45, 55 and 65^{0}C) and relative humidity (30%, 35%, 40%, 45% and 50% RH)	Saeed *et al*., 2008
3.	Tunnel drier	Roselle calyces were dried at 70ºC for 4.5 h	Hahn *et al*. (2011)
4.	Thin layer drying (Tray drier)	Drying was carried out at temperatures 40, 50 and 60ºC and the air velocity was 1.5-1.6 m/s.	Suherman *et al*. (2012)
5.	Sun and oven drying	Fresh samples of red and light red Roselle calyces were sun dried for three days, oven dried for 24 h at 50ºC	Ashaye (2013)
6.	Hot air drying	Roselle calyces were at 60ºC	Langova *et al*. (2013)
7.	Oven drying	Roselle calyces were dried at 105ºC temperature for 45-60 min	Ismail and Mohammed (2014)

evaluated for anthocyanin encapsulation, these include: spray drying using different coating materials, gelation using polymers as sodium alginate, pectin, curdlan and glucan and liophilization (Santos *et al*., 2013). Spray drying technique has been widely used in the microencapsulation of food ingredients susceptible to deterioration by external agents and consists of entrapping an active agent (solid particles, liquid droplets or gaseous compounds) in a polymeric matrix, in order to protect it from adverse conditions. The immediate drying of the mixture leads to the formation of a matrix system in which the polymer forms a tridimensional network which contains the encapsulated material (Tonon *et al*., 2010). Microencapsulation has been used by the food industry in order to protect sensitive food ingredients during storage, to mask or preserve aromas and flavours, to protect food against nutritional losses or even to add nutritive materials to food after processing (Re, 1998). The spray dry technique minimizes the loss of nutrients' content during processing and storage, the powder obtained is soluble and convenient to carry anywhere, it requires less storage space and it is one of the most commonly used methods to transform a wide range of liquid food products into powder. Some of the most used materials include pectin, whey protein, carrageenan, carboxymethyl cellulose (CMC), gelatin and xanthan gum amongst others, trying to protect the core of the particles against adverse environmental conditions, providing at the same time, an easy handling and release rate control (Diaz *et al*., 2015).

Conclusion

Roselle has been reported to use as a flavouring for sauces, jellies, marmalades and soft drinks or to use as a colourant for foods which Roselle appear to be good and promising sources of water soluble natural red colourants. The use of green technologies such as supercritical carbon dioxide (SC-CO_2) extraction provides a promising alternative for conventional solvent extraction. There is a huge demand for quantification and purification of anthocyanins found in the calyces of Roselle *viz*., delphinidin-3-sambubioside, cynidin-3-sambubioside, delphinidin-3-monoglucoside and cynidin-3-monoglucoside. This will further help in generating entrepreneurship opportunities and upliftment of socio-economic condition of the farming community.

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