Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 10 [12]November 2021 : 276-284

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

Fruits in weight loss: A natural approach to combat obesity

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ABSTRACT
Obesity, associated with risk of various metabolic disorders has become a global health pandemic affecting a large number of population (approx 80%), the reasons for which may be hereditary, life style, improper diet etc. Therefore, treatment of obesity is a major challenge for the persons who are affected by this disease. Synthetic drugs are available for the treatment but they are not safe due to their complicated side effects. Incorporating fruits in diet can work as an effective strategy in preventing obesity because fruits are energy rich compounds having high nutritional value with very low amount of fat. Therefore, the major objective of this study is to compile the effects of fruits (a natural approach) on weight loss because fruits can be included in diet very easily and can be the safest way to prevent obesity. Extensive literature survey was carried by scrutinizing peer reviewed articles from worldwide scientific databases available on SCOPUS, PUBMED, SCIELO, NISCAIR, Google Scholar and only relevant studies published in English were considered.
Keywords: Obesity, Fruits, Role, Fibres, Polyphenols

Received 21.09.2021 Revised 18.10.2021 Accepted 16.11.2021

INTRODUCTION

Obesity (BMI ≥ 30 kg/m^2), a chronic metabolic disorder, characterized by abnormal fat accumulation due to imbalance between energy intake and expenditure [1] is rising at an alarming rate and becoming a major global health concern leading to high mortality and morbidity [2] due to the risk associated with development of various metabolic disorders like diabetes, stroke, hypertension, osteoarthritis, sleep apnea, dyslipidemia, atherosclerosis, some cancers, and inflammation-based pathologies [3].

Treatment strategies include both pharmacological and non-pharmacological methods [4]. Pharmacological treatment includes administration of either anti-obesity drugs like Orlistat (lipase inhibitor), phentermine (centrally acting catecholamine), sibutramine (appetite suppressant) [5] under medical supervision or surgical procedures for excess fat removal [6-7] However non-pharmacological treatment includes management of obesity by life style changes which involve healthy diet, exercise along with behavioral therapy [8]. But it should be mentioned that pharmacological treatment is only justified if combined with life style changes (non-pharmacological treatment) including diet control, increasing physical activities, getting proper sleep and so forth. Many synthetic and herbal drugs (Pharmacological treatment) are available for treatment [9] but they cannot be continued permanently, have toxic side effects and their discontinuation also leads to weight gain. Moreover, their high costs, less safety, tolerance, efficacy, serious complications (gastrointestinal and kidney problems) also limits their use [5, 9-12]

As pharmacological approaches are facing a serious challenge in combating obesity, therefore more attention is now focused on the non-pharmacological methods like life style changes. Diet plays a very important role in controlling obesity and low calorie diet having no fat is in demand. Therefore incorporating fruits in diet can work as an effective strategy in preventing obesity because fruits are energy rich compounds having high nutritional value with very low amount of fat [13]. They contains high amount of water content, dietery fibres, vitamins, minerals, phytochemicals which work simultaneously [14] (Fig. 1) in preventing not only obesity but also other diseases like diabetes, inflammation, cardiovascular disorders etc [13]. The efficacy of fruits for weight loss in obese people has also been evaluated [15].

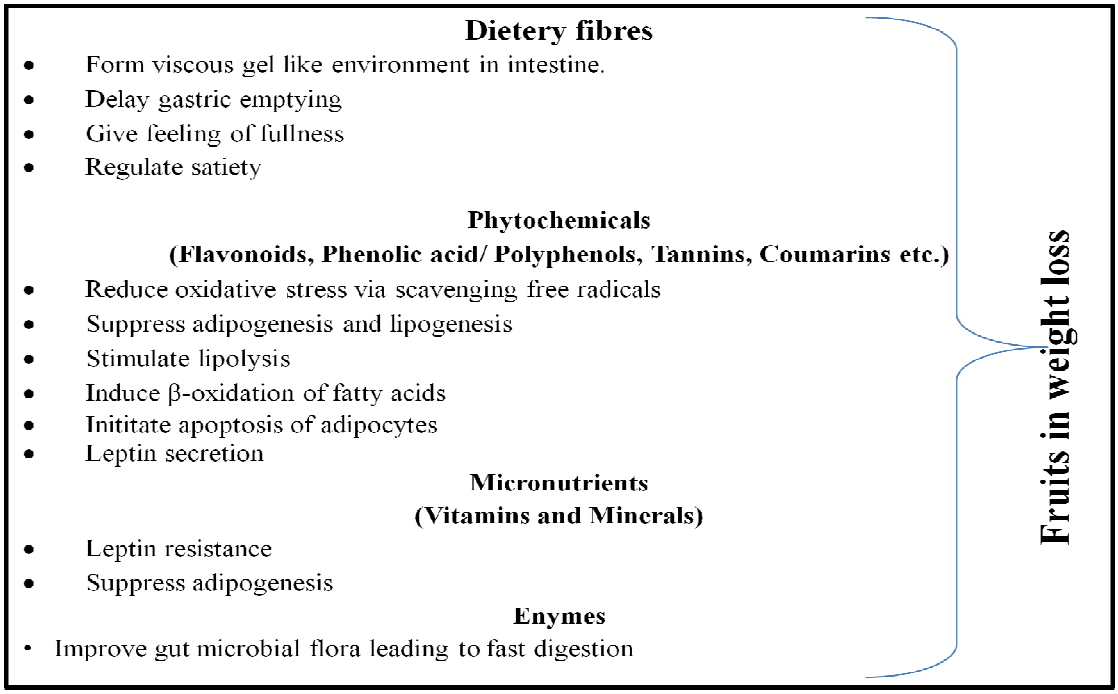

Fig. 1: Role of different components of fruits in weight loss

FRUITS USED FOR OBESITY TREATMENT

***Prunus avium* (Cherry)**

Prunus avium, (also known as wild cherry, sweet cherry, or gean) belonging to family Rosaceae is a fruit widely cultivated in Europe, Western Asia, Anatolia, North America and some parts of Australia [16]. The literature reveals its various pharmacological activities like antioxidant, anti-inflammatory, anticancer, antidiabetes etc. It is a rich source of dietary fibres, carotenoids, polyphenols (viz. coffee acid, myricetin, chlorogenic acid and p-coumaric acid), flavonoids (viz. quercetin and kaempferol), Vitamin C, minerals (phosphorus, calcium, potassium) and anthocyanins [17]

In a study by Seymour *et al.,* 2009, it was found that regular cherry due to presence of various anthocyanins like pelargonidin, cyanidin, peonidin intake prevents adiposity and adipose gene transcription in rats on high fat diet and reduces total body weight by 18%. Suppression of IL-6, TNF-α and NF-kB activity and upregulation of PPAR-a was considered for its anti-obesity effect [18].

Wu *et al.,* 2014 also studied inhibitory effects of sweet cherry anthocyanins on obesity development in C57BL/6 mice and concluded that anthocyanins (200 mg/kg dose) regulates adipocytes size, leptin secretion, cholesterol, serum glucose, triglycerides and lead to weight reduction by 11.2%. It also reduce IL-6 and TNFα gene expression and increase SOD and GPx activity [19]. The fruit is also found to be beneficial in bone impairment associated with childhood obesity [20].

***Prunus persica* (Peach/ Nectarine)**

Prunus persica (also known as peach/ nectarine/ aadoo) belonging to family Rosaceae is widely cultivated in China and reported to be effective in treatment of gastritis, inflammatory bowel disease, constipation and also having anticancer, anti-ageing, stress relieving, fast healing, demulscent and expectorant properties [21]. Chatragadda *et al.,* 2014 reported the anti-obesity effect of leaves of *Prunus persica* (peach) at the dose of 100mg/kg, 200mg/kg and 400mg/kg; p.o.in Wistar albino rats on high fat diet due to presence of polyphenols and naringenin which lowers blood cholesterol and thus responsible for the antiobesity effect [22]. They also have low calories and contain natural sugars which helps in increasing weight loss by burning extra fats deposited in body [23]. The flower are also observed to reduce lipogenesis and increase oxidation of fatty acids thereby improving hepatic lipid metabolism in high fat diet induced obese mice by Jungbin et al, 2019 [24].

***Prunus cerasifera* (Plum)**

Prunus cerasifera (plum/ aloo bukhara/ prume) is a fruit belonging to family Rosaceae and is first originated in Asia with China, USA, Turkey, Italy, Spain, France as main cultivators. It contains calcium, potassium, copper, zinc, vitamin A, vitamin C, vitamin K and insoluble dietary fibers, phenolic constituents making it highly nutritious, preventing overeating and helps in weight management [25]. It is reported to possess many pharmacological properties viz. preventing cancer, boost immunity, fights ageing etc [26].

In a report by Phillips, 2012 he concluded that plums have bioactive compounds like anthocyanins, quericitin, catechins, chlorogenic acid etc. which potentially combat obesity and its related disorders [27]. Siddiqui, 2017 in his study has well explained the anti-obesity potential of plum. Due to the presence of high amount of fibres along with low glycemic index, it regulates metabolism, reduce fat deposits and inflammation which in turn leads to alteration of cellular pathways which get deregulated in obesity [28].

***Actinidia deleciosa* (Kiwi or Chinese gooseberry)**

Actinidia deleciosa, commonly known as Kiwi, belonging to family Actinidiaceae is a fruit native to China and famous for its various beneficial properties including antioxidant, antidiarroheal, antiasthmatic, antifungal, antihypertensive etc [29]. Jang *et al.,* 2008 reported that kiwi act as anti-obesity agent by inhibiting enzyme porcine pancreatic lipase (PPL) [30, 31]. In another study by Jang *et al.,* 2009, he reported that ursolic acid isolated from actidinia is responsible for its anti-lipase and lipolytic activity which further is helpful in prevention of obesity [32].

Sunitha and Rani, 2018 in their recent studies discovered the antiobesity effect of *Actinidia deleciosa* and concluded that it may be due to presence of nutrients like dietary fibre, water-soluble antioxidants, vitamins, calcium and folic acid which help in maintaining weight by promoting fat burning, protein digestion and also lowers insulin resistance [33].

***Fragaria ananassa* (Strawberry)**

Fragaria ananassa, commonly known as strawberry, belonging to family Rosaceae is a fruit originated first in Brittany, France and cultivated all over world mainly for its fruits which are rich in fibres and various polyphenols mainly flavanoid, anthocyanin, flavanol etc. which are mainly helpful in weight loss [34]. In addition it also contains vitamin C, manganese, iodine, potassium, folic acid and vitamin K and is low in both calories and fat [35]. Prior *et al.,* 2008 reported the anti-obesity effect of strawberries is due to presence of anthocyanins (cyanidin 3-glucoside and pelargonidin-3-glucoside) in them [36-38]. Further Erika *et al.,* 2015 in his research reported that antiobesity activity of strawberries in female rat fed a high-fat diet is due to inhibition of pancreatic lipase enzyme [39].

***Ananas comosus* (Pineapple)**

Ananas comosus (Pineapple) belonging to family Bromeliaceae is native to South America and cultivated all over the world. Literature reveals various pharmacogical activities like antibacterial, antiviral, antifungal, antiparasitic, anti-inflammatory, anti-oxidant, anti-diabetic etc [40, 41]. The plant is found to contain an enzyme bromelain which improves digestion by causing protein breakdown which was confirmed by Baboota *et al.,* 2013 that bromelein is having inhibitory effect on adipocyte differentiation which suppresses PPAR regulated adipogenesis pathway and by augmenting TNF induced lipolysis and apoptosis in mature adipocytes [42].

El-Shazly *et al.,* 2018 assessed the anti-obesity potential of pineapple juice in rats fed on high fat diet and found that it markedly reduce obesity by decreasing leptin and serum insulin and increasing adinopectin treatment [43]. In addition pineapples also possess anti-oxidant property due to presence of vitamin A, C and beta-carotene which prevent free radical damage and also help in proper functioning of immune system [44].

***Malus domestica* (Apple)**

Malus domestica (Apple), belonging to family Rosaceae is indigenous to Eastern Turkey and now cultivated in many parts of the world. Polyphenols including anthocyanins, procyanidins, flavanols extracted from apples helps in preventing obesity by modulating genes responsible for adipogenesis, lipolysis, and fat oxidation in Wistar rats [45, 46]. Apples due to presence of high fiber content also reduces triacylglycerides and plasma lipid content in liver, thus improving oxidative status by producing larger intestinal pool and greater fecal excretion of bile acids in obese rats [47]. Boque *et al.,* 2013, in his another study, concluded that apple is having high anti-obesogenic effect due to its body fat-lowering ability [48].

In a compiled review by Asgari, 2018, he revealed that consuming either whole apple or its juice (240–720 mg/d) cause effective weight loss in obese people in 4–12 weeks due to presence of polyphenols, dietary fibre, carotenoids etc. in them which initiates antioxidant, antiproliferative, and cell signaling pathways [49].

***Punica granatum* (Pomegranates)**

Punica granatum (pomegranates) belonging to family Lythraceae are tropical fruits originated in Iran and cultivated since ancient times throughout the Mediterranean region and northern India. It is rich in phytochemicals such as tannins mainly ellagitannins, anthocyanins, anti-oxidants viz. flavonoids and polyphenols [50, 51] due to which it exhibited anti-obesity properties both in *in-vivo* and *in-vitro* by its hypoglycemic activity, decreasing insulin sensitivity, inhibit α-glucosidase enzyme activity, reduce total cholesterol, improve blood lipid profiles, and retard inflammation by modulating PPAR pathways [52]. In

addition, it also possesses anti-inflammatory, anticancer, neuroprotective, antiatherogenic and hypoglycemic activity [53].

***Carica papaya* (Papaya)**

Carica papaya, commonly known as papaya belonging to family Caricaceae is a nutritious fruit mainly belonging to America and also grown all over the world for its beneficial effects. Athesh *et al.,* 2012 evaluated the anti-obesity effect of aqueous fruit extract of *Carica papaya* in Wistar rats fed on high fat cafeteria diet and reported that polyphenols in papaya produce significant loss in weight and thus can be useful in obesity and related disorders [54]. It is also reported to have anti-fertility [55] and antibacterial effects [56].

Santana *et al.,* 2019 also discovered that the pulp as well as other parts of *Carica papaya* i.e. leaves and seeds has potential as antioxidant, and hypolipidemic, which, in turn, contribute to prevention and treatment of obesity and associated metabolic disorders [57]. Recently, its potential in reducing weight due to its inhibitory effect on pancreatic lipase is also observed by Phichittra et al., 2021 in HFD rats [58].

***Citrus paradise* (Grape Fruit)**

Citrus paradise (grape fruit), belonging to family Rutaceae is natural hybrid of pomelo and orange. It is widely grown in China (top producer) followed by USA and Mexico. It is rich in phytochemicals such as flavonoids (naringin, hesperidine), terpenes, furanocoumarins, and limonoids, Vitamin C, beta carotene, potassium and high contents of fibres which are responsible for its various therapeutic properties viz antiallergenic, anti-inflammatory, antimicrobial, anticarcinogenic, cardioprotective, and vasodilatory effects [59, 60]. Murase *et al.,* 2010 reported in his study that Nootkatone, a constituent present in grape fruit is helpful in treatment of obesity by stimulating energy metabolism by activating AMPK (activated protein kinase) and thus prevents diet-induced obesity [61]. Fujioka *et al.,* 2006 also reported anti-obesity effect of grapefruit in obese patient with diagnosed metabolic syndrome [62]. Hadir *et al.,* 2015 also in his research study on obese rats reported that grapefruit is even better antiobesity drug than sibutramine [63, 64].

***Morus nigra* (Mulberry)**

Morus nigra (black mulberry, blackberry or shahtoot), belonging to family Moraceae is an edible fruit native to southwestern Asia. Lim *et al.,* 2013 reported the antiobesity effect of mulberry extract on high fat diet-induced obesity [65]. Peng *et al.,* 2011 also concluded that mulberry polyphenol water extracts, on administration for 12 weeks reduced obesity in hamsters via suppressing HMG CoA reductase, hepatic fatty acid synthase, and dyslipidemia [66]. Lee et al., 2020 also concluded that leaves extract of *M. alba* fermented with 10% of *Cordyceps militaris* significantly activated pimary adipocytes lipolysis and therefore can be employed for treatment of obesity [67].

***Vaccinium ashei* (Blueberry)**

Vaccinium ashei (Blueberry), belonging to family Ericaceae is an edible fruit native to South America and is grown widely for its beneficial effects. Blueberries are rich source of anthocyanins, other polyphenols and various phytochemicals which are responsible for its therapeutic role in human body. Wu *et al.,* 2013 evaluated the effects of blueberry and mulberry fruit juice in C57BL/6 mice fed on high fat diet and found that both fruits are helpful in counteracting obesity by decreasing serum cholesterol, reducing insulin resistance, attenuating lipid accumulation and regulate leptin secretin due to presence of anthocyanins (polyphenols) in them [68].

***Rubus idaeus* (Raspberry)**

Rubus idaeus, commonly known as raspberry/ red raspberry is a red-fruit of temperate region belonging to family Rosaceae and is native to Europe and northern Asia. They contain anthocyanins, ellagic acid, quercetin, cyanidins, catechins and kaempferol [69]. Morimoto *et al.,* 2014 reported the antiobesity effect of raspberry ketone in rats by increasing norepinephrine-induced lipolysis associated with translocation of hormone-sensitive lipase from the cytosol to lipid droplets in rat epididymal fat cells [70]. Kshatriya *et al.,* 2019 evaluated that raspberry fruit due to its phenolic constituents prevented weight gain in male mice fed on high-fat diet by increasing ambulatory activity, elevated hepatic lipoprotein lipase and heme oxygenase-1 expression [71].

***Mangifera indica* (Mango)**

Mangifera indica L. commonly known as mango is a juicy tropical fruit belonging to family Anacardiaceae and is native to South Asia from where it is distributed all over the world. Kobayashi *et al.,* 2013 also investigated anti-obesity effects of mango extract in obese rats fed on high fat diet (HFD) and reported that mango cause significant decrease in activity of glycerol 2-phosphate dehydrogenase in 3T3-L1 adipocytes without eliciting cell cytotoxicity and inhibited cellular lipid accumulation through down-regulation of transcription factors such as PPARγ and C/EBPα and thus gives anti-obesity effects, both in vitro and in vivo [72]. In a study by Giuseppe *et al.,* 2019, it was discovered that *Mangifera indica* L. leaf extract due to presence of polyphenols caused increased adiponectin level by regulating adipogenesis and

decreased intracellular lipid content by causing reduced expression of genes involved in lipid metabolism and regulates adipogenesis thus can be used for controlling obesity [73]. Aqueous extract of its seed kernel is also reported to possess marked anti-obesity effects due to their pancreatic lipase inhibitory activity [74].

***Musa paradisiaca* (Banana)**

Musa paradisiaca, commonly known as banana/plantain is an edible fruit belonging to family Musaceae and is native to India and Southeast Asia. It possesses high medicinal value due to presence of dietary fibers, proteins, unsaturated fatty acids, vitamin E and flavonoids. Kumar *et al.,* 2012 reported that banana is one of best fruit for weight loss as it is full of nutrients and potassium for providing vitality and energy and are low in fats and calories [75].

***Litchi chinesis* (Lychee)**

Litchi chinesis, also knowm as lychee/lizhi is a sweet fruit belonging to soapberry family, Sapindaceae and is native to China which is the main producer of litchi followed by India. Litchi pericarp contains significant amounts of flavonoids (Flavan-3-ol monomers and dimers nearly 87% of total phenols), oligonol, anthocyanins (Cyanidin-3-glucoside about 92%, including procyanidin B_2, B_4, epicatechin, cyanidin-3-retinoside, cyanidin-3-glucoside, quercetin-3-retinoside and quercetin-3-glucoside, etc. Nishihira *et al.,* 2012 evaluated the antiobesity effects of lychee and reported that polyphenols present in lychee (Oligonol) reduced visceral fat obesity and ameliorates the metabolic syndrome [76].

***Psidium guajava* (Guava)**

Psidium guajava (guava/ lemon guava), belonging to family Myrtaceae is a tropical fruit native to Mexico, Central and northern South America. It is found to contain both carotenoids and polyphenols like (+)-gallocatechin and leucocyanidin [77]. Norazmir and Ayub, 2010 evaluated the anti-obesity effects of *Psidium guajava* (pink guava) puree in HFD (high fat diet) induced-obese rats and showed that pink guava puree significantly decreased body weight and systolic blood pressure of HFD induced-obese rats which may be due to presence of polyphenols [78].

Abdullah *et al.,* 2019 reported that guava leaf powder by causing significant reduction in fat deposition, oxidative stress and increasing activity of liver enzymes, prevents obesity on high carbohydrate high fat diet fed rats [79].

***Ficus carica* (Fig)**

Ficus carica, commonly known as fig, belonginging to family Moraceae is native to Middle East and is widely grown throughout the temperate world both for its fruit and as an ornamental plant. Phytochemical studies by Mawa *et al.,* 2013 on F. carica revealed the presence of various bioactive compounds like polyphenols, phytosterols, flavonoids, organic acids, anthocyanins, triterpenoids, coumarins, and many volatile compounds [80]. Joerin *et al.,* 2014 investigated effects of *Ficus carica* on hyperlipidemia in obese rats on high fat diet and reported that it improved lipid profile and decreased adipogenic risk factors in HFD rats by increasing HDL-C levels [81]. Mopuri *et al.,* 2018 reported the antidiabetic and antiobesogenic effect of *Ficus carica* due to presence of high amount of polyphenols and flavonoids in them [82].

***Citrullus lanatus* (Watermelon)**

Citrullus lanatus, belonging to family cucurbitaceae is a tropical or subtropical flowering plant originated from Africa and cultivated all over the world. The pulp contains high amount of vitamin C along with carotenoids especially lycopene. Okazaki *et al.,* 2014 evaluated the anti-obesity potential of watermelon extract on rats fed on high-fat diet by decreasing white adipose tissue secreting leptin in the liver [83].

***Citrus sinensis* (Orange)**

Citrus sinensis, commonly known as sweet orange and belonging to family Rutaceae is a citrus fruit mainly produced by Brazil followed by China, India and United States. Phytochemical studies assures the presence of high amount of Vitamin C along with carotenoids like lutein, β-carotene, β-cryptoxanthin, flavonoids like naringenin and various volatile compounds like esters, terpenes, alcohols [84]. Cardile *et al.,* 2015 evaluated *Citrus sinensis* juice for the weight management and discovered that presence of active compounds like anthocyanins, flavones, ascorbic acid etc. shows anti-obesity effects in in-vitro as well as in vivo studies [85].

CONCLUSION

From the above study, it can be concluded that due to presence of various bioactive compounds in fruits especially polyphenols, fruits are best and safest way to treat obesity by angiogenesis and suppressing fat absorption and glucose uptake by muscles. The main active constituent responsible for its anti-obesity effect are isolated from many fruits but still many fruits need to be explored for its main constituent responsible for its biological effect.

ACKNOWLEDGEMENT
The authors are thankful to management of MM (Deemed to be University), Mullana, Ambala for providing constant support and facilities.

CONFLICT OF INTEREST:
The authors declared no conflict of interest.

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CITATION OF THIS ARTICLE

C Jasmine, J Akash, M Bhatia. Fruits in weight loss: A natural approach to combat obesity. Bull. Env. Pharmacol. Life Sci., Vol 10[12] November 2021 : 276-284