ORIGINAL ARTICLE

Preventive Effects of Sesame Seeds on Hyperglycemia and Serum Lipids in Fructose fed Mice

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ABSTRACT

Objective: The aim of the study was to determine the effects of sesame seeds on anthropometric measurements (height, weight and body mass index), blood glucose, lipid profile and liver function tests in high fructose diet (HFD) fed mice.

Study Design: A randomized experimental laboratory trial.

Place and Duration of Study: The study was conducted at National Institute of Health Sciences, Islamabad from 1st February 2013 till 31st January 2014.

Materials and Methods: We allocated 30 female Balb/c mice into three groups. Control Group I (n=10) mice who were fed with standard laboratory diet were compared with Experimental groups; Group IIa (n=10) mice were fed on high fructose diet (HFD) for 08 weeks, Group IIb: (n=10) mice were fed with HFD plus sesame meal for 08 weeks. Anthropometric measurements (Weight, Height and BMI) and serum lipid profile, liver function tests and blood glucose were measured at baseline and after 8 weeks.

Results: The mean weight of the Balb/c mice was 23.33±1.44 grams, the mean height was 8.45±0.314 cm and the mean BMI was 3.27±0.33. The anthropometric measurement of the three groups of mice was similar at the baseline. After 8 weeks there was significant weight gain in the HFD group (IIa) 35.9±4.5 and HFD plus Sesame diet group (IIb) 30±4.5 as compared to control group 29.1±2.84. However the weight gain in HFD plus Sesame diet group (IIb) was significantly lesser as compared to the HFD alone group, signifying that perhaps sesame seeds prevented the significant weight. The mice that were fed on HFD (IIa) had significant derangement of their liver function tests, lipid profile and blood glucose as compared to control and HFD plus Sesame diet group (IIb).

Conclusion: High fructose diet results in significant weight gain, elevation of liver function tests, derangement of lipid profile and hyperglycemia. Sesame diet was effective in preventing these anthropometric and biochemical derangements. Hence it is likely that sesame diet has a hepato-protective role which needs to be confirmed by studies on a larger scale to demonstrate this hepatoprotective effect of sesame seeds beyond doubt.

Key words: *Fructose, High fructose diet, Sesame seeds, Hepatotoxitiy, Dyslipidemia.*

Introduction

Diabetes is the most common endocrine disorder and, it is estimated that more than 200 million people worldwide have diabetes mellitus and 300 million will subsequently have the disease by 2025. The new millennium has witnessed the emergence of a modern epidemic, the metabolic syndrome, with frightful consequences to the health of humans' worldwide.[1] The sole reason for this growing increase is excessive consumption of sweeteners. Caloric sweetener are in >95% of cakes/cookies/pies, granola/protein/energy bars, ready-to-eat cereals, sweet snacks, and sugar-sweetened beverages. Corn syrup, cane sugar and fruit juices are the common sweetening agents. These sweeteners contain high fructose content.[2]

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Fructose is a six carbon containing sugar present in juices, raisins, fruits, dates, cereals, beverages, corn syrup, soft drinks, cereals and bread. It is used as a nutritional supplement as well as sweetening agent. Studies investigating the effects of fructose consumption in humans and animals have been comprehensively reviewed strong evidence exists that consumption of diets high in fructose results in increased de novo lipogenesis (DNL), dyslipidemia, insulin resistance, and obesity in animals.[3-6] The potential role for dietary fibre in diabetes was first promoted more than 30 years ago by Trowell on the basis of his experience in East Africa where he noted a virtual absence of what is now known as Type 2 diabetes in association with the consumption of traditional diets, which were extremely high in 'lightly processed' cereal foods.[7]

Sesamin, a lignan occurring exclusively in sesame seeds and sesame oil, exerts diverse physiologically desirable functions. Although the mechanisms underlying the beneficial effects are not fully understood, sesamin specifically interferes with Δ5 desaturation of dihomo-γ-linolenic acid to

arachidonic acid, suppresses carcinogen-induced mammary tumori-genesis, induces liver microsomal and peroxisomal drug-metabolizing enzyme systems, and has a hypocholesterolemic effect.[8,9] In this study, we aimed to investigate the hepatoprotective effect of sesame seed on fructose fed mice.

Materials and Methods

This Randomized Controlled trial was carried out at National Institute of Health Sciences, Islamabad from 1st February 2013 till 31st January 2014 (1-Year). 30 laboratory bred Healthy, Balb/c strain mice of female sex aging between eight to ten weeks old were selected for study and were acclimatized for 1 week before being randomly assigned into control and experimental groups. Mice weighed between 15-25 grams. Simple random sampling was done using lottery method to divide mice into two groups. Group I comprised of Control Mice which were fed on a commercially available standard laboratory diet (20gm/mouse/day) and water ad libitum. Group II , experimental group was further divided into two as Group IIa: Mice were fed a high-fructose diet (20g/mouse/day) and water ad libitum for 08 weeks and Group IIb: Mice were fed with combined mixture of high-fructose diet and sesame meal for 08 weeks. Mice were weighed; naso-anal height was measured before any treatment. The experimental protocol was conducted in accordance with the internationally accepted principles for laboratory animal use. Mice were kept in healthy environment where ample amount of water and food availability was ensured. The mice were sacrificed at the end of the experimental (eight week) period after drawing blood from intra-cardiac puncture. 3-4ml blood was collected in two separate test tubes (one with EDTA and one without it, after twelve hours fasting), blood was centrifuged, serum was separated. Both the tubes were frozen (-80C) till analyzed. Biochemical analysis of blood glucose, triglycerides (TG), high density lipoproteins (HDL-Cholesterol), low density lipoproteins (LDL-Cholesterol), alanine transaminase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP) and bilirubin, was done by using chemical methods on automated analyzers. (Clinical Chemistry Analyzer, Humalyzer 3000, Germany. The reagents used were Randox laboratory kit reagent UK).

Data analysis plan: Data was analyzed using SPSS 17.0 (statistical package for social sciences). Descriptive statistics were used to describe the data. Mean and standard error of mean was used to describe numeric variables like age, weight, height, body mass index, blood glucose, TG, HDL, LDL, cholesterol, LDL, ALT, AST, ALP and bilirubin. ANOVA was applied for the comparison of numeric variables. P value of <0.05 was considered as significant.

Results

Our study included 30 mice which were divided in 3 groups of 10 mice each. Anthropometric measurements were taken in all 30 mice at the baseline. The weight of the mice ranged from 180 to 250 grams with a mean weight of 216.36±21.14 grams. The naso-anal length/ height ranged from 20 to 24 cm with a mean length of 21.9±1.08 cm. The BMI ranged from 3.69 to 5.95 with a mean of 4.51±0.49.The mean height, weight and BMI of the three groups of rats was similar at the baseline; p= 0.829, 0.074 and 0.387 respectively by ANOVA (all >0.05) (Table I). After 8 weeks the mean weight of rats in group I, IIa and IIb was 222±22.7, 302±11.35 and 261±10.48 grams respectively. The mean Cholesterol for group I, IIa and IIb was 162±14.13, 179.5±14.53 and 158.6±11.42 mg/dl respectively. The Cholesterol of HFD group was significantly higher as compared to controls; p=0.014 but the mean Cholesterol of sesame diet group was not significantly different from the control group; p= 0.561. This pattern is also observed in other biomarkers including Blood Glucose, LDL-C, HDL-C, ALT, AST, ALP and Bilirubin. (Table II).

Table I: Comparison of Anthropometric Measurements between Three Groups at Baseline

	Control group (I)	HFD group (IIa)	HFD plus sesame diet group (IIb)	P value by ANOVA
Height in cm	21.9±1.37	21.8±1.03	22.1±0.87	0.829^{NS}
Weight in grams	215.8±21.87	206±21.4	227±15.79	0.074^{NS}
BMI	4.52±0.55	4.35±0.54	4.66±0.35	0.387^{NS}

Discussion

Liver is the largest and most complex internal organ in the body. It plays an important role in the maintenance of internal environment through its multiple and diverse functions. Liver is involved in

Table II: Comparison of Serum Lipids, LFT and Glucose of Three Groups at 8 weeks

	Control group (I) n=10	HFD group (IIa) n=10	HFD plus sesame diet group (IIb) n=10	P value by ANOVA
Cholesterol (mg/dl)	162±14.13	179.5±14.53	158.6±11.42	.004*
LDL-C (mg/dl)	37.8±6.54	107.5±16.2	62.1±7.5	.000*
HDL-C (mg/dl)	90.9±6.36	60.4±16.7	72.0±7.58	.000*
TG (mg/dl)	166.1±22.13	245.1±36.48	177.3±13.8	.000*
ALT (I.U.)	51.7±9.34	215.5±69.8	66.6±18.79	.000*
AST (I.U.)	78.6±13.07	218.7±71.72	71.4±13.71	.000*
ALP (I.U.)	128.5±14.9	255.5±54.59	123.5±16.67	.000*
Bilirubin mg/dl)	1.13±0.13	3.04±0.74	1.14±0.206	.000*
Glucose (mg/dl)	135.9±29.67	215.9±9.55	196.0±13.65	.000*

several vital functions, such as metabolism, secretion and storage. Fructose is metabolically broken down before it reaches the rate-limiting enzyme (phosphofructokinase), thereby supplying the body with an unregulated source of three-carbon molecules. These molecules are transformed into glycerol and fatty acids, which are eventually taken up by the adipose tissue, leading to additional adiposity. Because of its lipogenic properties, excess fructose in the diet can cause glucose malabsorption, and greater elevations in TG and cholesterol compared to other carbohydrates. These metabolic disturbances appear to underlie the induction of leptin (a protein, encoded by obesity gene) and insulin resistance commonly observed with high fructose feeding in both humans and animal models. Fructose induced insulin resistant states are commonly characterised by a profound metabolic dyslipidemia, which appears to result from hepatic and intestinal over production of atherogenic lipoprotein particles.[10] The dietary sesame has been shown to possess hypocholesterolaemic and enhance antioxidant capacity in hypercholesterolemia humans.[11] Feeding of HFD resulted in the elevation of various parameters of lipid profile. The repeated administration of sesame for a period of 8 weeks resulted in a significant decrease in the lipid profile in serum when compared to the dyslipidaemic HFD. Similar findings were found in study by Sedigheh et al [12] that dietary supplementation with sesame oil significantly reduces TC and LDL-C concentrations in rabbits under a lipogenic diet. These findings are consistent with those of previous studies. Visavadiya and Narasimhacharya [13] examined the effects of supplementation with sesame seed powder at 5% and 10% doses along with either normal or hypercholesterolemic diet for a period of 4 weeks. Administration of sesame seed powder to hypercholesterolemic rats resulted in a significant decline in plasma and hepatic total lipid and cholesterol, and plasma LDL-C whilst increasing HDL-C concentrations. In another investigation to evaluate hypocholesterolemic and antioxidant activity of sesame protein isolate, Biswas et al.[14] fed 18% sesame protein isolate with or without 2% cholesterol in comparison with casein to rats for 28 days. The results revealed that dietary sesame protein isolate reduces plasma total cholesterol, triacylglycerol, and LDL-C, increases HDL-C, and mitigates lipid peroxidation in both hypercholesterolemia and normocholesterolemic diet groups. The present investigation clearly demonstrates the Glucose and cholesterol lowering effects of Sesame seed in dyslipidaemic mice.it also high lights hepatoproctective effect by showing improvement in liver function test. More studies in future on a larger scale and at cellular level are required to demonstrate this hepatoprotective effect of sesame seeds beyond doubt.

Conclusion

Our study concluded that high fructose diet results in significant weight gain, elevation of liver function tests, derangement of lipid profile and hyperglycemia. Sesame diet was effective in preventing these biochemical derangement and normalizing blood sugar, liver function tests and lipid profile. Hence it is likely that sesame diet has a hepatoprotective role.

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