

## Review on the Chemical Composition, Antioxidant and Anti-Diabetic Activities of *Hibiscus Rosa-Sinensis* L. Flowers

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### ABSTRACT:

Plants have been used by humans since the beginning of civilizations as food, shelter, clothing and fodder. Later, they began to be used in cosmetics, and medicines. Since past decades substantial use of plants as sources of medicines has led to their immense appeal to humankind, which has been attributed to the presence of a wide variety of pharmacological applications. *Hibiscus rosa-sinensis* L. is an ornamental plant which grows worldwide. The bioactive components present in considerably large amounts are flavonoids, glycosides, terpenoids and saponins. These plants have a wide variety of drug related actions against fertility, microbes, inflammation, diabetes and as an antioxidant and febrifuge. This study emphasizes the chemical composition, and uses of the plant for antioxidant and anti-diabetic activity as well as future prospects of harnessing its beneficial effects in the form of beverages.

**Key Words:** Medicinal, *Hibiscus rosa-sinensis* L., bioactive, distribution, antioxidant, febrifuge

### INTRODUCTION

#### *Botany*

*Hibiscus rosa-sinensis* L., with spectacular flowers is known as China rose, shoeblack plant, Hawaiian hibiscus, rose mallow, Rudrapushpa (Sanskrit), Jaya (Hindi, Punjabi), Joba (Bengali), Mandara (Telugu) and Gudhal (Urdu)

It is mainly found in warm-temperate, tropical, and subtropical regions, such as south-east China and some islands in the Pacific and Indian Ocean (Missoum, 2018).

It belongs to the family *Malvaceae*, and is one of the 275 species of the genus *Hibiscus* (Kapoor *et al.*, 2021). *Hibiscus rosa-sinensis* L. is a perennial shrub with tap root system. Leaves are simple, entire with serrate margins and are 3 to 12 cm in length and 2 to 5cm broad. Flowers are actinomorphic, complete, pentamerous and pedicillate. Corolla consists of five petals and is 3 inches in diameter (Rao *et al.*, 2014). A variety of cultivars consist of flowers in shades of red, peach, white, pink, and orange (Phillips and Martyn 1998). Fruit is a capsule (Ross, 2003). Plants show optimum growth in well-drained and slightly acidic soils and require full sunlight however, they can tolerate partial shade (Mushtaq *et al.*, 2017)

#### *Cultural Significance and uses:*

The *Hibiscus* flower holds cultural importance for people across the world. The official state flower of Hawaii is the yellow *Hibiscus* and it is often seen worn in hair for ceremonial occasions (Braglia *et al*, 2010; Melzer *et al*, 2013). Other species of *Hibiscus* are the national flowers of Haiti, South Korea and Malaysia. In Hindu rituals, people offer red *Hibiscus* to Lord Ganesha and the Goddess Kali. In addition, the juice obtained from the leaves and flowers has been used since antiquity as a natural remedy for several diseases as well as in herbal cosmetics (Reddy *et al*, 2017; Kumari *et al*, 2015). Crushed flowers are used to make a dark purple dye which is used as shoe polish. Various applications of this dye are applied for pigmentation of eyebrows, hair, liquor, and as food colorant in many regions of the world. Extracts of this flower are used as a treatment for ulcers, sore eyes and hypertension.

Several studies have proved the presence of antioxidant, anti-fungal, and antimicrobial properties in flowers of *Hibiscus rosa-sinensis* L. (Vastrad and Byadgi, 2018). The flowers were also used as contraceptive agents as well as an abortifacient in rural regions of India (Bhakta and Das, 2017). *Hibiscus* stems, roots, leaves, and flowers extracts have shown to contain such components which are responsible for enhancing antioxidant activity (Zubairi and Jaies, 2014).

This ornamental flower has multifarious applications in food, cosmetics, and medicine. *Hibiscus* is added to enhance the aroma and flavour of beverages as tea, tisanes etc. This plant contains essential oils having a pleasant, calming, and soothing fragrance. It is also used in pharmaceutical industry as cosmetics. *Hibiscus rosa-sinensis* L. flowers are said to have cooling, emmenagogue, and demulcent properties.

Traditional health and folk medicine systems have proved to be more effective in health problems worldwide as proclaimed by the World Health Organization.

Since ancient times flowers have been consumed as part of human diet and they have nutritional value as well as medicinal properties (Wongwattanasathien *et al*, 2010). Recent literature indicates that presently more than 50% of the clinical medications are plant-based. Many of them have played a significant role in pharmacological industry and in developing better therapies for various diseases (Udo *et al*, 2016). This plant is beneficial owing to the several low-cost herbal products and medicinal uses. In view of insufficient current pharmacological information, not much scientific research or clinical trials have been conducted on its chemical extracts. To investigate its prospective medicinal applications, further research is crucial. Hence an attempt has been made to shed light on its chemical composition; potential health benefits, related to antioxidant activity and anti-diabetic property which could be useful for consumers and public health workers.

### ***Chemical composition***

Of the studies reviewed, it was found that the chemical *composition* of different varieties of *Hibiscus rosa-sinensis* L. varied due to environment, and harvesting conditions. It was reported to contain proteins, carbohydrates, fats, and fiber and also contains appreciable amounts of vitamins, iron,  $\beta$ -carotene and calcium. Flower are rich in nutrients that comprises of protein (3.9g/100g), fat (3.9g/100g), carbohydrates (86.3g/100g), fiber (15.7g/100g), calcium (39mg/100g), phosphorous (265mg/100g), iron (1.7mg/100g), ash (5.9mg/100g), vitamin B1 (0.29mg/100g), vitamin B2(0.49mg/100g), vitamin B3 (5.9mg/100g), and vitamin C (3.9mg/100g) (Yashaswini *et al*, 2011). Different plant sections contain bioactive components such glycosides, terpenoids, saponins, and flavonoids, which impart medicinal properties to it. Members of the genus *Hibiscus* produce a variety of bioactive compounds, such as lignanamides, naphthalenes, polyphenols (Salib *et al*, 2011), carotenoids , tocopherols , flavonoids , anthocyanins(cyanidin-3,5-diglucoside,cyanidin-3-sophoroside-5 glucoside, quercetin-3,7-diglucoside, quercetin-3-diglucoside), phytosterols, long – chain fatty esters and a cyclopeptide alkaloid (Khokhar and Ahmed, 1992), cyanidin chloride, hentriacontane, and vitamins(Sorachai *et al*, 2011; Srivastava , 1974; Gupta *et al*, 2005).

#### ***Antioxidant activity***

Antioxidants act as free radical-scavengers, and inhibit lipid peroxidation and other free radical-mediated processes; thereby helping to protect the human body from several diseases accredited to the reactions of radicals (Atoui *et al*, 2005). Synthetic antioxidants when used to prevent free radical damage have been reported to involve toxic side effects (Cornwell *et al*, 1998; Shahidi *et al*, 1992), making the search for natural antioxidants a requisite.

Studies have shown that flavonoids prevent low-density lipoprotein (LDL) oxidation in-vitro by scavenging radical species or sequestering metal ions (Morel, Lescoat, Cillard, & Cillard, 1994). Phenolic compounds are major plant secondary metabolites found in rather large quantities in plant-based foods and beverages and considered beneficial for human health. The key role of phenolic compounds as scavengers of free radicals is emphasized (Dueñas, Hernández and Estrella, 2006; Savikin *et al*, 2009). Higher antioxidant activity has been positively correlated with the concentration of phenolic compounds in extracts (Sun *et al.*, 2007; Al-Mamary *et al.*, 2002).

In order to investigate the antioxidant activity of several solvent extracts of *Hibiscus rosa-sinensis* L., their DPPH free radical scavenging potential, total phenolic and flavonoid levels, and capacity to inhibition linoleic acid oxidation were determined. (Khan *et al.*, 2014). Another study was conducted to assess the antigenotoxic and antioxidant (in vitro) potentials of flower ethanolic extracts (Khatib *et al.*, 2009). The antioxidant capacity of *Hibiscus rosa-sinensis* L. flower aqueous extracts, which included significant levels of tannins and anthocyanins and demonstrated strong antioxidant effect, was examined using ferric reducing antioxidant power (FRAP) and DPPH inhibition assays according to a

study (Mak *et al.*, 2013). Reducing properties based on the transformation of Fe<sup>3+</sup> to Fe<sup>2+</sup> in the presence of the extracts of the instant cocoa–HFE–ginger beverage was studied (Awe *et al.*, 2013).

#### ***Anti-diabetic activity***

Diabetes mellitus is rapidly emerging as a disease with major public health implication all around the world (WHO, 2010; (Huizinga and Rothman, 2006).

Defects in insulin secretion, insulin action or both lead to abnormalities in carbohydrate, fat and protein metabolism which results in Diabetes mellitus (Craig *et al.*, 2009). The International Diabetes Federation (IDF) estimates the total number of diabetics to be around 40.9 million in India and this is further set to rise to 69.9 million by the year 2025 (Sicree *et al.*, 2006). Significant complexities arise due to hyperglycaemia in both type 1 (IDDM) and type 2 diabetes mellitus (NIDDM) (Papatheodorou *et al.*, 2015). In developing countries, where the cost of treatment and medicines is a burden to the population traditional medicine is used for the treatment of diabetes (Saravanan *et al.*, 2008).

Many indigenous Indian medicinal plants have been found to be useful in successful management of diabetes. Medicinal plants are easily sourced by people and have low side effects (Arumugam *et al.*, 2013). In diabetic rats, the ethyl acetate extract of *Hibiscus rosa-sinensis* L. petals was studied for its ability to treat diabetes. After treatment, the elevated levels of blood glucose and glycated haemoglobin rapidly decreased. Levels of hepatotoxicity marker enzymes were restored in serum and glycogen level was normalized because of regulation of glycogen converting enzyme activities. The most commonly observed lipid abnormalities in diabetes were hyper triglyceridemia and hypercholesterolemia (Shepherd *et al.*, 2005). The results were similar to the study of Sachdeva and Khemani (2003) in which effect of *Hibiscus rosa-sinensis* L. ethanolic floral extract on blood glucose and lipid profile in streptozotocin induced diabetes in rats was examined. The results were in accordance to the study of (Basha and Subbarao, 2015) conducted on studies of ethanolic extract of leaves of *Hibiscus rosa-sinensis* L. in alloxan mono hydrate induced diabetic rats. Results indicated that leaves extract showed significant antidiabetic effects. (Gosain *et al.*, 2010; Lee *et al.*, 2009) observed hypolipidemic activity of high doses of flower extract in diabetic rats.

#### ***Value addition as nutraceuticals***

Beverages with bioactive compounds are consumed for their food value, thirst quenching ability and the health benefit they confer on consumers. Both cocoa and *Hibiscus* flower-extract have high antioxidant properties and their combined effect increased the free radical scavenging potentials of the beverages.

With varied range of uses in medicinal applications as food additives substituting synthetic food colorants, several traditional curing methods were attributed with *Hibiscus* flowers, that aid with gastrointestinal problems, and also helps in soothing anxieties and stress. One of the main ingredients in pleasingly refreshing teas made all over the world, especially in Mexico, Latin America, and North Africa. Known as “Agua de Jamaica”, or simply “Jamaica” in Mexico, this tea is usually served chilled with ample amounts of sugar to sweeten the natural tartness of *Hibiscus*. Due to its high levels of antioxidants, it has been added to many ready-made teas and has even become the main ingredient in certain sodas. A study by The Journal of Human Hypertension published an article that showed that drinking *Hibiscus* tea can reduce the blood pressure in people with type-2 diabetes.

*Hibiscus* has medicinal properties and takes part as a primary ingredient in many herbal teas. *Hibiscus rosa-sinensis* L. blooms have antioxidant and anti-infertility properties. (Anusha *et al*, 2011) and anti-depressant activity (Pallavi *et al*, 2012). Flowers are used in diabetes, epilepsy, bronchial and leprosy (Pekamwar *et al*, 2013).

*Hibiscus rosa- sinensis* L. possesses many properties and this plant maybe procured at large scale for providing herbal alternative to many diseases. Herbal drugs are prescribed widely because of their effectiveness, less side effects and relatively low cost. Therefore, investigation on such agents from traditional medicinal plants has become more important. *Hibiscus rosa- sinensis* L. has antidiabetic effect (Mozaffari *et al*, 2009).

### ***Pharmacological Activities of Hibiscus rosa – sinensis L.***

The pharmacological activities reported by *Hibiscus rosa - sinensis* L. are immense. There is progress to develop *Hibiscus rosa – sinensis* L. into various formulations. The major advantages are its easy availability, low cost, biocompatibility, least side effects, etc. (Bhaskar *et al*, 2011; Sheth and De *et al*, 2012) observed antioxidant activity in flowers. (Mak *et al*, 2013) and (Khan *et al*, 2014) observed antioxidant and anti-bacterial activity of flowers. (Khatib *et al*, 2009) showed Antigenotoxic effects in addition to antioxidant activity.

(Venkatesh *et al*, 2008; Afiune *et al*, 2017; Pethe *et al*, 2017; Chauhan *et al*, 2016) studied that Hibiscus flowers have anti-diabetic properties. In addition, (Sankaran and Vadivel, 2011) found antioxidant activity and (Kumar *et al*, 2010) noted it to be a gastroprotectant.

### **CONCLUSION**

From this study, we can conclude that *Hibiscus rosa- sinensis* L. flower powder supplementation decreased fasting and post prandial blood glucose level, glycosylated haemoglobin, total cholesterol,

total triglyceride, LDL-C, VLDL-C and there was no significant effect on HDL-C parameter due to short period of supplementation. *Hibiscus rosa - sinensis* L. has a beneficial role in diabetes having no ill effects on human health, easily available. Hence, it may be a safe and better alternative available over other agents in diabetes associated dyslipidaemia and can be further used as a dietary supplement

## REFERENCES

- Al-Mamary, M., Al-Meerri, A. , & Al-Habori, M. (2002). Antioxidant activities and total phenolics of different types of honey. *Nutrition Research* 22(9) 1041–1047.
- Afiune, LAF., Leal-Silva, T., Sinzato, YK., Moraes-Souza, R.Q., & Soares, T.S. (2017). Beneficial effects of *Hibiscus rosa-sinensis* L. flower aqueous extract in pregnant rats with diabetes *PLoS ONE* 12(6).
- Anusha, B., Nithya, V., & Vidhya, V.G. (2011). Phytochemical screening and in vitro antioxidant activities of the ethanolic extract of *Hibiscus rosa sinensis* L. *Annals of Biological Research* 2 (5) 653-661.
- Arumugam, G., Manjula, P., & Paari, N. (2013). A review: Anti diabetic medicinal plants used for diabetes mellitus. *Journal of Acute Disease* 196-200.
- Atoui, A.K., Mansouri, A., Boskou, G., & Kefalas, P. (2005). Tea and herbal infusions: their antioxidant activity and phenolic profile. *Food Chemistry* 89(1) 27–36.
- Awe,F.B., Fagbemi, T.N., Ifesan, BOT., & Badejo, A.A. (2013). Antioxidant properties of cold and hot water extracts of cocoa, Hibiscus flower extract, and ginger beverage blends. *Food Research International* 52(2) 490–495.
- Bhakta, S., & Das, S.K. (2017). A review on *Hibiscus rosa sinensis*: a rural traditional medicine for contraception. *International Journal of Engineering and Information Systems* 1(9)77–79.
- Braglia, L., Bruna, S., Lanteri, S., Mercuri, A., & Portis, E. (2010). An AFLP-based assessment of the genetic diversity within *Hibiscus rosa-sinensis* and its place within the *Hibiscus* genus complex. *Scientia Horticulturae* 123(3) 372–378.
- Chauhan, E.S., Sharma, K., & Pareek, A. (2016). Evaluation of Hyperglycemic and Hyperlipidemic Mitigating Impact of *Hibiscus Rosa Sinensis* (Gudhal) Flower in Type II Diabetes Mellitus Subjects. *International Journal of Applied Biology and Pharmaceutical Technology* 7(2) 223-228.
- Cornwell, D.G., Jones, K.H., Jiang, Z., Lantry, L.E., Southwell, Keely, P., & Kohar, I. (1998). Cytotoxicity of tocopherols and their quinones in drug sensitive and multidrug-resistant leukemia cells. *Lipids* 33(3) 295–301.
- Craig, M.E., Hattersley, A., & Donaghue, K.C. (2009). Definition, epidemiology and classification of diabetes in children and adolescents. *Pediatric Diabetes* 10 3-12.
- Dueñas, M., Hernández, T., & Estrella, I. (2006). Assessment of in vitro antioxidant capacity of the seed coat and the cotyledon of legumes in relation to their phenolic contents. *Food Chemistry* 98 (1) 95–103.



Gosain, S., Ircchiaya, R., & Sharma, P.C.(2010). Hypolipidemic effect of ethanolic extract from the leaves of *Hibiscus sabdariffa* L. in hyperlipidemic rats. *Acta Poloniae Pharmaceutica* 67(2)179-184.

Gupta, A.K., Tandon, N., & Sharma, M. (2005). Quality Standards of Indian Medicinal Plants, Indian Council of Medical Research, New Delhi 2 131

Huizinga, M.M., & Rothman, R.L. (2006). Addressing the diabetes pandemic: A comprehensive approach. *Indian Journal of Medical Research* 124 481-4.

Mushtaq, A., Khan, I.M., Rahman, R., & Rezgui, M. (2017). (*Hibiscus rosa-sinensis* L. (Malvaceae): Distribution, Chemistry and Uses. *International Journal of Chemical and Biochemical Sciences* 12 147-151

Kapoor, M., Kaur, G., Kaur, N., Sharma, C., Batra, K., & Singh, D. (2021). The Traditional Uses, Phytochemistry and Pharmacology of Genus *Hibiscus*: A Review. *European Journal of Medicinal Plants* 32(4) 1–37.

Khan , Z.A., Naqvi, S.A., Mukhtar, A., Hussain, Z., Shahzad, S.A., Mansha, A., Ahmad, M., Zahoor, A.F., Bukhari, I.H., Ashraf-Janjua, M.R., Mahmood, N., & Yar, M. (2014). Antioxidant and antibacterial activities of *Hibiscus rosa-sinensis* Linn flower extracts. *Pakistan Journal of Pharmaceutical Sciences* 27(3) 469-474.

Khatib, N.A., Ghoshal, G., Nayana, H., Joshi, R.K., & Taranalli, A.D. (2009). Effect of *Hibiscus rosa-sinensis* extract on modifying cyclophosphamide induced genotoxicity and scavenging free radicals in swiss albino mice. *Pharmacologyonline* 3 796-808.

Khokhar, I., & Ahmad, I. (1992). Studies in Medicinal Plants of Pakistan: A new Cyclopeptide Alkaloids from the Flowers of *Hibiscus Rosa Sinensis*. *Science International Lahore* 4 (2) 147-150.

Kumar, S., Kumar, V., & Prakash, O. (2010). Antidiabetic and Hypolipidemic Activities of *Hibiscus Tiliaceus* (L.) Flowers Extract in Streptozotocin Induced Diabetic Rats. *Pharmacologyonline* 2 1037-1044

Kumari, O.S., Rao, N.B., & Reddy, V.K. (2015). Phyto-chemical analysis and anti-microbial activity of *Hibiscus rosa-sinensis*. *World Journal of Pharmacy and Pharmaceutical Sciences* 4(5) 766–771.

Lee ,W.C., Wang, C.J., & Chen, Y.H. (2009). Polyphenol extracts from *Hibiscus sabdariffa* Linnaeus attenuate nephropathy in experimental type I diabetes. *Journal of Agriculture and Food Chemistry* 57 (6) 2206- 2210.

Mak, Y.W., Chuah, L.O., Ahmad, R., & Bhat, R. (2013). Antioxidant and antibacterial activities of hibiscus (*Hibiscus rosa-sinensis* L.) and Cassia (*Senna bicapsularis* L.) flower extracts. *Journal of King Saud University-Science* 25(4) 275-282.

Melzer, M.J., Simbajon, N., Carillo, J., Borth, W.B., Freitas-Astúa, J., & Kitajima, E.W. (2013). A cilevirus infects ornamental hibiscus in Hawaii. *Archives of Virology* 158 (11) 2421–2424.

- Missoum, A. (2018). An update review on *Hibiscus rosa sinensis* phytochemistry and medicinal uses. *Journal of Ayurvedic and Herbal Medicine* 4(3) 135-146.
- Morel, I., Lescoat, G., Cillard, P., & Cillard, J. (1994). Role of flavonoids and iron chelation in antioxidant action. *Methods in Enzymology* 234 437–443.
- Mozaffari-Khosravi, H., Jalali-Khanabadi, B.A., Afkhami-Ardekani, M., & Fatehi, F. (2009). Effects of sour tea (*Hibiscus sabdariffa*) on lipid profile and lipoproteins in patients with type II diabetes. *Journal of Alternative Complementary Medicine* 15(8) 899-903
- Pallavi, B.S., Rupali, P.A., & Yogesh, H.A. (2012). Antidepressant-like activity of anthocyanidins from *Hibiscus rosa sinensis* flowers in tail suspension test and forced swim test. *Indian Journal of Pharmacology* 44(4) 454- 457.
- Pekamwar, S.S., Kalyankar, T.M. , & Jadhav, A.C. (2013). *Hibiscus Rosa-Sinensis*: A Review on Ornamental Plant. *World Journal of Pharmacy and Pharmaceutical Sciences* 2 (6) 4719-4727.
- Pethe, M., Yelwatkar, S., Manchalwar, S., & Gujar, V. (2017). Evaluation of biological effects of hydroalcoholic extract of *Hibiscus rosa-sinensis* flowers on alloxan induced diabetes in rats. *Drug research* 67(08) 485- 492.
- Pillai, S.S., & Mini, S. (2016). *Hibiscus rosa-sinensis* Linn. petals modulates glycogen metabolism and glucose homeostasis signalling pathway in streptozotocin-induced experimental diabetes. *Plant foods for human nutrition*. 71(1) 42-48.
- Phillips, R., & Martyn, R., (1998). *Conservatory and Indoor Plants London: Pan Macmillan*. (1) 94–99.
- Rao, K., Geetha, K., & Banji ,D. (2014). Quality control study and standardization of *Hibiscus rosa-sinensis* L. flowers and leaves as per WHO guidelines. *Journal of Pharmacognosy and Phytochemistry* 3(4).
- Reddy, U.K., Rajesh, S., Sindhu, G., & Aruna , B .(2017). Herbs used in formulating poly herbal hair oil – a review. *Indo American Journal of Pharmaceutical Research* 4(6) 1527–1539.
- Ross, I.A. (2003). *Hibiscus rosa-sinensis*. *Medicinal Plants of the World*. 1 253–266.
- Sachdewa, A., & Khemani, L.D. (2003). Effect of *Hibiscus rosa sinensis* Linn. Ethanol flower extract on blood glucose and lipid profile in streptozotocin induced diabetes in rats. *Journal of Ethnopharmacology* 89 (1) 61-6.
- Salib, J., Daniel, E., Hifnawy, M., Azzam, S., Shaheed, I., & Abdel-Latif, S. (2011). Polyphenolic Compounds from Flowers of *Hibiscus rosa-sinensis* Linn. and their Inhibitory Effect on Alkaline Phosphatase Enzyme Activity in vitro. *Zeitschrift für Naturforschung C* 66 (9-10) 453-459.
- Sankaran, M., & Vadivel , A. (2011). Antioxidant and Antidiabetic Effect of *Hibiscus rosasinensis* Flower Extract on Streptozotocin Induced Experimental Rats-a Dose Response Study. *Notulae Scientiae Biologicae* 3(4) 13-21



Saravanan, G., & Pari, L. (2008). Hypoglycaemic and ant hyperglycaemic effect of *Syzygium cumini* bark in streptozotocin-induced diabetic rats. *Journal of Pharmacology Toxicology* 3 1-10.

Savikin, K., Zdunic, G., Jankovic, T., Tasic, S., Menkovic, N., & Stevic, T. (2009). Phenolic content and radical scavenging capacity of berries and related jams from certificated area in Serbia. *Plant Foods for Human Nutrition* 64(3) 212–217.

Shahidi, F., Janitha, P. K., & Wanasundara, P.D. (1992). Phenolic antioxidants. *Critical Reviews in Food Science and Nutrition* 32(1) 67–103.

Sheth, F., & De, S. (2012). Evaluation of comparative antioxidant potential of four cultivars of *Hibiscus rosa-sinensis* L. by HPLC-DPPH method. *Free Radicals and Antioxidants* 2(4) 73-78.

Sicree, R., Shaw, J., & Zimmet, P. (2006). Diabetes and impaired glucose tolerance. In: Gan D, editor. *Diabetes Atlas. International Diabetes Federation*: 15 103.

Sorachai, K., Boonsom, L., Saisunee, L., Aphiwat, T., Stephen, G., Mary, R.P., & Gajalakshmi, K.J. (2011). Antimalarial, anticancer, antimicrobial activities and chemical constituents of essential oil from the aerial parts of *Cyperus kyllingia* Endl Rec. *Natural Products* 4 324-327.

Srivastava, D.N. (1974). Phytochemical analysis of *Japa kusum*. *Journal of Research and Education in Indian Medicine* 9(4) 103-4.

Subbarao, M., & Basha, D.P. (2015). Antidiabetic, Hypolipidemic and Histopathological Studies of Ethanolic Leaves Extract of *Hibiscus rosa sinensis* in Alloxan Mono Hydrate Induced Diabetic Rats. *World Journal of Pharmacy and Pharmaceutical Sciences* 43 1064-1074.

Sun, T., Xu, Z., Wu, C.T., Janes, M., Prinyawiwatkul, W., & HK, No. (2007). Antioxidant activities of different colored sweet bell peppers (*Capsicum annuum* L.). *Journal of Food Science* 72(2) S98–S102.

Udo, I.J., Ben, M.G., Etuk, C.U. & Tiomthy, A.I. (2016). Phytochemical, proximate and antibacterial properties of *Hibiscus rosa-sinensis* L. Leaf. *Journal of Medicinal Plants Studies* 4(5)193–195.

Vastrad, J.V., & Byadgi, S.A. (2018). Phytochemical screening and antibacterial activity of *Hibiscus rosa - sinensis* leaf extracts. *International Journal of Current Microbiology and Applied Sciences* 7(3) 3329–3337.

Venkatesh, S., Thilagavathi, J., & Shyam Sundar, D. (2008). Anti-diabetic activity of flowers of *Hibiscus rosasinensis*. *Fitoterapia* 79(2):79-81.

Wongwattanasathien, O., Kangsadalampai, K., & Tongyonk, L. (2010). Antimutagenicity of some flowers grown in Thailand. *Food and Chemical Toxicology* 48(4) 1045–1051.

WHO. (2010). Diabetes Programme.

Yashaswini, S., Hegde, R.V., & Venugopal, C.K. (2011). Health and nutrition from ornamentals, *International Journal of Research in Ayurveda and Pharmacy* 2(2) 375-382

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Zubairi, S.I. & Jaies, N.S. (2014). *Hibiscus rosa sinensis* leaves: Analysis of proximate, antioxidant activities and inorganic compound. *Malaysian Journal of Analytical Sciences* 18(2) 260-270