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EVALUATION OF ANTI-OBESITY POTENTIAL OF CASHEW NUT (*ANACARDIUM OCCIDENTALE*) IN ANIMALS

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ABSTRACT

Obesity is often associated with the increase prevalence of of chronic diseases such as insulin resistance diabetes mellitus, hypertension, hypercholesterolemia, cerebrovascular accident, heart attack, congestive cardiac diseases, cancer, gallstone formation, gout, etc. The anti-obesity effect of cashew nut in animals fed on Cafeteria and Atherogenic diet was evaluated. The animals were divided into three major groups viz. Normal diet, Cafeteria diet and Atherogenic diet. Under these groups, they were further divided into five sub-groups. The first sub-group consists of control animals and they were not treated with any drug. The second sub-group was treated with the standard drug, i.e. Ayurslim. The third, fourth and fifth sub-groups were treated with cashew nut at the dose of 100, 150 and 200 mg/kg respectively. The treatment period was 40 days. After 40 days, change in body weight, lipid profile and CNS activity were evaluated in all the groups. There was a significant reduction in body weight, locomotor activities, fat pad weights (kidney fat, mesenteric fat and uterine fat), cholesterol, triglycerides, LDL, VLDL level and increased in HDL level of the animals treated with Ayurslim and Cashew nut. These results suggest that cashew nut possessed potent anti-obesity activity.

Keywords: *Anacardium occidentale*, Anti-obesity, Ayurslim.

INTRODUCTION

Obesity is defined as an increase in total fat mass and it occurs when unilocular adipocytes show hyperplasia or hypertrophy following macrophage infiltration of fat tissue [1]. Obesity is a serious health problem. Among the multiple factors contributing to its etiology, the sedentary life styles, white collar jobs, lack of exercise, psychological factors, and the consumption of energy rich diets are the major ones [2,3].

Obesity is reaching epidemic proportions worldwide; it is correlated with various comorbidities, among which the most relevant are dyslipidemia [4], diabetes mellitus type-2 [5], fatty liver (which can later progress to nonalcoholic fatty liver disease) [6], cardiovascular diseases(CVD) such as congestive heart failure(CHF) and coronary heart disease (CHD) [7]. Due to obscure aetiology, the treatment of obesity is difficult and challenging. Although a number of pharmacological approaches for treatment of obesity have been investigated, but only few are safe and all of these have adverse effects [8]. Further, the cause of concern is the non-availability of drugs for its treatment and the short-term efficacy and limiting side effects of the available drugs [9].

So, the alternative is to discover anti-obesity agents from plants or other natural resources which have less or no side effects. In nutrition, a new era is emerging that is characterized by the search for dietary constituents that have benefits beyond those ascribed to the macro and micronutrients. Historically, in the area of CVD, efforts have been directed toward identifying the type and, to some extent, amount of dietary fat that can achieve maximal risk reduction. It is now clear that although a fat-modified diet can significantly affect CVD risk, other components in the diet, such as dietary fiber, plant protein, and soy protein appear to confer additional protective effects that extend beyond the lipid-lowering effects of the recommended diets.

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Identification of additional dietary constituents that elicit favorable effects will facilitate the development of diets. that are even more effective for both the prevention and treatment of CVD and other chronic diseases. In the search for bioactive components in foods that favorably affect CVD risk, nuts have begun to attract attention. Nuts are complex plant foods that are not only rich sources of unsaturated fat but also contain several nonfat constituents such as plant protein, fiber, micronutrients (e.g., copper and magnesium), plant sterols, and phytochemicals [10]. Because nuts have a favorable fatty acid profile and contain several bioactive compounds that may confer additional protective effects, there is interest in evaluating the role of nuts in cholesterol-lowering diets.

As noted earlier, cashew is devoid of cholesterol with energizing capacity [12]. It contains healthy monounsaturated fat that promotes good cardiovascular health, because monounsaturated fats reduce high triglyceride levels which are associated with increased risk for heart disease. Moreover, it is a good source of magnesium; this mineral works with calcium to support healthy muscles and bones in the body. In addition to this, cashew nuts have a high energy density and high amount of dietary fibre, both have been attributed to a beneficial effect on weight management. It is also evident that there is direct correlation between the cholesterol lowering diet and reduction in body weight. Thus, the present study was designed to explore the role of cashew nut in the treatment of obesity.

MATERIALS AND METHODS

Experimental Animals

Male Swiss albino mice weighing between 25-30 g and Female Sprague Dawley rats weighing 150-200g were selected for the proposed study. These animals were procured from Krupanidhi College of Pharmacy. They were housed six per cage at room temperature 25° ± 5°C in a well-ventilated animal house under 12 hour light and dark cycle. Institutional Animal Ethics Committee approved the experimental protocol. The animals were maintained under standard conditions as per the guidelines of CPCSEA.

Preparation of Cashew Nut Extract, Standard Drug and Dose selection

Cashew nuts were purchased from the local super market. They were ground into a paste by suspending in distilled water. The dose for Cashew nut was found out by carrying out Acute Toxicity studies according to OPPTS guidelines 67. The animals were fasted overnight prior to the studies. Mice were divided into two groups of three each. Test dose of 2 g/kg body weight and 5 g/kg body weight were given orally to albino mice (20-30g). 1/10th, 1/25th and 1/50th of the maximum safe dose was selected as low, medium and high doses respectively. Cashew nut preparation were suspended in distilled water and administered orally twice a day for 40 days at a constant volume of 0.5 ml/100 g of body weight. Ayurslim was the standard antiobesity agent used in this study. It is a herbal formulation comprising powders of Garcinia (*Garcinia cambogia*), Guggul (*Commiphora wightii*), Gymnema (*Gymnema sylvestre*), *Terminalia chebula* and Fenugreek (*Trigonella foenum*-graecum) [12]. It was manufactured by the Himalaya Drug Company, Bangalore. AyurSlim was suspended in distilled water and administered orally in a dose of 3 mg/kg, p.o. twice a day for 40 days. For AyurSlim Capsules, the dose was converted from prescribed human dose to the appropriate animal dose via the FDA dose calculator on the US FDA website.

Apparatus and chemical used

Analytical balance (Schimadzu, Japan), Semi Auto Analyzer(Qualigens, Mumbai), Centrifuge, Triglycerides and Cholesterol kits (Span Diagnostics, Bangalore, India), Ethanol (Hong yang chemical corp. China), Ayurslim capsules (Himalaya Drug company, Bangalore, India), Heparin (Gland Pharmaceutical Ltd, Hyderabad, India), Ketamine (Prem Pharmaceutical Ltd, Indore, India), Sodium chloride (Merck Specialities Private Limited, Mumbai, India), Xylazine (Indian Immunological, Guntur, India).

Description of Diet

According to a research published by Rolls BJ et al, the availability of a variety of foods is an important factor in the amount eaten in the meal and in the etiology of obesity 68. When animals are exposed to different diets, their energy intake is increased, which leads to increase in lipid profile, and hence development of obesity. Therefore, our study comprises of 3 separate diets.

Normal Pellet Chow: This is the staple diet for rats. It is complemented with water, and is given throughout the day. The first model comprises of this diet only.

Cafeteria Diet

The cafeteria diet [13] consisted of 3 diets-

1st diet-condensed milk, 40g + bread, 40g

2nd diet-chocolate, 15g + biscuits, 30g + dried coconut, 30g

3rd diet-cheese, 40g + boiled potatoes, 50g.

The three diets were given to group of 6 animals on day 1, 2 and 3 respectively and then repeated in same succession.

Atherogenic Diet

The atherogenic diet [14] consisted of - cholesterol 1%, cholic acid 0.5%, lard oil 5%. These diets were provided in addition to normal pellet chow.

Phytochemical estimations of the Cashew nut extract [15,16].

Aqueous extract of Cashew nut was subjected to qualitative analysis to investigate the presence of various phytochemical constituents such as alkaloids,

carbohydrates, glycosides, phytosterols, proteins, amino acids, saponins, tannins and flavonoids.

Experimental Groups

The female Sprague Dawley rats were divided into three major groups. Each of the subgroups consists of six animals as follows:

Methods and parameters used for evaluation of obesity [17]:

Body weight: The body weight (g) of the animals were recorded on day 1 and then on alternate days for 40 days in each group.

Body temperature: The body temperature was recorded on day 39 using rectal telethermometer before and after drug administration at 30, 60, 90, 120 and 180 min with a contact time of 1 minute.

Locomotor activity: Elevated plus maze test and despair swim test were conducted for this activity. This activity was recorded on day 40 using elevated plus maze test-open field, 30 minutes after cashew nut administration to treatment groups. Despair swim test was also conducted 30 minutes after cashew nut administration to treatment groups to find out its locomotor activity.

Biochemical parameters: On day 41 changes in total cholesterol, LDL, VLDL, HDL and triglyceride levels will be measured from serum samples using the biochemical kits.

Fat pad weights: The animals were sacrificed by cervical dislocation and then then the fat pads (mesenteric fats, uterine fats and kidney fats) were removed, dried and weighed.

Sampling and tissue preparation

Blood Sampling

By the end of the experimental periods, blood samples were collected by retro-orbital route of normal, obese control, obese treated rats via capillary tubes at a fasting state. The blood samples were collected in dry glass centrifuge tubes and centrifuged at 3500 rpm for 15 minutes at room temperature for separation of serum. The clear, non-haemolysed supernatant sera were separated using clean dry disposable plastic syringes and stored for subsequent biochemical measurements like total cholesterol, triglycerides, LDL, VLDL, and HDL level [15].

Tissue samples

Rats were sacrificed by decapitation and an abdominal incision was immediately done for separation of fat pads like uterine fat, mesenteric fat and kidney fat. These were dried on filter paper and weighed [17].

Statistical Analysis

Statistical analysis was carried out using Graph Pad Instat software (version 3, ISS-Rome, Italy). Unless otherwise specified, groups of data were compared with an unpaired t-test one-way ANOVA followed by Tukey-Kramer (TK) multiple comparisons post-test. Values of $P < 0.05$ were regarded as significant. Data were expressed in tables and figures as mean ± standard error (SEM).

RESULTS

Effect of Cashew Nut and Standard Drug on Body Weight (Table 2)

In the normal diet, cashew high dose showed a significant decrease ($p<0.001$) in the body weight of the animals when compared with control and also caused a significant decrease ($p<0.05$) when compared to cashew low dose. However, it did not show a significant decrease when compared with the standard drug. Cashew medium dose also caused a significant decrease ($p<0.01$) in the body weight when compared to control. Cashew low dose, however it did not show a significant decrease in the body weight when compared with control.

In cafeteria diet, cashew high dose showed significant decrease ($p<0.001$) in the body weight when compared to control and low dose but it did not show a significant decrease when compared with the standard drug. Cashew medium dose also caused a significant decrease ($p<0.001$) when compared to control and low dose. Cashew low dose showed significant activity showed a significant decrease ($p<0.05$) when compared to control.

In atherogenic diet, cashew high dose showed significant decrease ($p<0.001$) in the body weight when compared to control and low dose. Cashew medium dose showed significant decrease ($p<0.001$) when compared to control and low dose. Cashew low dose showed significant decrease ($p<0.05$) in the body weight when compared to control.

In all the three groups, the standard drug showed a significant decrease ($P<0.001$) in the body weight of the animals when compared with the control group. These results showed that cashew high dose has better activity in reducing the body weight than the cashew medium dose and low dose. The standard drug is more active than the cashew low dose and medium dose and cashew high dose has almost similar effects like that of the standard drug in reducing the body weight.

Effect of Cashew Nut and Standard Drug on Cholesterol level (Table 2)

In the normal diet, cashew high dose showed a significant decrease ($p<0.001$) in the Total cholesterol (TC) level when compared to control and low dose. Cashew medium dose also caused a significant decrease ($p<0.001$) when compared to control and ($p<0.01$) when compared to low dose.

In cafeteria diet, cashew high dose showed a significant decrease ($p<0.001$) in the TC level when compared to control and low dose and ($p<0.01$) when compared with medium dose. Cashew medium dose also caused a significant decrease ($p<0.001$) when compared to control and ($p<0.01$) when compared to low dose.

In atherogenic diet, cashew high dose showed a significant decrease ($p<0.001$) in the TC level when compared to control and low dose. Cashew medium dose showed a significant decrease ($p<0.001$) when compared to control and ($p<0.01$) when compared to low dose.

In all the three groups, the standard drug showed a significant decrease ($P<0.001$) in the TC level when compared with the control group. However, cashew low dose did not show any significant decrease in the TC level when compared to the control group.

Thus, there was a significant decrease in the total cholesterol level in all the groups except in cashew low dose when compared to the control group. This indicates that the standard drug and the cashew high dose and medium dose are effective in reducing cholesterol levels.

Effect of Cashew Nut and Standard Drug on Triglycerides level (Table 3)

In normal diet, cashew high dose showed a significant decrease ($p<0.001$) in Triglycerides (TG) level when compared with control and low dose. Cashew medium dose also caused a significant decrease ($p<0.001$) when compared with control and low dose. Cashew low dose showed a significant decrease ($p<0.05$) when compared with control.

In cafeteria diet, cashew high dose showed a significant decrease ($p<0.001$) in the TG level when compared with control and low dose and ($p<0.01$) when compared with medium dose. Cashew medium dose showed a significant decrease ($p<0.001$) when compared with control and low dose. Cashew low dose also caused a significant decrease ($p<0.01$) in TG level when compared with control group. In atherogenic diet, cashew high dose showed a significant decrease ($p<0.001$) in TG level when compared with control, low dose and medium dose. Cashew medium dose also showed a significant decrease ($p<0.001$) when compared with control and low dose. Cashew low dose showed a significant activity ($p<0.01$) when compared with control. In all the three groups, the standard drug showed a significant decrease ($P<0.001$) in the TG level when compared with the control group. This showed that the standard drug is better acting than all the cashew preparations. Compared to cashew low dose and medium dose, cashew high dose showed better activity in reducing the TG level.

Effect of Cashew Nut and Standard Drug on HDL level (Table 4)

In normal diet, cashew high dose showed a significant increase ($p<0.001$) in the HDL level when compared to control, low dose and medium dose. Cashew medium dose also caused a significant increase ($p<0.001$) in HDL level when compared with control and ($p<0.05$) when compared with low dose.

In cafeteria diet, cashew high dose showed a significant increase ($p<0.001$) in HDL level when compared to control, low dose and medium dose. Cashew medium dose showed a significant increase ($p<0.001$) when compared with control and low dose

In atherogenic diet, cashew high dose showed a significant increase ($p<0.001$) in HDL level when compared to control and low dose and ($p<0.05$) when compared with medium dose. Cashew medium dose showed a significant increase ($p<0.001$) when compared with control and low dose. Cashew low dose also showed a significant increase ($p<0.05$) when compared with control.

In all the three groups, the standard drug showed a significant increase ($P<0.001$) in the HDL level when compared with the control group. However, in normal diet and cafeteria diet, cashew low dose did not show any significant increase in the HDL level when compared to the control group.

Effect of Cashew Nut and Standard Drug on LDL level (Table 5)

In normal diet, cashew high dose showed a significant decrease ($p<0.001$) in the LDL level when compared with control and low dose and ($p<0.05$) when compared with medium dose. Cashew medium dose also caused a significant decrease ($p<0.001$) when compared with control.

In cafeteria diet, cashew high dose showed a significant decrease ($p<0.001$) in the LDL level when compared with control and low dose and ($p<0.01$) when compared with medium dose. Cashew medium dose also showed a significant decrease ($p<0.001$) when compared with control and ($p<0.01$) when compared with low dose.

In atherogenic diet, cashew high dose showed a significant decrease ($p<0.001$) in the LDL level when compared with control and low dose and ($p<0.01$) when compared with medium. Cashew medium dose showed a significant decrease ($p<0.001$) when compared with control and ($p<0.01$) when compared with low dose.

In all the three groups, the standard drug showed a significant decrease ($P<0.001$) in the LDL level when compared with the control group. However, cashew low dose did not show any significant decrease in the LDL level when compared to the control group.

Effect of Cashew Nut and Standard Drug on VLDL level (Table 6)

In normal diet, cashew high dose showed a significant decrease ($p<0.001$) in the VLDL level when compared with control and low dose. Cashew medium dose also showed a significant decreased ($p<0.001$) when compared with control and low dose. Cashew low dose

showed a significant decrease (p<0.05) when compared with control. In cafeteria diet, cashew high dose showed a significant decrease (p<0.001) in the VLDL level when compared with control and low dose and (p<0.01) when compared with medium dose. Cashew medium dose showed a significant decrease (p<0.001) when compared with control and low dose. Cashew low dose also showed a significant decrease (p<0.01) when compared with control group.

In atherogenic diet, cashew high dose showed a significant decrease (p<0.001) in the VLDL level when compared with control, low and medium dose. Cashew medium dose showed a significant decreased (p<0.001) when compared with control and low dose. Cashew low dose also showed a significant decrease (p<0.01) when compared with control. In all the three groups, the standard drug showed a significant decrease (P<0.001) in the VLDL level when compared with the control group.

Effect of Cashew Nut and Standard Drug on Uterine fat (Table 7)

In normal diet, cashew high dose showed a significant decrease (p<0.01) in the uterine fat when compared with control and low dose. Cashew medium dose also showed a significant decrease (p<0.01) when compared with control and low dose.

In cafeteria diet, cashew high dose showed a significant decrease (p<0.001) in the uterine fat when compared with control and (p<0.01) when compared with low dose. Cashew medium dose showed a significant decrease (p<0.01) when compared with control.

In atherogenic diet, cashew high dose showed a significant decrease (p<0.001) in the uterine fat when compared with control. Cashew medium dose also showed a significant activity (p<0.001) when compared with control.

In all the three groups, the standard drug showed a significant decrease (P<0.001) in the uterine fat when compared with the control group. However, cashew low dose did not show any significant decrease in the uterine fat when compared to the control group.

Effect of Cashew Nut and Standard Drug on despair swim test

In the normal diet, cashew high dose showed a significant decrease (p<0.001) in immobility time when compared to control and low dose. Cashew medium dose also showed a significant decrease (p<0.001) when compared to control and low dose.

In the cafeteria diet, cashew high dose showed a significant decrease (p<0.001) in immobility time when compared to control and low dose. Cashew medium dose showed a significant decrease (p<0.001) when compared to control and low dose.

In the atherogenic diet, cashew high dose showed a significant decrease (p<0.001) in immobility time when compared to control and low dose. Cashew medium dose also showed a significant decrease (p<0.001) when compared to control and low dose. Cashew low dose showed a significant activity (p<0.01) when compared to control.

In all the three groups, the standard drug showed a significant decrease (P<0.001) in the immobility time when compared with the control group. However, in normal diet and cafeteria diet, cashew low dose did not show any significant decrease in the immobility time when compared to the control group.

Table 1. Experimental Protocol in different models

Groups	Normal Diet	Cafeteria diet	Atherogenic diet	dose
I	Control	Control	Control	
II	Ayur Slim	Ayur Slim	Ayur Slim	3mg/kg
III	Cashew low dose	Cashew low dose	Cashew low dose	100mg/kg
IV	Cashew medium dose	Cashew medium dose	Cashew medium dose	150mg/kg
V	Cashew high dose	Cashew high dose	Cashew high dose	200mg/kg

Table 2. Effect of Cashew Nut and Standard Drug on Body Weight.

Groups	Normal diet	Cafeteria diet	Atherogenic diet
Control	52.33 ± 2.801	65 ± 0.8563	75 ± 0.8563
Standard	37.33 ± 2.616[a]	41.66 ± 0.9545[a]	47 ± 0.8563[a]
Cashew low dose	47.33 ± 2.565[f]	59.33 ± 1.333[c,d]	68.33 ± 2.028[b,d]
Cashew medium dose	38.66 ± 1.520[b]	49 ± 1.528[a,e,g]	56.66 ± 1.116[a,d,g]
Cashew high dose	36.66 ± 1.333[a,i]	45 ± 0.8563[a,g]	52.33 ±0.9545[a,f,g]

All values are Mean ± SEM; [a] *P*<0.001 when compared with control; [b]*P*<0.01 when compared with control ; [c]*P*<0.05 when compared with control; [d]*P* <0.001 when compared with standard; [e]*P* <0.01 when compared with standard; [f]*P*<0.05 when compared with standard; [g]*P*<0.001 when compared with low dose; [i]*P* <0.05 when compared with low dose.

Table 3. Effect of Cashew Nut and Standard Drug on Cholesterol level.

Groups	Normal diet	Cafeteria diet	Atherogenic diet
Control	145.83 ± 0.7032	149.33 ± 1.022	151.66 ± 1.202
Standard	128.5 ± 1.522[a]	132.83 ± 0.7491[a]	132.5 ± 1.088[a]
Cashew low dose	143 ± 0.9661[d]	147.66 ± 1.282[d]	148.66 ± 0.6667[d]
Cashew medium dose	137.33 ±0.8819[a,d,h]	142.5 ± 0.9574[a,d,h]	143 ± 1.125[a,d,i]
Cashew high dose	133.66 ±0.6667[a,e,g]	136.8 ± 0.6009[a,f,g]	138.83 ± 1.352[a,e,g]

All values are Mean ± SEM; [a] $P<0.001$ when compared with control; [d]$P<0.001$ when compared with standard; [e]$P<0.01$ when compared with standard; [f]$P<0.05$ when compared with standard; [g]$P<0.001$ when compared with low dose; [i]$P<0.05$ when compared with low dose; [k]$P<0.01$ when compared with medium dose.

Table 4. Effect of Cashew Nut and Standard Drug on Triglycerides level.

Groups	Normal diet	Cafeteria diet	Atherogenic diet
Control	88.63 ± 0.7098	120.13± 1.111	122.81 ± 1.031
Standard	70.5 ± 0.6256[a]	81.2 ± 0.7677[a]	83.18 ± 0.7821[a]
Cashew low dose	84.65 ± 0.9124[c,d]	110.96 ± 3.278[b,d]	115.13 ±2.076[b,d]
Cashew medium dose	77.95± 1.300[a,d,g]	93.61 ± 0.9163[a,d,g]	97.51 ± 0.8023[a,d,g]
Cashew high dose	74.5 ± 0.6099[a,f,g]	84.76 ± 0.9305[a,g,k]	86.53 ± 1.189[a,g,j]

All values are Mean ± SEM; [a] $P<0.001$ when compared with control; [b]$P<0.01$ when compared with control ; [c]$P<0.05$ when compared with control; [d]$P<0.001$ when compared with standard; [f]$P<0.05$ when compared with standard; [g]$P<0.001$ when compared with low dose; [j]$P<0.001$ when compared with medium dose; [k]$P<0.01$ when compared with medium dose.

Table 5. Effect of Cashew Nut and Standard Drug on HDL level.

Groups	Normal diet	Cafeteria diet	Atherogenic diet
Control	55.26 ± 1.064	58.3 ± 1.032	58.63 ± 1.111
Standard	80.4 ± 0.5933[a]	83.7 ± 0.8714[a]	84.65 ± 0.9294[a]
Cashew low dose	59.41 ± 0.6615[d]	62.15± 1.261[d]	65.41 ± 2.223[c,d]
Cashew medium dose	64.06± 0.6354[a,d,i]	72.4 ± 1.111[a,d,g]	75.35 ± 0.6495[a,d,g]
Cashew high dose	77.53 ± 1.932[a,g,j]	80.03 ± 1.001[a,g,j]	81.83 ± 1.559[a,g,m]

All values are Mean ± SEM; [a] P<0.001 when compared with control; [c]P<0.05 when compared with control; [d]P <0.001 when compared with standard; [g]P<0.001 when compared with low dose; [i]P <0.05 when compared with low dose; [j]P <0.001 when compared with medium dose; [m]P>0.05 when compared with medium dose.

Table 6. Effect of Cashew Nut and Standard Drug on LDL level.

Groups	Normal diet	Cafeteria diet	Atherogenic diet
Control	50.95 ± 1.228	56.16 ± 0.5437	57.87 ± 0.9659
Standard	35.39 ± 0.7064[a]	38.18 ± 1.147[a]	31.22 ± 0.8540[a]
Cashew low dose	47.26 ± 1.241[d]	53.22 ± 0.6454 [d]	59.17 ± 1.372[d]
Cashew medium dose	43.48 ± 0.8432[a,d]	49.59 ± 0.8579[a,d,i]	48.14 ± 0.6569[a,d,g,k]
Cashew high dose	38.39± 0.7064[a,g,m]	44.40 ± 1.011[a,d,g,k]	39.69 ± 2.517[a,d,g,k]

All values are Mean ± SEM; [a] P<0.001 when compared with control; [d]P <0.001 when compared with standard; [g]P<0.001 when compared with low dose; [h]P <0.01 when compared with low dose;[i]P <0.05 when compared with low dose; [k]P <0.01 when compared with medium dose; [m]P>0.05 when compared with medium dose.

Table 7. Effect of Cashew Nut and Standard Drug on VLDL level.

Groups	Normal diet	Cafeteria diet	Atherogenic diet
Control	17.72 ± 0.1420	24.02 ± 0.2222	24.56 ± 0.2061
Standard	14.1 ± 0.1251[a]	16.24 ± 0.1535[a]	16.63 ± 0.1564[a]
Cashew low dose	16.93 ± 0.1825[c,d]	22.19 ± 0.6557[b,d]	23.19 ± 0.4151[b,d]
Cashew medium dose	15.59 ± 0.26[a,d,g]	18.72 ± 0.1833[a,d,g]	19.50 ± 0.1605[a,d,g]
Cashew high dose	14.9 ± 0.1220[a,f,g]	16.95 ± 0.1861[a,g,k]	17.30 ± 02378[a,g,j]

[a] P<0.001 when compared with control; [b]P<0.01 when compared with control ; [c]P<0.05 when compared with control; [d]P <0.001 when compared with standard; [f]P<0.05 when compared with standard; [g]P<0.001 when compared with low dose; [j]P <0.001 when compared with medium dose; [k]P <0.01 when compared with medium dose.

Table 8. Effect of Cashew Nut and Standard Drug on Uterine fat.

Groups	Normal diet	Cafeteria diet	Atherogenic diet
Control	2.21 ± 1.065	3.11 ± 0.1167	3.51 ± 0.1014
Standard	1.11 ± 0.098[a]	2.2 ± 0.0577[a]	2.45 ± 0.131[a]
Cashew low dose	2.06 ± 1.1229[d]	2.93 ± 0.1256[d]	3.18 ± 0.0792[d]
Cashew medium dose	1.3 ± 0.1155[b,h]	2.56 ± 0.0666[b]	2.83 ± 0.0954[a]
Cashew high dose	1.28 ± 0.0872[b,h]	2.45 ± 0.0619[a,h]	2.75 ± 0.118[a]

All values are Mean ± SEM; [a] P<0.001 when compared with control; [b]P<0.01 when compared with control ; [d]P <0.001 when compared with standard; [h]P <0.01 when compared with low dose.

Table 9. Effect of Cashew Nut and Standard Drug on despair swim test

Groups	Normal diet	Cafeteria diet	Atherogenic diet
Control	118 ± 1.065	122.33 ± 2.404	126.5 ± 2.110
Standard	81.23 ± 1.200[a]	83.66 ± 1.022[a]	86.83 ± 1.195[a]
Cashew low dose	109.16 ± 4.070[d]	114 ± 3.011[d]	117.83 ± 1.641[b,d]
Cashew medium dose	89.33 ± 1.542[a,g]	94.5 ± 3.394[a,f,g]	97 ± 0.8563[a,e,g]
Cashew high dose	85.16 ± 1.302[a,g]	86.83 ± 1.195[a,g]	91 ± 2.160[a,g]

All values are Mean ± SEM; [a] P<0.001 when compared with control; [b]P<0.01 when compared with control ; [d]P <0.001 when compared with standard; [e]P <0.01 when compared with standard; [f]P<0.05 when compared with standard; [g]P<0.001 when compared with low dose.

DISCUSSION

Cashew is devoid of cholesterol with energizing capacity. Cashew nuts provide protein and fibre to body [18,19]. It also contains healthy monounsaturated fat that promotes good cardiovascular health, because monounsaturated fats reduce high triglyceride levels which are associated with increased risk for heart disease [20]. Cashews are rich in antioxidants that help in the elimination of free radicals which are one of the causes of cancer [21,22]. Cashew nuts are very rich source of minerals. The high energy density and high amount of dietary fibre in Cashews both are attributes to a beneficial effect on weight management. They are packed with soluble dietary fibre, vitamins, minerals and numerous health-promoting phyto-chemicals that help protect from diseases and cancers. Because dietary fibre can produce a feeling of fullness in the stomach, it has long been suggested as an aid in weight loss diets.

Cashews have a lower fat content than most other nuts, approximately 75% of their fat is unsaturated fatty acids, plus about 75% of this unsaturated fatty acid content is oleic acid, the same heart-healthy monounsaturated fat found in olive oil. The unsaturated fats, which include polyunsaturated and monounsaturated fat, can actually help to lower blood cholesterol levels giving them the distinction of "healthy" fats.

Phytochemical screening indicated the presence of phenolic compounds, carbohydrates, proteins, fats, vitamins, minerals, soluble fibres%% and flavonoids* in the aqueous extract of cashew nut. Anti-obesity activity of the aqueous extract of cashew nut might be due to the presence of soluble fibres and flavonoids, namely, (+)-catechin, (-)-epicatechin, and epigallocatechin, whuch inhibit lipoxygenase. In this study the animals were categorised into three main models and five groups. The main models are: Normal diet in which the animals were fed with normal pellet chow and treated with ayurslim (standard drug), extract of cashew nut in high, medium and low dose and a control group which was the untreated group.

Cafeteria diet in which the animals were fed with cafeteria diet [described in the methodology] and treated with ayurslim (standard drug), extract of fig in high, medium and low dose and a control group which was the untreated group. Atherogenic diet in which the animals were fed with atherogenic diet [described in the methodology] and treated with ayurslim (standard drug),extract of fig in high, medium and low dose and a control group which was the untreated group. The treatment was carried out for about 40 days and body weight of the animals were measured on alternative days. On day 41, biochemical parameters such as LDL, VLDL, HDL, Triglycerides and Total Cholesterol were measured using biochemical kits. The animals were sacrificed and their organ weights were measured.

From the results obtained it was found that the standard drug (Ayurslim) effectively reduced the body weight, cholesterol, LDL, VLDL, triglyceride levels and also caused a significant change in the locomotor activity and also caused an increase in the HDL level. This implies that the standard drug is very effective. The cashew high dose also effectively reduced the body weight, cholesterol, LDL, VLDL, triglyceride levels and also caused a significant change in the locomotor activity and also caused an increase in the HDL level almost similar to that of the standard drug. This indicates that the cashew high dose is also as effective as that of the standard drug. The medium and the low dose also reduced the body weight,

cholesterol, LDL, VLDL, triglyceride levels and also caused a significant change in the locomotor activity and also caused an increase in the HDL level but not as significant as compared to the cashew high dose. Thus it was evaluated that cashew nut can be used as an anti-obesity agent and the probable mechanism by which it causes the effect is described below.

The possible mechanism may be due to the increased secretion of leptin from the adipose tissue. Leptin is a hormone that is secreted by adipose cells. It acts on the arcuate nucleus of the hypothalamus and elsewhere in the brain to decrease appetite and increase energy expenditure [23]. It may also be due to increased secretion of several gut hormones, notably those released by the intestine in respond to passage of digesting food such as glucagon-related peptide-1, oxyntomodulin, and peptide YY. Each of these hormonal signals suppresses eating in animals and humans. It may also be due to suppression of Ghrelin, another important gut hormone that is released from the distal stomach and duodenum that stimulates appetite.

Garcinia (Garcinia cambogia) which is the main constituents of Ayurslim limits the synthesis of fatty acids in the muscles and liver and thus limits production of lipids by inhibiting the enzymes ATP-citrate lyase. With no further synthesis, the existing fatty acids are generally metabolized, resulting in the reduction of body weight. Garcinia also contain a biologically active compound which is known to inhibit the synthesis of lipids and fatty acids and lowers the formation of LDL and triglycerides[55]. Additionally, appetite is also suppressed by promoting synthesis of glycogen, this way the brain gets signals of fullness and satisfaction sooner.

Since cashew nut showed the same effect as Ayurslim, it may act by decreasing the synthesis of fatty acids in the muscles and liver, thus limiting the production of lipids by inhibiting the enzymes ATP-citrate lyase, thereby resulting in the reduction of body weight. Central Nervous System related studies: It is scientifically proved that obese patients are more prone to depression than people who are not obese. Depression maybe caused due to decrease secretion of serotonin and Nor-epinephrine in the brain. Therefore it is important to assess the effect of obesity on the central nervous system and to understand the parameters that cause depression. In the present study, 2 models were used to determine CNS activity in brain. Despair Swim test and the Open Field Behavior Test. Despair Swim test checks the depression state of the rats or mice. Immobility time is the period in which the limbs of the animal are in a state of immobility. When the animal is first placed in the water, it vigorously moves its legs. As the time goes on, the animal attains a state of immobility. It has given up swimming and now assumes that it is going to die. Animals that are obese had greater immobility time compared to the non-obese ones. In our present study, Cashew high dose had significant effect in reducing the immobility time. This is mostly attributed to the weight loss, and lowering of lipid parameters in the body. However, we don't know whether the action is central or peripheral.

Elevated plus maze test is a test for the anxiolytic activity of a drug. Obese patients are less anxious compared to the non-obese patients. Elevated plus maze test reveals the extent to which anxiety affects the rats/mice. In our present study, all the control groups had higher grooming time. That is they spent most of their time in closed arm. This was observed in all diets, the highest time being the cafeteria diet. Cashew preparations and the standard anti-obesity herb decreased the grooming time, and increased the ambulatory time significantly. In normal diet, ambulatory time was increased significantly by all cashew preparations. However, in cafeteria and atherogenic diet, only the cashew medium and high dose significantly increased the ambulatory time.

Organ weights provide an in-vitro assessment of the deposition of fat present in the body. Left and Right kidney, Heart, Liver, Spleen, Mesenteric, Uterine, and Kidney fat was measured. There was a significant change between the liver and heart weights of control groups in all diets. Cashew high dose significantly reduced the fat pads. This shows that there is sufficient fat mobilization for its breakdown.

CONCLUSION

It can be concluded that Cashew high dose (200 mg/kg) is effective in decreasing body weight, lipid parameters like LDL, VLDL, TG, TC and increased HDL level. It also decreased fat-pad weights like Kidney fat, Mesenteric fat, and Uterine fat. Hence, Cashew can be potentially used as an Anti-Obesity agent. However, further research must be carried out to accurately figure out the mechanism of action of cashew in human.

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