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ANTI-OBESITY EFFECT OF HIBISCUS SABDARIFFA *L.*- A REVIEW

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ABSTRACT

Obesity is a serious health issue prevailing worldwide and has become a global epidemic. Obesity affects all age groups; it has become particularly common among children and women. Obesity is associated with increased risk of several health problems. Using synthetic drugs and surgery for treating obesity entails a high cost and side effects. As a result an alternative approach for treatment is emphasized. Traditional medicine is explored extensively from ancient times and the use of medicinal plants and their phytochemicals for treating various diseases is well documented. The present review deals with the anti-obesity effect of *Hibiscus sabdariffa L*., an annual herbaceous shrub belonging to Malvaceae family. Leaves, seed, flower and root of *H.sabdariffa L.* are rich in phytochemicals. It has been reported that *H.sabdariffa L.* modulates obesity through its antioxidant mechanism and reduction in adipogenesis. It has a significant effect on lipid metabolism, fat absorption and excretion, and obesity related enzymes.

KEYWORDS: ***Hibiscus sabdariffa L.,*** **phytochemicals, anti-obesity, adipogenesis**

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INTRODUCTION

Obesity is a common and one of the most prevalent health disorders among all populations, age groups, sex and ethnicity, that has led to reduced life expectancy.[1-2] Obesity is a multifactorial, chronic metabolic disorder that has reached an epidemic proportion world-wide.[3] According to WHO reports, worldwide obesity has been doubled since 1980. In 2014, more than 1.9 billion adults, 18 years and older, were reported to be overweight. Of these over 600 million were obese and 39% of adults aged 18 years and over were overweight and 13% were obese. About 42 million children under the age of 5 were overweight or obese according to WHO reports in 2013.[4] Obese and overweight patients are at higher risk from coronary artery disease, hypertension, hyperlipidemia, diabetes mellitus, cancers, gall bladder disorders, cerebrovascular accidents, osteoarthritis, restrictive pulmonary disease and sleep apnea.[5-6] Though the etiology of obesity is diverse, the root cause is energy disparity; imbalance between energy intake and expenditure culminating in excessive accumulation of fat in adipose tissue, liver, muscle, pancreatic islets, and other organs involved in metabolism.[7-8] It is caused by altered lipid metabolic processes including lipogenesis and lipolysis. There are several pharmacologic substances available as anti-obesity drugs, however they are at high cost and have hazardous side effects and are not prescribed for long term usage. Hence much attention has been focused on developing plant-based safe and effective drugs which are more endurable to patients to treat obesity.[9-10] It has been reported from several studies and evidence that phytochemicals exert anti-obesity effects through regulation of various metabolic pathways, including lipid absorption, intake and expenditure of energy, increase of lipolysis, and decrease in proliferation of adipocyte cells.[11] *Hibiscus sabdariffa L.* is known for its delicacy and medicinal properties. *H.sabdariffa* finds equally significant in alternative system of medicine as well as in conventional system of medicine.[12] *H.sabdariffa* L. (family: Malvacea) is popularly known as Roselle or Sorrel. It is native to Asia (India to Malaysia) or tropical Africa. The plant is widely grown in tropics like Carribean, Central America, India, Africa, Brazil, Australia, Hawai, Florida and Phillipines. In Indian languages, it is called as Gongura, Lalambari, Patwa (Hindhi) Lal-mista, Chukar (Bengali), Lal-ambadi (Marathi), Yerra gogu (Telugu), Pulichchai Keerai(Tamil), Pulachakiri, Pundibija (Kannada), Polechi, Pulichchai (Malayalam) and Chukkiar (Assam).[13] It is a dicotyledonous plant. It is an annual or perennial herb or woody-based sub-shrub, growing 2-2.5 m tall. The leaves are deeply 3-5 lobed, 8-15 cm long, arranged alternately on the stems. The flowers are 8–10 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, 1-2 cm wide, enlarging to 3-3.5 cm, fleshy and bright red as the fruit matures.[14]

Figure 1
Hibiscus sabdariffa

A myriad of health effects have been attributed to *H.sabdariffa*. Different parts of this plant have been recommended as a remedy for various ailments like hypertension, pyrexia and liver disorders. In traditional medicine, *H.sabdariffa* finds several applications, such as antidotes to poisonous chemicals (acids, alkali, and pesticides) and venomous mushroom.[15-16] The leaves are antiscorbutic, emollient; diuretic, refrigerant, and sedative. The plant is also reported to be antiseptic, aphrodisiac, astringent, cholagogue, demulcent, digestive, purgative and resolvent. It is used as a folk remedy in the treatment of abscesses, bilious conditions, cancer, cough, debility, dyspepsia, fever, hangover, heart ailments, hypertension, and neurosis.[17-18] Phytochemical investigations showed that the plant is rich in antioxidants such as phenolic compounds, anthocyanins, flavonols, protocatechuic acid (PCA), etc.[19-20] There are reports that *H.sabdariffa* is traditionally used as weight losing remedy. A great deal of research has been carried out with *H.sabdariffa* regarding its anti-obesity effect. With this in mind, the present review discusses the anti-obesity potential of *H.sabdariffa* emphasizing on its role in lipid metabolism, effect on adipose tissue and its antioxidant activity, with particular reference to preclinical and clinical studies.

PHYTOCONSTITUENTS AND ANTIOXIDANT POTENTIAL

Previous studies have reported that *H.sabdariffa* as an excellent source of phytochemicals. The leaves, stem, flower (calyces and petals) and seeds are rich in phytochemicals such as phenols, alkaloids, anthocyanins, tannins, flavonoids including quercetin and rutin, and saponins. Besides these compounds, *H.sabdariffa* is also rich in organic acids such as hydroxycitric acid, hibiscus acid, hibiscus acid glucoside and hibiscus acid 6-methyl ester. It is a well-documented fact that most medicinal plants enriched with phenolic compounds and bioflavonoids have excellent antioxidant properties. The strong antioxidant activity of *H.sabdariffa* is evident from various *in vitro*

and *in vivo* studies carried out using its leaf, stem, flower and seed extracts.[21-25] In these studies the extract of *H.sabdariffa* is found to exhibit strong scavenging effect on reactive oxygen and free radicals, inhibit xanthine oxidase activity, show protective action against ter-butyl hydroperoxide (t-BHP)-induced oxidative damage, protect cell from damage by lipid peroxidation, inhibit Cu^{2+}-mediated oxidation of LDL and the formation of thiobarbituric acid reactive substances (TBARs) , inhibit the formation of malondialdehyde content, reduce glutathione depletion, increase liver and decrease blood activity of superoxide dismutase and catalase.[25]

EFFECT ON LIPID METABOLISM

Several studies have shown that extracts of *H.sabdariffa* have a lipid lowering effect. In one such *in vitro* study, the extract (water and ethanol extracts of dried calyces or leaves) has been found to decrease LDL cholesterol, VLDL cholesterol, total cholesterol and lipid peroxidation.[25-26] Functional ingredients such as galloyl ester, chlorogenic acid, caffeic acid, quercetin, tiliroside and anthocyanins of *H.sabdariffa* extract have been implicated for these effects. These functional ingredients play an important role in regulating lipid metabolism and thus reducing body weight. Galloyl ester decreases hepatic lipid and body weight. Chlorogenic acid lowers serum cholesterol and attenuate fatty liver by up-regulating the expression of PPARα. Chlorogenic acid and caffeic acid improves and modulates body weight, lipid metabolism and obesity-related hormone levels. Caffeic acid inhibits hepatic lipogenesis but promotes lipolysis and regulates obesity related hormone, thus reducing body weight. Quercetin inhibits adipocyte differentiation and adipocyte apoptosis. Tiliroside regulates obesity related hormone and promote hepatic lipolysis by activating adiponectin signaling and hepatic lipid oxidation. Anthocyanins decrease body weight and body fat by increasing adiponectin and decreasing leptin and adipocytes.[27] In a study conducted by Yang, the polyphenol extract containing protocatechuic acid, catechin, gallocatechins, caffeic acid and gallocatechin gallates exhibits a greater ability to decrease total cholesterol and LDL-C cholesterol and increase HDL-C cholesterol than the aqueous extract of *H.sabdariffa* containing anthocyanins, polyphenolic acid and flavonoids. It decreases the lipid content of hepatocyte through the activation of AMPK and reduction of SREBP-1, thus inhibiting the expression of fatty acid synthase and HMG-CoA reductase.[28] It has been stated that anthocyanins, particularly delphinidin-3-sambubioside and cyanidin-3-sambubioside, are generally believed to be the active constituents responsible for the antihypertensive, antioxidant and hypocholesterolemic effects of *H.sabdariffa*.[29] The hypocholestrolemic effect of *H.sabdariffa* is evident from a study in which *H.sabdariffa* extracts have found to decrease serum cholesterol levels in fructose-fed and cholesterol-fed rats and rabbits.[30] In another study, calyces and leaves extracts of *H.sabdariffa* show significant anti-hyperlipidemic activity in cholesterol induced hyperlipidemic model of rats by increasing HDL-cholestrol and decreasing lipid peroxidation.[31] Cholesterol lowering potential of *H.sabdariffa* in human subjects has been studied using oral preparation of *H.sabdariffa* extract capsules and it is reported that *H.sabdariffa* extract lowers cholesterol in these subjects.[32]

EFFECT ON ADIPOCYTES

Adipocyte differentiation and lipid accumulation are associated with the occurrence and development of obesity. Studies demonstrate that *Hibiscus* or sorrel extracts contain various phytochemicals that may have inhibitory effects on adipocyte differentiation. Hibiscus extract inhibits adipocyte differentiation by modulating PI3-K/Akt and ERK pathway that play pivotal roles during adipogenesis. The extract inhibits the expression of the adipogenic transcription factors, C/EBPα and PPARγ.[33] Inhibition of adipocyte differentiation and induction of adipocyte apoptosis by quercetin is evident from a study in which 3T3-L1 adipocyte cells treated with sorrel extract results in inhibition of adipogenesis and accumulation of cytoplasmic lipid droplets. The inhibition of adipogenesis and decrease in adipocyte cell mass can be due to lipolytic effect of sorrel.[34]

EFFECT ON OBESITY RELATED ENZYMES

Sorrel extract inhibits obesity related enzymes such as pancreatic lipase, lipoprotein lipase, *α*-glucosidase and *α*-amylase. Studies indicate that hibiscus acid and cyanidin-3-glucoside present in sorrel are active pancreatic *α*-amylase inhibitors.[34-35] In a study conducted with aqueous extracts of two varieties (red and white) of *H.sabdariffa* calyces on carbohydrate hydrolyzing enzymes (α-amylase and α-glucosidase), the red variety exhibits a higher α-glucosidase inhibitory activity than the white variety, while the white variety exhibits a higher α-amylase inhibitory activity than the red variety.[36]

EFFECT ON FAT ABSORPTION AND EXCRETION

It has become evident from several investigations that *H.sabdariffa* showed a significant effect on fat absorption and excretion. In a study carried out by O.Carvajal, *H.sabdariffa* calyx extract increases the fat excretion in feces in rats.[37] In another study it has been found that greater fat excretion in experimental animal is accompanied by a decrease in TAG, and cholesterol level including HDL cholestrol.[38]

HYDROXY CITRIC ACID

Recent studies reveals the relationship between hydroxycitric acid (HCA) and body weight control. The calyx and leaves of *H.sabdariffa* are rich in HCA. This acid has four stereoisomers, (2S, 3S), (2R, 3R), (2S, 3R) and (2R, 3S), and their lactone forms. The structure is shown in Figure 2.

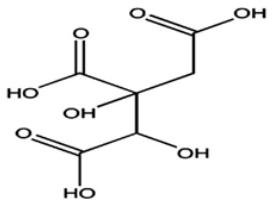

Figure 2
Structure of (2S, 3R)-Hydroxycitric acid

HCA is also found in the fruit rinds of certain species of *Garcinia*, which include *G.cambogia*, *G.indica*, and *G.atroviridis.* Hydroxy citric acid inhibits citrate cleavage enzyme, that is, ATP:citrate lyase (ATP:citrate oxaloacetate lyase, EC 4.1.3.8) that catalyzes the extra-mitochondrial cleavage of citrate to oxaloacetate and acetyl-CoA, thus limiting the availability of acetyl-CoA units required for fatty acid synthesis and lipogenesis. In an experiment conducted in rat with purified ATP:citrate lyase and (-)-HCA, ATP:citrate oxaloacetate lyase encounters a powerful inhibition by (-)-HCA.[39-40] Hydroxycitrate has been shown to inhibit the synthesis of both fatty acid and cholesterol and increase the LDL receptor activity.[41] Therefore, HCA has a potential for use as a body weight controlling agent.

CONCLUSION

The available information on *H.sabdariffa* shows its promising effects on its anti-obesity potential. Obesity is a growing problem affecting not only adults but also children. So, more robust and controlled clinical trials would be desirable with well-characterized *H.sabdariffa* preparations to corroborate its beneficial effects in obese patients.

CONFLICT OF INTEREST

Conflict of interest declared none.

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