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SESAME MEAL ADMINISTRATION ATTENUATE THE HIGH-FAT DIET INDUCED LIPID ABNORMALITIES AND IMPROVE INSULIN SENSITIVITY IN WISTAR RATS

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ABSTRACT

Obesity and lipid metabolism abnormalities are associated with numerous non communicable diseases such as metabolic syndrome, type2 diabetes, arthrosclerosis, fatty liver diseases, infertility etc. Modern life style choices such as consumption of high caloric diet and sedentary living conditions are implicated in the pathogenesis of these diseases. Most of the currently available drugs for these diseases are either ineffective or causing numerous side effects. The western lifestyle choices have intruded into every corner of the world. As the people started to adapt to the westernized food and lifestyle, the traditional and indigenous customs, foods of the local areas are being forgotten from the human mind. Sesame is one such dietary ingredient used in the Indian culinary from time immemorial. Consumption of sesame, sesame oil and food prepared from sesame meal is practiced for long time and possess several medicinal values. Sesame meal in particular is assumed to possess weight reducing effects in humans. In the present study, the sesame meal was administered to the wistar rats fed with high-fat diet and their protective roles were compared with pioglitazone. After 13 weeks of sesame and pioglitazone treatment on high-fat diet fed rat, the changes in the lipid profile such as fasting insulin, glucose, triglycerides, total cholesterol, Low Density Lipoprotein, High Density Lipoprotein, Free Fatty Acid levels were measured. A comparison of the performance of sesame meal in the respect of lipid abnormalities on high fat diet rat clearly indicates that the changes of lipid profiles are improved towards the normal level. All these effects were also comparable to that of pioglitazone treated rats.

KEYWORDS

sesame, lipid metabolism, high-caloric diets, pioglitazone, Wistar rats.

INTRODUCTION

Non-communicable diseases such as metabolic syndrome, type 2 diabetes, atherosclerosis, fatty liver disease, infertility etc. are increasing at an alarming rate world over. The most recent National Health and Nutrition Examination Survey (NHANES) reported that 68.3% of those studied were considered overweight (BMI ≥25) and 33.9% were obese (BMI ≥30)[1]. Childhood obesity is particularly important as more children are developing what were previously considered adult diseases, like type II diabetes, high blood pressure, elevated serum insulin and dyslipidemia; with obese children often progressing to obese adults[2, 3]. Chronic positive caloric balance caused by the consumption of high-caloric diets and sedentary life style are proposed to play a major role in the development of obesity and its associated diseases. Life style factors, high caloric diet and lack of physical activity, lead to acquired hyperlipidemia[4].

Hyperlipidemia is an excess of fatty substances called lipids largely cholesterol and triglycerides, in the blood. Hyperlipidemia can be of two types one is hypercholesterolemia in which there is a high level of cholesterol and the another one is hypertriglyceridemia, in which there is a high level of triglycerides, the most common form of fat. The fat-protein complexes in the blood are called lipoproteins. The best-known lipoproteins are LDL (Low Density lipoprotein) and HDL (High Density Lipoprotein). Excess LDL cholesterol contributes to the blockade of arteries, which eventually leads to heart attack and is also known as the bad cholesterol. In contrast, the lower level of HDL cholesterol, the greater the risk of coronary heart disease and is also known as “good” cholesterol. Low HDL cholesterol levels are usually accompanied by an increase in blood triglyceride levels[5].

The pharmacological agents commonly used for treatment of type2 diabetes include sulfonylurea, biguanides, thiozolidione and alpha-glucosidase inhibitors. These agents, however, have restricted usage due to several undesirable side-effects and fail to significantly alter the course of diabetic complications[6].

Sesamum indicum Linn. (*Pedaliacea)* has long been used extensively as a traditional food in the orient for various purposes and commonly known as sesame. Sesame is an important oil seed crop of the world. India being a major producer of Sesame oil it is widely used in cooking and as an ingredient of confectionary and for making margarine. Sesame seed provides highly stable oil and nutritious protein and meals used in sweet meats and confectionary foods, and have varieties of medicinal properties[7].

Phytochemical study has shown that the sesame plant is rich in phenolic compounds (phenol, lignans and flavonoids), non-protein amino acids, cyanogenics, glycosides, alkaloids, polyunsaturated fats and lipids, mucilage, phospholipids, vitamins B1, B2 and E, trace elements and minerals such as calcium, iron, magnesium, copper and phosphorous[8, 9].The sesame meal is the residue after pressing the oil from the seed. It is an excellent source of protein (47%[10] to 52.9%[11]) and has an amino acid composition similar to that of soybean meal (14.9%) [10].Sesame being one of the important seed for medicinal treatment in the world. In addition, there has been a paucity of studies on the effect of sesame treatment on lipid profiles in high fat diet fed animal. Therefore, this paper evaluates data on the effect of sesame meal on high-fat fed rats related to different lipid profile by comparing pioglitazone treatment.

MATERIALS AND METHODS

Experimental Animal

Healthy adult male albino rats [wistar stain] were purchased from central animal house, Rajah Muthiah Medical College and Hospital, Annamalai University and were used for the present study. The rats were housed in polypropylene cages at room temperature (27±2˚C). The animals were randomized and separated into normal and experimental groups of body weight ranging from 170 to 200g. The animals fed with a diet of standard pellets (Hindustan Lever Ltd, Bombay) and provided free access to water and libitum and food during the tenure of acclimatization to the environment for a minimum period of two weeks prior to the commencement of experiments, according to NH guidelines.

Sesame cake

Sesame cake was purchased from local market from Chidambaram, Tamilnadu, india.

Chemicals

Pioglitazone hydrocholoride ($C_{19}H_2ON_2O_3S.HCl$) was obtained as a gift sample from Flembic pharmaceuticals Pvt. Ltd. Baroda, India. All the other chemicals used in the experiments were of analytical grade.

Experimental design

The animals were divided into five groups of six rats in each

Group 1 [CONTROL]: Rats were fed with standard laboratory diet.

Group 2 [HF] : Rats were fed with High-fat diet alone.

Group 3 [HF+SM] : Rats were fed with mixture of High-fat diet and sesame meal (50mg/kg of body weight).

Group 4 [HF+PIO]: Rats were fed with mixture of High-fat diet and pioglitazone (25mg/kg of body weight).

Group 5 [SM] : Rats were fed with sesame meal alone (50 mg/kg of body weight).

Table -1

Composition and energy content of the high-fat diet (HFD)

I-Type of composition	
Casein [≥85%deprotein]	190
Corn starch	250.7
Sucrose	100
Soybean oil	40
Lard	320
Fiber	50
Vitamin mix	10
Mineral mix	35
L-cystein	1.8
Choline	1.5
Antioxidant	0.008
Total grams	1000
II-Energy content	
Total energy content [Kcal/kg]	5,404
carbohydrate [%]	26
protein [%]	14
Lipids]%]	60

Recommended by American Institute of Nutrients Recommendation (AIN 93M)[12]. Sesame meal was purchased from local market at Chidambaram, Tamil nadu, India.

Sample collection

At the end of experimental period (13 weeks), the animals were fasted overnight and anesthetized using ketamine hydrocholoride (24mg/kg of total body weight) intramuscular injection, and scarified by cervical decapitation. Blood samples were collected in tubes containing potassium oxalate and sodium fluoride [5:1] mixture for the estimation of plasma glucose and in tubes with ethylenediamine tetra acetic acid [EDTA] for the estimation of total cholesterol [TC], triglycerides [TG], free fatty acid [FFA] HDL and LDL.

Biochemical assays

Determination of plasma glucose was estimated colorimetrically using commercial kit (Sigma diagnostics Pvt. Ltd., Baroda, India.)[13]. Plasma insulin was assayed using an enzyme linked immunosorbent assay (ELISA) kit, Boeheringer, Mannhim, Germany.

Plasma and tissue total cholesterol, triglycerides and free fatty acids were estimated by the methods of [14, 15,] and [16]. Plasma high density lipoprotein was estimated by the method of [17]. Low density lipoproteins were calculated by this method [18].

Statistical analysis

Values were given as mean ±SD for six rats in each group. Data analyses were carried out using one-way analysis of variance followed by Duncan's Multiple Range Test (DMRT) using the SPSS version 10 (SPSS, Chicago, IL). The limit of statistical significance was set at P≤0.05 and the values sharing a common superscript did not differ significantly

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RESULTS

Table 2

Changes in the level of total cholesterol (TC), triglycerides (TG), high density lipoprotein (HDL), low density lipoprotein (LDL), free fatty acid (FFA) in control and experimental rats.

EXPERIMENTAL GROUPS	TC [mg/dL]	TG [mg/dL]	HDL-C [mg/dL]	LDL-C [mg/dL]	FFA [mg/dL]
CONTROL	80.06±3.65^{a}	59.20±3.96^{a}	47.12±3.13^{a}	21.10±1.62^{a}	53.20±5.54^{a}
HF	152.25±7.79^{b}	164.15±9.54^{b}	28.60±2.80^{b}	90.82±7.65^{b}	110.18±11.02^{b}
HF+ SESAME MEAL	99.83±5.67^{c}	82.74±6.49^{c}	43.12±3.78^{c}	40.17±3.45^{c}	69.82±6.27^{c}
HF+PIO	74.96±2.46^{d}	54.46±2.73^{d}	44.29±4.40^{d}	19.78±6.48^{d}	65.45±5.75^{d}
SESAME MEAL	79.06±3.65^{e}	59.80±39.6^{e}	46.06±3.65^{e}	20.12±3.13^{e}	54.27±5.54^{e}

Values are expressed as mean of six individuals in each group ± SD.

HF-High Fat diet; PIO-Pioglitazone.

^{a,b,c,d,e} ***Values sharing a common superscript (a, b, c, d, e) do not differ significantly at p<0.05 (DMRT***).

Table 3
Changes in the level of plasma glucose and insulin in control and experimental rats.

EXPERIMENTAL GROUPS	Glucose [mg/dL]	Insulin [units/ml]
CONTROL	89.93±4.74[a]	15.62±1.10[a]
HF	281.10±9.57[b]	6.01±0.44[b]
HF+SESAME MEAL	242.38±7.96[c]	12.08±1.04[c]
HF+PIO	88.01±6.83[d]	15.77±0.91[d]
SESAME MEAL	88.93±4.74[e]	15.45±1.10e

Values are expressed as mean of six individuals in each group ± SD.
HF-High Fat diet; PIO-Pioglitazone.
[a,b,c,d,e] Values sharing a common superscript (a, b, c, d, e) do not differ significantly at p<0.05(DMRT).

Table 2 shows the level of total cholesterol, triglycerides, high density lipoprotein, low density lipoprotein, free fatty acid in the plasma of all the experimental groups. HF intake rat had elevated level of plasma total cholesterol, triglycerides, low density lipoprotein and free fatty acid with decreased level of high density lipoprotein. Treatment of sesame meal or Pioglitazone prevented the above changes in HF fed rats and also improved towards normal.Table 3 shows an increased in plasma glucose and decreased in insulin level of HF fed rats. Treatment of sesame or Pioglitazone prevented the above changes in HF fed rats and also improved towards normal levels.

DISCUSSION

Management of diabetes without side effects is still a challenge to the modern medicine. This leads to increasing demand for searching new drug from natural origin with antidiabetic and free from side effect or less side effects. In ayurvedic or indigenous folk medicines, the hypoglycemic plants have been used generally in their natural forms (fresh juice, paste or dry powder). These include both the inorganic and organic constituents of the concerned herbs. Further it is important to note that the inorganic part of a medicinal plant containing mainly mineral elements sometimes plays a contributory role in enhancing medicinal properties (including hypoglycemic activity) of that plant [19, 20].Diabetes is associated with profound alterations in the plasma lipid, triglycerides and lipoprotein profile and with an increased risk of coronary heart disease[21, 22].Lowering the plasma lipid levels through dietary or drug therapy appears to be associated with decrease in the risk of vascular disease[23]. Normally circulating LDL undergoes reuptake in the liver via specific receptors and gets cleared from the circulation[24].

In the present study, the observed HF fed rats have elevated level of total cholesterol, triglycerides, low density lipoprotein and free fatty acid and decreased high density lipoprotein, whereas the HF fed rat treated with sesame meal or pioglitazone prevented the above changes and improved towards normal level. These results are equal to the effects of sesame oil food to a hypertensive diabetic patient[25], that rise in liver weight which might be due to excess of lipid/collagen accumulation. HF fed rat developed a significant elevation in both glucose and insulin levels, indicating the development of insulin resistance which are closely resemblance to the report of previous work[26, 27]. The elevated level of plasma glucose and decreased level of insulin in HF fed rats when treated with sesame meal and pioglitazone prevented the above changes and also improved towards the normal level, which agree with the statement of Ramesh *et al*[28] in wistar rat. Moreover they have reported that after 42 days of eating a diet supplemented with 6% sesame oil, mean blood glucose dropped from approximately 322.61 mg/dL to 222.02mg/dL. In 2007 Dhar et al[29], also using rats with chemically induced diabetes, reported that sesame lignans not only improved the lipid profile but significantly reduced the peroxidation of the LDL cholesterol. Sanker et al[25] reported the results from a pilot study on 40

hypertensive diabetics that found eating sesame oil caused significant effects in hypertensive diabetics medicated with atenolol and glibenclamide. The patients switched to sesame oil for cooking for 45 days at which point they switched to other oils like palm or peanut oils for another 45 days. During the period of sesame oil used in the study, systolic and diastolic BP decreased remarkably, whereas the oil substitution was withdrawn, the BP values rise again. Furthermore, during the sesame oil phase of the study, the body weight, body mass index, girth of waist, girth of hip, and waist to hip ratio decreased.

Thus our findings demonstrate that sesame meal has hypolipidemic effect, which is evidenced by the decreased levels of total cholesterol, triglycerides, free fatty acids, phospholipids, low density lipoprotein and elevated levels of high density lipoprotein in the plasma and tissues of high fat fed rats.

CONCLUSION

From the above findings, we conclude that high fat diet fed rats with reduced insulin and plasma glucose, TC, TG, LDL, FFA level and increased HDL cholesterol level. Administration of sesame meal significantly increased insulin secretion, TC, TG, LDL, FFA and normalized the deranged carbohydrate metabolism in high fat fed rats by enhancing glucose utilization and decreasing hepatic glucose production and decreased HDL level.

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