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ANTIOBESITY ACTIVITY OF HYDROALCOHOLIC EXTRACT OF SPONDIAS PINNATA FRUITS IN RATS

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ABSTRACT
The anti-obesity activity of *Spondias pinnata* fruits against Cafeteria diet induced and Fructose diet induced obesity in rats was performed. Two doses 200 mg/kg and 400 mg/kg b.w p.o of the extract were subjected for the evaluation of anti-obesity activity against the obesity induced by feeding cafeteria diet and fructose diet. Orlistat was served as standard drug in both the models. Evaluation of body weight, serum lipid profile and glucose level, liver weight and its triglyceride (TG) level was carried out in above experimental models. Body temperature and locomotor activity was also evaluated. Orlistat(10mg/kg) and *Spondias pinnata* hydroalcoholic extract (200mg/kg) and (400mg/kg) treated animals significantly decreased body weight, liver weight, serum lipid profile and glucose level, liver TG level in all experimental models compared to obese control animals. The present study concluded that *Spondias pinnata* fruits were found to be helpful in lowering body weight, total cholesterol, triglyceride, LDL, VLDL, and increasing HDL levels in both the obese models. Result of biochemical estimation indicates the *Spondias pinnata* hydroalcoholic extract (400mg/kg) showed significant results with Orlistat. The mechanism has pointed towards inhibiting cholesterol and triglyceride synthesis.

KEYWORDS: Obesity, Orlistat, Serum lipid profile, *Spondias pinnata*.

INTRODUCTION
Obesity is a medical condition involving an excess accumulation of body fat. The prevalence of obesity is increasing not only in adults, but also among children and adolescents. The prevalence of obesity has increased steadily over the past five decades, and may have a significant impact on the quality adjusted life years.[1] In Medical definition, obesity is characterized as increased body weight and specifically adipose tissue to a degree to cause adverse health effects in the human body. Body mass index (BMI) identified as weight/height is a commonly used index to classify overweight and obesity in adults for both sexes and all age groups. According to the World Health Organization (WHO) definition a BMI greater than or equal to 25 is overweight and a BMI greater than or equal to 30 is obesity. The etiological risk factors accounted for obesity are genetic, epigenetic, metabolic, behavioral and environmental variables. The rapid increase in the prevalence of obesity and overweight magnifies the influence of behavioral and environmental matters.[2]

Obesity is a complex, multifactorial, and largely preventable disease, affecting, along with overweight, over a third of the world's population today.[3] It is one of the most preventable risk factors for morbidity and mortality and it is a major risk factor for many common chronic diseases. If secular trends continue, by 2030 an estimated 38% of the world's adult population will be overweight and another 20% will be obese.[4] In general; the two main reasons for overweight and obesity are increased intake of energy-dense foods and low physical activity. Therefore, the fundamental treatment is calorie restricted diet and exercise.[5]

Obesity can be managed by lifestyle changes such as increasing physical activities, eating more fruits and vegetables, and decreasing intake of fats and sugars. Today, there are agents sold in the market which assist patients in achieving healthy body weight called anti-obesity drugs.[6] Lifestyle modification is considered the safest method of inducing a persistent weight loss. However, compliance with conventional weight management programs is low, leading to physicians increasingly becoming reliant on drug therapy. Therefore, there is a constant demand for safe and effective pharmacological options.[7]

The currently licensed drug is best, when used in conjunction with diet, exercise, and behavior change regimens. However, they do not cure obesity; weight rebounds when discontinued. Thus, there is a great demand for the search of new and safer anti-obesity medicines. Plants have formed the basis for traditional

medicine systems. Numerous preclinical and clinical studies, with various herbal medicines reported significant improvement in controlling body weight, without any noticeable adverse effects in comparison with many chemically synthesized drugs.[8] The aim of the present study was to examine the possible anti-obesity and antihyperlipidemic activities of *Spondias pinnata* fruits in cafeteria diet and fructose induced obesity.

MATERIALS AND METHODS

Collection and Authentication of plant material

The fresh *Spondias pinnata* fruits used for the present studies were collected from local areas and was authenticated by Botanist. The fresh unripe fruits were collected, dried, powdered and used for extraction.

Preparation of hydroalcoholic extract

The shade dried fruits were ground into a coarse powder with a help of a suitable grinder. The powder was stored in an airtight container and kept in a cool, dark and dry place until used. The required quantity of powder was macerated with hydro-alcohol (50:50). The whole mixture was filtered through Whatman filter paper. The filtrate thus obtained was evaporated using a rotary flash evaporator and water bath until dried. Thus, obtained extract was stored in 4°C until used.

Experimental animals

Healthy Wistar albino rats (150–200g) of either sex was used for the experiment were procured from the animal house of Srinivas College of Pharmacy, Mangalore. They were maintained under standard conditions (temperature 22 ± 2°C, relative humidity 60±5% and 12 h light/dark cycle). The animals were housed in sanitized polypropylene cages containing sterile paddy husk as bedding. They had free access to standard pellet diet and water *ad libitum*. The Institutional Animal Ethics Committee approved the experimental protocol (Approval no. SCP/IAEC/F150/P109/2017). All the animals received humane care according to the criteria outlined in the "Guide for the Care and Use of Laboratory Animals" prepared by the "National Academy of Sciences" and published by the "National Institute of Health". The animals were acclimatized for at least one week before use.

Preliminary qualitative phytochemical analysis

The prepared hydroalcoholic extract of *Spondias pinnata* fruits was subjected to preliminary phytochemical screening for the detection of chemical constituents.

Evaluation of anti-obesity activity

Cafeteria diet induced obesity in rat[9]

The Wistar albino rats (150-180g) of either sex was randomly divided into five groups (n=6) as follows:

Group I: Normal control animals (fed with laboratory pellet chow & *ad libitum*)

Group II: Obese control animals (fed with cafeteria diet)

Group III: Obese animals (cafeteria diet + Orlistat 10mg/kg)

Group IV: Obese animals (cafeteria diet + *Spondias pinnata* extract 200mg/kg)

Group V: Obese animals (cafeteria diet + *Spondias pinnata* extract 400mg/kg)

All the animals except in Group I, obesity was induced by feeding cafeteria diet along with normal diet for six weeks and continued along with the treatment for next four weeks. All the treatment was given post orally daily once.

Cafeteria diet: Cafeteria diet consists of commonly consumed energy-intense foods namely flavored potato chips, chocolate chip cookies and butter flavored cookies.

Fructose induced obesity in rats

The Wistar albino rats (150-180g) of either sex was randomly divided into following groups:

Group I: Normal control animal (fed with laboratory pellet chow & *ad libitum*)

Group II: Obese control animal (fed with 20% Fructose)

Group III: Obese animal (20% Fructose + Orlistat 10mg/kg per day)

Group IV: Obese animal (20% Fructose + *Spondias pinnata* extract 200mg/kg)

Group V: Obese animal (20% Fructose + *Spondias pinnata* extract 400mg/kg)

All the animals except in Group I, obesity was induced by replacing normal drinking water with 20% fructose for six weeks and continued along with the treatment for next four weeks. All the treatment was given post orally daily once.

Parameters evaluated

Body Weight and Food Intake

In both the model the body weight and food intake were recorded every week till completion of the experiment.

Body temperature

In both the model the body temperature was measured using a rectal thermometer on the last day of experiment with a contact time of one minute.

Estimation of liver Weight and Liver triglyceride content

After completion of the experiment, the animals of both the model were sacrificed with an overdose of diethyl ether. The liver was quickly removed, weighed and used for estimation of triglyceride.

Biochemical estimations

In both the model after completion of the experiment, blood was collected by retro-orbital puncture from the ether-anesthetized rats and serum was separated for estimation of biochemical parameters. Serum triglycerides,[10] Serum total cholesterol,[11] Serum high

density lipoprotein-c (HDL-c),[12] LDL cholesterol, VLDL- cholesterol[13] and serum glucose[14] were estimated.

Statistical analysis

All data were expressed as Mean ±SEM. The statistical significance between groups were compared using one way ANOVA, followed by Tukey's t-test (multiple comparison test).

RESULTS

Preliminary phytochemical screening

Results of the preliminary phytochemical investigation of hydroalcoholic extract of *Spondias pinnata* fruits are shown in the table 1.

Table 1: Preliminary phytochemical screening of hydroalcoholic extract of *spondias pinnata* fruits.

Sl. no.	Test	Result
1.	Alkaloids	+ve
2.	Carbohydrates	+ve
3.	Flavonoids	+ve
4.	Proteins	+ve
5.	Saponins	+ve
6.	Steroids	+ve
7.	Tannins	+ve
8.	Glycosides	-ve

Cafeteria diet induced obesity

Effect of extract on body weight in rats with cafeteria diet induced obesity

There was significant increase in the body weight of cafeteria diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly reduced body weight compared to cafeteria diet induced obese animals as shown in table 2.

Effect on serum total cholesterol (TC) level

There was significant increase in the serum total cholesterol of cafeteria diet induced obese animals compared to control animals (P<0.05). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly decreased serum total cholesterol compared to cafeteria diet induced obese animals as shown in the table 2.

Effect on serum HDL cholesterol (HDL-C) level

The serum HDL cholesterol significantly decreased in cafeteria diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly increased serum HDL, cholesterol compared to cafeteria diet induced obese animals as shown in table 2.

Table 2: Effect of extract on body weight and serum lipid profile in rats fed with cafeteria diet (CD) induced obesity.

Sl no.	Groups	Body weight difference(g)	Serum TG (mg/dl)	Serum TC (mg/dl)	Serum HDL-C (mg/dl)
1	Normal Control group	18.15±0.28	82.67±0.26	98.57±0.31	60.25±0.38
2	CD Obese control group	36.65±0.26	160.3±0.37	210.5±0.31	36.10±0.30
3	CD and Orlistat treated group	20.98±0.22***	104.3±0.28***	120.8±0.41***	53.97±0.29***
4	CD and extract (200mg/kg) treated group	31.20±0.26**	134.1±0.32*	162.6±0.37**	44.15±0.38***
5	CD and extract (400mg/kg) treated group	24.63±0.25***	116.1±0.31**	132.5±0.29***	50.10±0.33***

All values are expressed as mean± SEM n=6, One way analysis variance (ANOVA) followed by Tukey's multiple comparison test *P<0.01, **P<0.001, ***P<0.0001 compared with obese control group.

Effect on serum LDL cholesterol (LDL-C) level

The serum LDL cholesterol significantly increased in cafeteria diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly decreased serum LDL cholesterol compared to cafeteria diet induced obese animals as shown in table 3.

Effect on serum VLDC cholesterol (VLDL-C) level

There was significant increase in the serum VLDL cholesterol level in cafeteria diet induced obese animals compared to control animals (P<0.0001). Orlistat (10 mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly decreased serum VLDL cholesterol compared to cafeteria diet induced obese animals as shown in table 3.

Effect on serum glucose level

The serum glucose level significantly increased in cafeteria diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) significantly decreased serum glucose level compared to cafeteria diet induced obese rat as shown in table 3. Both extract (200mg/kg) and (400mg/kg) treated animals significantly decreased serum glucose compared to cafeteria diet induced obese animals.

Effect of extract on liver TG level in rats with cafeteria diet induced obesity

Liver TG level significantly increased in the cafeteria diet induced obese animals compared to control animals (P<0.0001). Both Orlistat (10mg/kg) and extract (200mg/kg), (400mg/kg) treated animals significantly

decreased liver TG level compared to cafeteria diet induced obese animals as shown in table 3.

Table 3: Effect of extract on serum lipid profile, glucose levels & liver TG level in rats with cafeteria diet (CD) induced obesity.

Sl No	Groups	Serum LDL-C (mg/dl)	Serum VLDL-C (mg/dl)	Serum glucose (mg/dl)	Liver TG (mg/g)
1	Normal Control group	55.35±0.28	18.25±0.38	90.45±0.37	88.25±0.38
2	CD obese control group	205.40±0.33	34.37±0.36	137.5±0.39	168.3±0.38
3	CD and Orlistat treated group	88.50±0.32***	22.30±0.36***	102.7±0.46***	108.3±0.36***
4	CD and extract (200mg/kg) treated group	144.5±0.32*	28.25±0.38**	122.5±0.41***	138.2±0.35**
5	CD and extract (400mg/kg) treated group	105.6±0.28**	24.32±0.36***	111.2±0.38***	117.4±0.55***
All values are expressed as mean± SEM n=6, One way analysis variance (ANOVA) followed by Tukey's multiple comparison test *P<0.01, **P<0.001, ***P<0.0001 compared with obese control group.					

Effect of extract on liver weight in rats with cafeteria diet induced obesity

There was significant increase in the liver weight of cafeteria diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg) and (400mg/kg) treated animals significantly reduced liver weight compared to cafeteria diet induced obese animals as shown in table 4.

Effect of extract on food intake in rats with cafeteria diet induced obesity

There was significant increase in the food intake of cafeteria diet induced obese animals compared to control animals (P<0.05). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly reduced food intake compared to cafeteria diet induced obese animals as shown in table 4.

Effect of extract on body temperature in rats with cafeteria diet induced obesity

There was significant increase in body temperature of cafeteria diet induced obese animals compared to control animals (P<0.0001). A little but significant (p < 0.0001) increase in body temperature was also observed in Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals as shown in table 4.

Effect of extract on locomotor activity in rats with cafeteria diet induced obesity

There was significant decrease in locomotor activity in cafeteria diet induced obese animals as compared to control group (p < 0.0001). Treatment with Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) resulted in significant increase in locomotor activity in cafeteria diet animals as shown in Table 4.

Table 4: Effect of extract on Liver weight, food intake body temperature & locomotor activity in rats with cafeteria diet (CD) induced obesity.

Sl. no.	Groups	Liver weight (g)	Food intake (g/day/rat)	Body temperature (^{0}C)	Locomotor activity
1	Normal Control group	5.25±0.38	6.91±0.53	36.10±0.0067	169.9±0.05
2	CD obese control group	10.25±0.38	12.92±0.53	36.20±0.0060	107.3±0.37
3	CD and Orlistat treated group	6.38±0.31***	8.83±0.44***	36.30±0.0066***	154.3±0.25***
4	CD and extract (200mg/kg) treated group	8.40±0.30***	11.25±0.38***	36.63±0.1706***	132.6±0.28**
5	CD and extract (400mg/kg) treated group	6.75±0.46***	10.08±0.47***	36.73±0.0188***	144.2±0.33***
All values are expressed as mean± SEM n=6, One way analysis variance (ANOVA) followed by Tukey's multiple comparison test *P<0.01, **P<0.001, ***P<0.0001 compared with obese control group.					

Fructose diet induced obesity

Effect of extract on body weight in rats with fructose diet induced obesity

There was significant increase in the body weight of dextrose diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly reduced body weight compared to fructose diet induced obese animals as shown in table 5.

Effect of extract on serum lipid profile & glucose levels in rats with fructose diet induced obesity

Effect on serum triglyceride (TG) level

Serum TG levels significantly increased in the fructose diet induced obese animals compared to control animals

(P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly decreased serum TG level compared to fructose diet induced obese animals as shown in table 5.

Effect on serum total cholesterol (TC) level

There was significant increase in the serum total cholesterol of fructose diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly decreased serum total cholesterol compared to fructose diet induced obese animals as shown in the table 5.

Effect on serum HDL cholesterol (HDL-C) level

The serum HDL cholesterol significantly decreased in fructose diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly increased serum HDL, cholesterol compared to fructose diet induced obese animals as shown in table 5.

Table 5: Effect of extract on body weight and serum lipid profile in rats fed with fructose diet induced obesity.

Sl no.	Groups	Body weight difference(g)	Serum TG (mg/dl)	Serum TC (mg/dl)	Serum HDL-C (mg/dl)
1	Normal Control groups	18.25±0.38	81.08±0.56	93.17±0.44	49.83±0.44
2	Fructose diet obese control group	40.25±0.38	155.0±0.48	190.5±0.46	35.75±0.38
3	Fructose and Orlistat treated group	22.33±0.52***	100.2±0.57***	112.7±0.52***	46.25±0.38***
4	Fructose and extract (200mg/kg) treated group	30.42±0.47**	128.4±0.47**	148.3±0.38**	40.17±0.57***
5	Fructose and extract (400mg/kg) treated group	24.42±0.47***	110.2±0.57***	122.8±0.38***	44.75±0.38***

All values are expressed as mean± SEM n=6, One way analysis variance (ANOVA) followed by Tukey's multiple comparison test *P<0.01, **P<0.001, ***P<0.0001 compared with obese control group.

Effect on serum LDL cholesterol (LDL-C) level

The serum LDL cholesterol significantly increased in fructose diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly decreased serum LDL cholesterol compared to fructose diet induced obese animals as shown in table 6.

Effect on serum VLDL cholesterol (VLDL-C) level

There was significant increase in the serum VLDL cholesterol level in cafeteria diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly decreased serum VLDL cholesterol compared to fructose diet induced obese animals as shown in table 6.

Effect on serum glucose level

The serum glucose level significantly increased in fructose diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) significantly decreased serum glucose level compared to fructose diet induced obese rat as shown in table 6. Both extract (200mg/kg) and (400mg/kg) treated animals significantly decreased serum glucose level compared to fructose diet induced obese animals.

Effect of extract on liver TG level in rats with fructose diet induced obesity

Liver TG level significantly increased in the fructose diet induced obese animals compared to control animals (P<0.0001). Both Orlistat (10mg/kg) and extract (200mg/kg), (400mg/kg) treated animals significantly decreased liver TG level compared to fructose diet induced obese animals as shown in table 6.

Table 6: Effect of extract on serum lipid profile, glucose levels & liver TG level in rats with fructose diet induced obesity.

Sl. No.	Groups	Serum LDL-C (mg/dl)	Serum VLDL-C (mg/dl)	Serum glucose (mg/dl)	Liver TG (mg/g)
1	Normal Control group	58.67±0.27	16.53±0.29	84.57±0.42	80.75±0.38
2	Fructose obese group	185.8±0.37	30.75±0.38	143.3±0.38	160.8±0.43
3	Fructose and Orlistat treated group	85.78±0.36***	20.72±0.39***	108.8±0.38***	101.8±0.35***
4	Fructose and Extract (200mg/kg) treated group	133.5±0.31**	25.22±0.40***	128.3±0.38**	130.8±0.35**
5	Fructose and Extract (400mg/kg) treated group	99.57±0.40***	21.75±0.38***	117.4±0.36***	110.8±0.35***
All values are expressed as mean± SEM n=6, One way analysis variance (ANOVA) followed by Tukey's multiple comparison test *P<0.01, **P<0.001, ***P<0.0001 compared with obese control group.					

Effect of extract on liver weight in rats with fructose diet induced obesity

There was significant increase in the liver weight of fructose diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly reduced liver weight compared to fructose diet induced obese animals as shown in table 7.

Effect of extract on food intake in rats with fructose diet induced obesity

There was significant increase in the food intake of fructose diet induced obese animals compared to control animals (P<0.0001). Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals significantly reduced food intake compared to fructose diet induced obese animals as shown in table 7.

Effect of extract on body temperature in rats with fructose diet induced obesity

There was significant increase in body temperature of fructose diet induced obese animals compared to control animals (P<0.0001). A little but significant (P< 0.0001) increase in body temperature was also observed in Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) treated animals as shown in table 7.

Effect of extract on locomotor activity in rats with fructose diet induced obesity

There was significant decrease in locomotor activity in fructose diet induced obese animals as compared to control group (p < 0.0001). Treatment with Orlistat (10mg/kg) and both extract (200mg/kg), (400mg/kg) resulted in significant increase in locomotor activity in fructose diet animals as shown in table 7.

Table 7: Effect of extract on Liver weight, food intake, body temperature & Locomotor activity in rats with fructose induced obesity.

Sl. no.	Groups	Liver weight (g)	Food intake (g/day/rat)	Body temperature(^{0}C)	Locomotor activity
1	Normal Control group	4.83±0.44	8.25±0.38	36.17±0.087	162.8±0.35
2	Fructose obese group	9.38±0.31	15.38±0.45	36.28±0.007	110.4±0.47
3	Fructose and Orlistat treated group	6.58±0.24***	10.78±0.34***	36.34±0.006***	150.8±0.38***
4	Fructose and Extract (200mg/kg) treated group	8.25±0.38**	14.21±0.36**	36.54±0.003***	132.5±0.47***
5	Fructose and Extract (400mg/kg) treated group	6.81±0.34***	11.80±0.35***	36.75±0.015***	141.7±0.41***
All values are expressed as mean± SEM n=6, One way analysis variance (ANOVA) followed by Tukey's multiple comparison test *P<0.01, **P<0.001, ***P<0.0001 compared with obese control group.					

DISCUSSION

Obesity is a chronic metabolic disorder that results from the imbalance between energy intake and energy expenditure, characterized by enlarged fat mass and elevated lipid concentration in blood. Obesity is also a primary risk factor for CVD (cardiovascular disorders). It has reached epidemic proportions globally, with approximately 1.6 billion persons (aged 15 years old and above) being overweight. Many attempts have been made to correct the metabolic disparity of the obesity condition, producing a number of reagents, including fibrates, Sibutramine (an anorectic or appetite suppressant), and Orlistat, but no one is free from the severe side effects.[15] At present, because of dissatisfaction with high costs and potentially hazardous side-effects, the potential of natural products for treating obesity is under exploration and this may be an excellent alternative strategy for developing future effective, safe anti-obesity drugs. A variety of natural products including crude extracts and isolated compounds from

plants can induce body weight reduction and prevent diet-induced obesity. Therefore, they have been widely used in treating obesity.[16]

Several infusions or decoctions of plants used in traditional medicine to reduce obesity could be utilized to delete the clinical side effects of the current chemically formulated anti-obesity agents; the examples include *Camellia sinensis* L. (Theaceae), *Citrus aurantium* L. (Rutaceae), *Garcinia cambogia* L. (Clusiaceae), *Nelumbo nucifera* (Nymphaeaceae),and *Hibiscus sabdariffa* L. (Malvaceae).[17] *Spondias pinnata* distributes around 20 countries all over the world and normally in India, Sri Lanka and South East Asian countries. In India it is commonly seen the deciduous to semi evergreen forests of the Western Ghats.[18] Used in treatment of hemorrhagic disease, anti-emetic, dyspepsia, gonorrhea, severe cough, aphrodisiac, leprosy, diabetes, diuretic, eye inflammation, antioxidant, antimicrobial, thrombolytic agent, purgative.[19]

In the present study we have studied the effects of hydroalcoholic extracts of *Spondias pinnata* for 28 consecutive days, by p.o. administration, on body weight changes, locomotor activity, change in body temperature, blood lipid levels, liver weight, liver TG level and food intake in normal and cafeteria diet fed rats and in fructose fed rats. Initially phytochemical analysis was carried out and It was clear that *Spondias pinnata* contained triterpenoids, glycoside, carbohydrates, proteins, flavonoids and saponins. Some chemical constituents like saponins, flavonoids, and some triterpenoids have been noted for their anti-obesity effect in various plants.[20] Based on this phytochemical study and ethnobotanical claims, this plant was selected to carry out this study.

Our results demonstrated in both cafeteria diet induced obese and fructose induced obese rats showed a significant increase in weight gain compared with the normal chow diet- feed rats, which was significantly decreased by the co-administration of extract, in a dose-dependent manner. In both the models treatment with Orlistat, had shown significant reduction in weight gain compared with the obese control and normal control groups. This increase in weight gain in the cafeteria diet-treated group and fructose treated group was probably due to more palatability.[21]

Reduction in weight gain by co-administration of extract, in low and high doses, may be due to its crude saponin and flavonoid content. Crude saponin and flavonoid have been reported for their appetite-suppressant property. From this study we are predicting that saponin and flavonoids, after absorption from the gastrointestinal tract (GIT) cross the Blood Brain Barrier (BBB) and enter the brain, and amplify signaling in the basal hypothalamus energy sensing function, which is the master regulator of food intake and energy expenditure or it may also be possible that saponin inhibits the re-uptake of 5-HT in the hypothalamus. Some flavonoids also activate β-adrenergic receptors, which are involved in the burning of fats.[22]

Locomotor activity was performed on last day of the study. Administration of extract and standard Orlistat have shown a significant increase in locomotor activity compared to obese control rats. The increases in rectal temperature by extract may be attributed to the thermogenic property of the phytoconstituents in the extracts. In both cafeteria diet induced obese and fructose induced obese rats showed elevated levels of serum glucose, Triglycerides (TG), Total cholesterol (TC), and Low-density lipoprotein cholesterol (LDL-C), and a fall in the HDL-C levels as compared to normal control animals, which was significantly decreased by the administration of extract 200 and 400 mg/kg. Orlistat was most significant in this case.

In culmination with the results, the study was initiated due to the presence of phytoconstituents such as flavonoids, glycosides, sapogenins, cycloartenone, cycloartenol, β-sitosterol and tannins, and alkaloids in the ethanolic extract. It could be responsible for the possible significant anti-obesity activity. This activity initially was assessed with the ethno-pharmacological survey, but finally confirmed with the above animal model.

There was an assumption that there may be inhibition of pancreatic lipase activity. The pharmacological activity of orlistat results in partial inhibition of triglyceride absorption by reducing hydrolysis and production of absorbable unesterified fatty acids and monoglycerides. Due to structural similarities with triglycerides, orlistat interacts with the lipases in a substrate like manner. Studies in animal models of obesity showed dose dependent reductions of body weight and body fat although the predictability of these data for clinical efficacy and safety was considered to be limited. The hydroalcoholic extract of *Spondias pinnata* fruit helps to lowering body weight, total cholesterol, triglycerides, LDL, VLDL and increasing HDL levels and locomotor activity in both the obesity models i.e., cafeteria diet and fructose diet induced obesity.

CONCLUSION

In conclusion, the finding of the study suggests that *Spondias pinnata* hydroalcoholic fruit extract is an appetite suppressant and anti-obesity drug. The present study proves that the hydroalcoholic extract of *Spondias pinnata* exhibited a significant anti-obesity activity. Oral administration of extracts reduced the level of circulating lipids resulting in the decrease of body weights in albino wistar rats, which bearing close resemblance to human obesity. The outcome of the research work suggests that the hydroalcoholic extract of *Spondias pinnata* fruit may have beneficial effects against Obesity that holds the hope of new generation of anti-obesity drugs.

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