Effect Of Gum Arabic On Oxidative Stress Markers In The Liver Of High Fat Diet Induced Obesity In Mice
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Abstract: Obesity is a global health concern associated with high morbidity and mortality. Therapeutic strategies include surgery and synthetic drugs may cause high costs and serious complications. The anti-obese effect of dietary fiber is generally accepted. Gum arabic (GA) works as a dietary fiber that helps reduce body fat deposition. Yet, the effect of GA on oxidative stress in mice fed with high fat diet induced obesity has not been well studied. In the present study we fed mice either a normal diet (control), low fat diet (low), high fat diet (high) or a high fat diet supplemented with 10% w/w GA (High+gum) for 30 days. Oxidative damage to liver tissue was evaluated by measurement of lipid peroxidation and antioxidant enzymes. Activities of superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx) were significantly (p<0.05) increased in GA group compared with high and low fat diet groups. Treatment with GA was significantly (p<0.05) decreased liver malondialdehyde (MDA) while increased glutathione (GSH) compared with the high or low fat diet groups. Liver of both high and low fat diet groups’ mice showed marked degeneration whereas slight degeneration was observed in GA treated mice compared with the control group. The results conclude that GA may protect liver by improvement of antioxidant status.

Keywords: Gum Arabic, obesity, Oxidative stress, Mice

1. INTRODUCTION

Obesity is defined as a state of increased abdominal fat deposition consequential from chronic nutrient intake, where energy intake much exceeds energy expenditure. Energy intake is balanced by food intake and energy expenditure was influenced by several factors including basal metabolism rate, physical activity, body size and lifespan, and thermogenesis. Disturbances of either central or peripheral signals lead to a state of obesity or anorexia. The increase in obesity, a predisposing factor for developing hypertension, diabetes, hyperlipidemia, cancer and other metabolic disorders, has driven a major interest in the regulation of food intake, appetite and fat deposition.

Cellular oxidative stress plays a key role in the initiation of tissue damage. Oxidative stress induced by the imbalance of oxidants/antioxidants damage biological macromolecules, including carbohydrates, proteins, lipids, and nucleic acids, resulting in the instability in cellular homeostasis and production of other reactive molecules that cause more damage. The importance of oxidative stress and its relationship in the pathology of diabetes mellitus (DM) along with associated complications have been extensively investigated. A numerous studies reported that production of reactive oxygen species (ROS) in diabetes could initiate the development of lesions on many tissue and organs including blood vessels, kidneys, and nervous system.

Dietary fiber promotes satiation and satiety, alter glycaemic index, affects gastric emptying, gut hormone secretion and thus helps to manage weight. Gum arabic an edible dried sticky exudate from Acacia seyal and Acacia senegal is rich in non-viscous soluble fiber. It is generally used in food industry and pharmaceutical field as an emulsifier and preservative. In the North Africa and Middle East, it used as an oral hygiene material by different communities for centuries. Previous studies revealed that a high ingestion of dietary fiber, including GA is associated with beneficial effects on fat metabolism. The majority of studies investigating the effects of GA focused on body mass index and fat deposition. However, the effect of GA on oxidative stress biomarkers in liver remains unclear. In the present study we used mice to investigate that gum arabic may improve
antioxidative capacity which may be associated with increase of antioxidative enzymes activity in mice fed high fat diet induced obesity.

2. MATERIALS AND METHODS

2.1 Animals
Eight-week-old male C57BL/6 J mice were housed in a room at 23±1°C with a 12/12-h light–dark cycle. Animals had free access to water and standard mouse chow for an acclimatization period of one week. Thereafter, animals weighing 23-24 g were randomly divided into four groups, control group (n = 20) was fed standard mouse chow, low-fat diet (low, n = 20), high-fat diet (high, n = 20) and high-fat diet with GA groups (high with gum, n = 20) for 30 days. The food was purchased from Jiangsu Province Cooperative Medical and Biological Engineering Co. Ltd (Table 1). Body weight and food intake were recorded throughout the study. Mice were killed by rapid decapitation, liver samples were dissected and washed shortly in cold PBS (pH 7.4) and immediately frozen in liquid nitrogen and stored at -80°C until further analysis. The experimental procedures were approved by the Animal Ethics Committee of Nanjing Agricultural University (Nanjing, China).

2.2 Assessment of hepatic lipid peroxidation
Liver lipid peroxidation was evaluated by measuring the amount of malondialdehyde (MDA) as described by Bloom and Westerfeld using commercial MDA kit (Nanjing Jiancheng Bioengineering Company, Nanjing, China), and the absorbance of spectrophotometer was assessed at 532nm. Approximately 0.5g of liver samples were homogenized in 4.5ml of ice-cold PBS buffer for preparing liver homogenate, the homogenates were then centrifuged for 10min at 3000rpm and the supernatant was stored at -20°C until analyzed. Total protein concentration was determined as described by Bradford and bovine serum albumin was used as the standard. The results were expressed as nmol MDA per mg protein.

2.3. Measurement of Oxidative Stress Markers
The oxidative stress markers were measured on liver tissues, superoxide dismutase (SOD) activity was assayed according to the method of Minami and Yoshikawa. Glutathione peroxidase (GPx) activity was determined according to the method of Lawrence and Burk. Glutathione reductase (GSH) activity was assayed according to the method of Horn and catalase (CAT) activity was determined following the method of Cohen et al.

2.4 Histological analysis
Liver tissues were fixed in 10% buffered formalin (pH 7.2) and dehydrated through a series of ethanol solutions, embedded in paraffin, and routinely processed to investigate the morphologic changes in control, low-fat diet, high-fat diet and high-fat diet with GA groups.
Sections of 5 μm thickness were cut and stained with hematoxylin and eosin, and examined by light microscopy (Nikon, Tokyo, Japan).

2.5. Statistical Analysis
Data were expressed as mean ± SEM and compared by one way analysis of variance (ANOVA) and student t-test, and P< 0.05 was considered significant. Analyses were performed using SPSS 16.0 software (Chicago, IL, USA).

3. RESULTS

3.1 Lipid peroxidation and Antioxidant enzymes activity
Both low fat diet and high fat diet significantly increased MDA concentration in liver tissue compared with the control group. Treatment with GA significantly (P<0.05) decreased MDA concentration compared to the low fat diet and high fat diet (Fig. 1A). Low and high fat diet significantly (P<0.05) reduced the tissue concentrations of GPx and GSH compared to the control and high fat diet + gum arabic groups (Fig. 1B and 1C). The concentration of CAT was significantly (P<0.05) reduced in low and high fat diet groups, whereas the treatment of GA significantly restored CAT concentration compared to the low and high fat diet groups (Fig. 1D).

![Figure 1](image)

Figure 1 Effect of gum arabic on hepatic lipid peroxidation and hepatic antioxidant enzyme activity
A, MDA; B, GPx; C, GSH; and D, CAT concentrations
Bars with different letters are significantly different at P<0.05.

3.2 Liver histological changes
The livers of mice fed with high fat diet and low fat diet showed marked degeneration compared with the control group. However, the treatment with GA slightly reduced the degeneration compared to the low fat, high fat diet and control group (Fig. 2A, 2B, 2C and 2D).
Figure 2 Effect of gum arabic on liver histology
A, control; B, low fat; C, high fat diet; D, high fat diet with gum Arabic

4. DISCUSSION

Superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) are the most important defense mechanisms enzymes against reactive oxygen metabolites which implicated in the oxidative damage. In the present study, high fat diet reduced CAT, GPx, GSH levels while increased MDA levels. The reduction of antioxidant biomarkers concentrations together with an increase of MDA concentrations ultimately reflects oxidative stress in the liver of mice fed with high fat diet, which may decreased antioxidant defense potential. Our results are in agreement with previous studies that fiber-enriched diets improve oxidative stress biomarkers in Zucker fatty rats. Moreover, diet rich in dietary fibre from cocoa reduces malondialdehyde in hypercholesterolemic rats. Here we reported for the first time that the treatment of GA significantly increased activity of SOD, CAT and GPx in the liver. Our results are in line with earlier studies that the consumption of asparagus, a dietary fibre improved antioxidant by increasing SOD and CAT enzymes activates. Gum arabic may act either directly scavenging the reactive oxygen metabolites, because of the presence of various antioxidant compounds, or increasing the synthesis of antioxidant molecules. Elevation of MDA level together with reduction of GSH in mice fed with high fat diet suggests that peroxidative injury may be involved in the development of obesity complications, due to free radical damage which is one of the possible mechanisms in the progress of diabetic hepatopathy. Administration of GA significantly decreased MDA levels which indicate that the GA treatment could improve the oxidative stress. Increased oxidative stress was also reported as a contributory factor in the development of the complications of diabetes.

Oxidative stress frequently develops in obesity and has been acknowledged as the unifying mechanism underlying the development of obesity-related co-morbidities. Oxidative stress plays an important role in pathogenesis of alcoholic liver injury. In the present study, the administration of GA significantly protected the degeneration of liver cell. Our findings are consistent with previous reports that supplementation of chickpea seed coat fibre in the diet decreased pathological changes in different tissues (heart, liver and lungs).

5. CONCLUSION
We concluded that the gum arabic treatment reduced lipid peroxidation, increased the activities of oxidative enzymes in the liver of high fat diet mice and slightly decreased the hepatocyte degeneration. Thus, gum arabic may be used to decrease oxidative stress as well as increase the antioxidant capacity in obese patient.

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