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RESEARCH ARTICLE

Effects of omega-3 fatty acid in experimentally induced obesity in rats

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Abstract

High-fat diet (HFD) administration lead to increased onset of obesity. Obesity, associated with metabolic abnormalities as glucose intolerance and hypercholesterolemia increased mortality rates. In obesity, adipose tissue expands to accommodate this increase in exogenous lipids and endogenous lipid synthesis leading to overall weight gain. An Omega-3 fatty acid used in this study as a treatment to modulate these metabolic disturbances. This study was designed to elucidate the effect of Omega-3 fatty acid on high fat diet induced obesity in albino Wister rats. Obesity induced by allowing rats to feed on the high fat diet for 20 weeks. Omega-3 fatty acid was used in doses of 0.8 mg/Kg body weight. Plasma glucose and total cholesterol were measured by enzymatic method. It can be concluded that administration of high fat diet caused obesity in rats via abnormal or extensive fat accumulation when energy intake exceed energy expenditure. Omega-3 fatty acid succeeded in ameliorating the deleterious effects of high fat diet induced obesity.

INTRODUCTION

Obesity is defined as abnormal or extensive fat accumulation that negatively affects health[1] . According to the World Health Organization classification , Obesity in human has been defined as a body mass index [BMI] > 30 kg/ m2 while morbid obesity defined as BMI > 40 kg/ m2. [2]. Its prevalence is increasing, with 400 million obese and 1·6 billion overweight adults around the world[3].

It has become a universal and a serious public health problem and its prevalence has dramatically increased in both children and adults in the 21st century, even in developing countries[4, 5].

Consumption of a high-fat diet (HFD) is correlated with passive overconsumption and the onset of obesity with also increased morbidity and mortality in both rats and humans. rats with chronic HFD-induced obesity behaved similarly to humans [6]. High fat diets contribute to obesity, as the caloric excess must be stored; adipose tissue expands to accommodate this increase in exogenous lipids and endogenous lipid synthesis. high-fat diets have been shown to induce the hepatic expression of several lipogenic enzymes involved in the de novo synthesis of many lipids[7]. Subsequent studies have revealed that high-fat diets promote hyperglycemia and whole-body insulin resistance. From this experience, it is generally accepted that high-fat diets can be used to generate a valid rodent model for obesity [8].

Events of hyperglycemia and hyperlipidemia, and their association present major risk factors for the development of diabetic and cardiovascular complications. To reduce these serious complications and negative outcome of the metabolic syndrome, the control not only of blood glucose but also of lipids is necessary[9].

Fish oil containing high concentrations of DHA and EPA is considered a good source of omega-3 fatty acid (n-3 PUFAs) [10].

N-3 PUFAs are important constituents of cell membranes and play a role for the function of various membrane channels and receptors.In addition, n-3 PUFAs affect the expression of genes involved in lipid

metabolism [11].This explains why n−3 PUFA supplementation may have relevant clinical effects that are not limited to the cardiovascular system but also include maternal and offspring health, growth and development, immune system disorders, cancer, and psychological status[12]. n−3 PUFA are known as antiobesity factors.

Therefore the present study aimed to investigate the biochemical effect of omega-3 fatty acid involved in treatment of obesity induced by high fat diet in rats.

Materials and Methods

1. Materials

Omega-3 fatty acid was purchased from Sedico Co. (Giza, Egypt). Glucose kits were purchased from Spinreact Co. (Santa Coloma, Spain), total cholesterol kits obtained from Spinreact Co. (Santa Coloma, Spain).

2. Animals

The present study was carried out on Thirty male Wistar rats of 96 ± 10 gm as body weight range. They were obtained from animal house of research institute of ophthalmology (Giza, Egypt). They were housed in groups of five rats per cage under controlled environmental condition of air and temperature with a 12 h light- dark cycle. Animal were allowed the diet and water in a free manner. Body weight of rats was recorded every two weeks.

3. Diet

In this experiment there were the standard normal rat chow diet and the high fat diet for induction of obesity in rats.

The standard normal chow diet (ATMID Company, Egypt) consists of soybean, Corn, soybean oil, calcium carbonate, dicalcium phosphate, sodium chloride, lecithin, methionine, and vitamin/mineral mixture.

The high fat diet consists of 25% fat "beef tallow" + 10% sucrose + 20% corn starch + 45% normal chow with 30% sucrose in drinking water according to[13] with modification.

4. Experimental design and animal grouping

The rats were divided randomly into three groups of ten rats each and treated as follows

Group I (normal control): rats were fed on a normal chow diet for 20 weeks and administered water as a vehicle via oral gavage.

Group II (High fat diet group): rats were fed on the high fat diet for 20 weeks and administered water as a vehicle via oral gavage.

Group III (omega-3-fatty acid treated group): rats were fed on the high fat diet for 20 weeks and administered fish oil daily for the last two consecutive weeks via oral gavage in a dose accounting for (0.8 gm/ kg body weight) of Omega-3fatty acid[14, 15]

The rats were weighed then sacrificed at the end of the experiment after about 18 hours fasting to minimize variation in lipid pattern during two successive days after blood samples have been collected from retro - orbital veins into tubes containing EDTA and centrifuged at 1500 RPM for 30 minutes. An aliquot of the separated plasma was used for immediate estimation of fasting blood glucose. Second aliquot was kept on -20ºC for total cholesterol analysis

All animal procedures were performed upon approval from the Ethics Committee of Beni-Suef University and in accordance with the recommendations of the proper care and use of lab animals.

5. Biochemical analysis

Fasting blood glucose was carried out by enzymatic method (Spinreact, Santa Coloma,Spain). The total cholesterol level was determined according to the enzymatic method (Spinreact, Santa Coloma, Spain).

6. Statistical analysis

Data were presented as means ± SEM values. The results were analyzed statistically by one-way analysis of variance (ANOVA) with subsequent multiple comparisons using Tukey multiple comparison Post-Hoc test. The p-values less than 0.05 were considered significant**.** Correlations between variables were assessed by Pearson's correlation test.

All calculations were made using the computer program SPSS 16.0 (SPSS, Chicago, III, USA). The data were graphed using GraphPad Prism 6 (GraphPad Software, Inc., USA).

Results

1. <u>Metabolic markers:</u>

1.1. <u>Fasting plasma glucose level:</u>

The fasting plasma glucose level was significantly increased in high fat diet treated group when compared to that of the normal control group as shown in table (1). Treatment with omega-3 fatty acid significantly reduced fasting plasma glucose elevation as shown in table (1) and fig. (1).

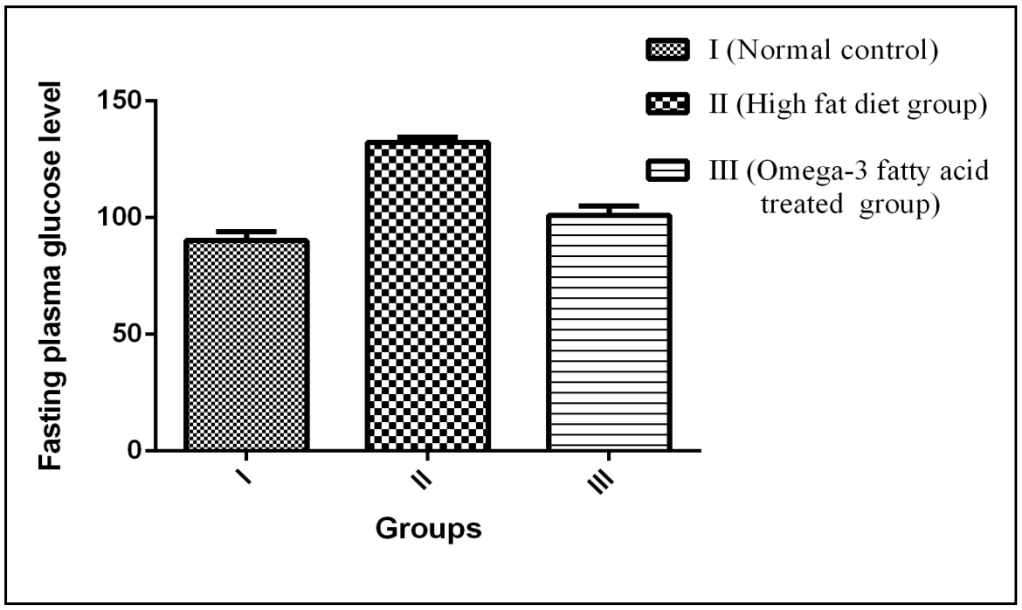


Figure (1): Changes in fasting plasma glucose level in different groups.

1.2. Plasma Total cholesterol level:

The plasma total cholesterol level was significantly increased in high fat diet treated group when compared to that of the normal control group as shown in table (1). Treatment with omega-3 fatty acid succeeded in significantly reducing Plasma total cholesterol level as shown in table (1) and fig. (2).

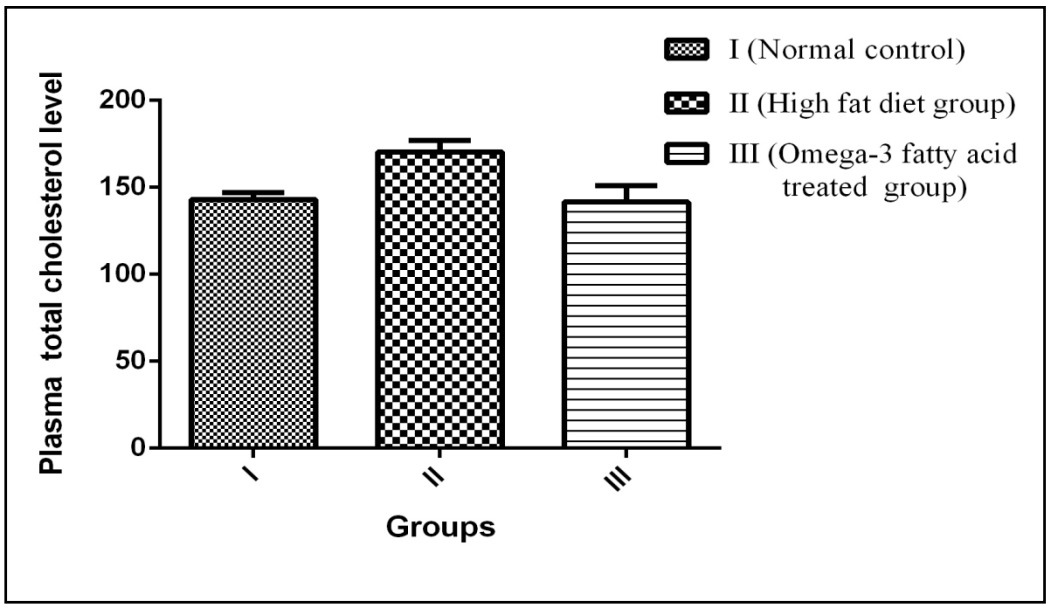


Figure (2): Changes in plasma total cholesterol level in different groups.
Table (1): Fasting plasma glucose and total cholesterol level in the rats of various studied groups.

2. Rat body weight:

Rat body weight showed significant increase in high fat diet treated group compared to that of normal control group.Treatment with omega-3 fatty acid showed significant decrease in body weight level as shown in table (2) and fig. (3).

Table (2): Rat body weight in rats of different groups.

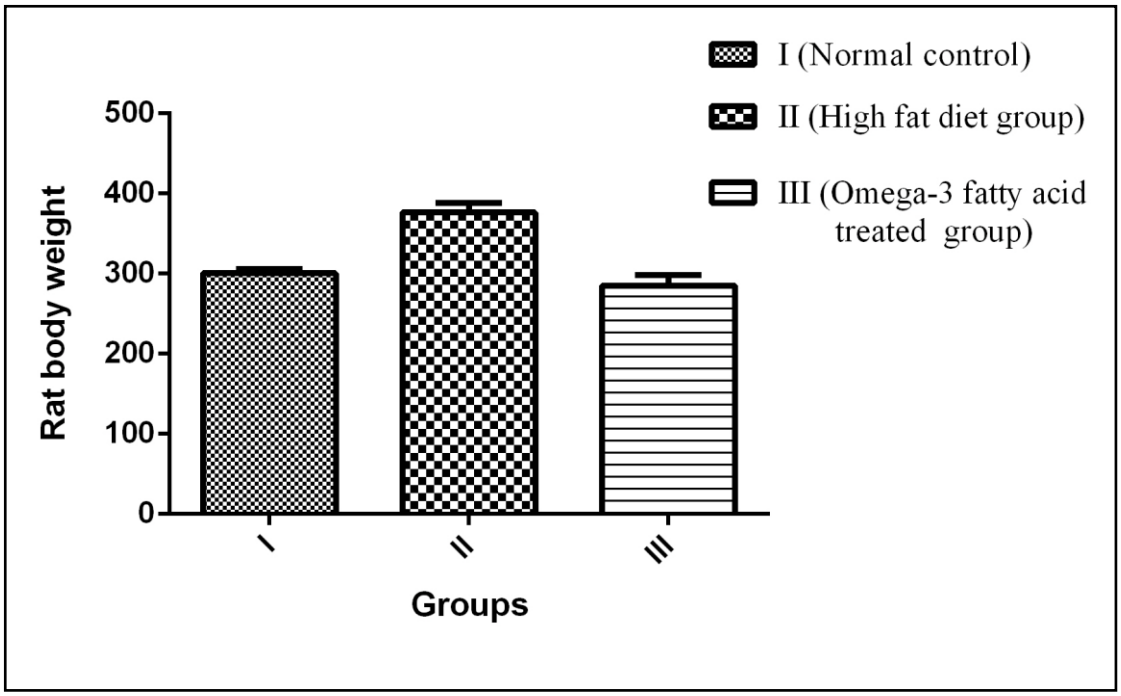
Groups / Parameter	Normal control	High fat diet group	Omega-3 fatty acid treated group
Rat body weight	300.75 ± 5.28	376.25 ± 12.07$^{\#}$	285.12 ± 12.80*

- Data are means ± SEM (n = 10).
- Data are expressed as gm.
- $^{\#}P < 0.05$ compared with the normal control group.
- $^{*}p < 0.05$ compared with the high-fat fed group.

Figure (3): Changes in body weight in rats of different groups.

Groups / Parameter	Normal control	High fat diet group	Omega-3 fatty acid treated group
Fasting plasma glucose level	90.13 ± 3.92	132.26 ± 2.31$^{\#}$	101.00 ± 4.11*
Plasma total cholesterol level	143.03 ± 4.12	170.35 ± 6.59$^{\#}$	141.65 ± 9.32*

- Data are means ± SEM.
- Data are expressed as mg/dl.
- $^{\#}P < 0.05$ compared with the normal control group.
- $^{*}p < 0.05$ compared with the high fat fed group.



Discussion

The rise in human obesity is caused by increased energy intake and decreased energy expenditure that results in a massive increase in adipose tissue that is generally harmful to health[16].It is well known that obesity with associated glucose intolerance and hypercholesterolemia increase mortality rates[17]. Diets rich in fat not only induce obesity in humans but also make animals obese[3]. It is generally believed that diets based on saturated fatty acids induce the typical high-fat diet phenotype, whereas diets containing polyunsaturated fatty acids exert beneficial effects on body composition and metabolic pattern [18].

The present study demonstrated that the level of fasting plasma glucose in the high fat diet treated group was significantly increased compared to a normal control group. These data were in harmony with the previous study [19] which reported that a significant increase in fasting plasma glucose level with a defect in insulin signaling in adipose tissue after high fat diet induced obesity in rats compared to that of control rats.

The treatment with omega-3 fatty acid caused a significant decreased in level of plasma glucose, which elevated as a result of obesity induced by high fat diet. These data are parallel line with previous study[19, 20],which reported that n-3 PUFAs enhanced glucose uptake and improved insulin resistance in obesity. These findings indicate a role of fish oil in reducing the glucose metabolism abnormalities.

Data presented in this study indicated that high fat diet treated group exhibited an elevation of total cholesterol level rats compared to that of normal control group. The observations of current study are in accordance with previous studies[19] which reported that there is a significant increase in the level of total cholesterol in high fat diet treated rats compared to the control animals.

In this study the treatment with omega-3 fatty acid in high fat diet treated animals effectively modulate the elevation in the total cholesterol level. The present study revealed that omega-3 fatty acid treated group was significantly decreased the level of total cholesterol compared to that of high fat diet treated group. The current results are in parallel line with previous studies[20] which reported the loweing effect of omega-3 fatty acid in total cholesterol.

The present study demonstrated that body weight in the high fat diet treated group was significantly increased compared to that of normal control group. These data were in harmony with the previous study [3, 21] which reported that a significant increase in body weight after high fat diet induced obesity in rats compared to control rats as a result of obesity which occurs when energy uptake surpasses energy expenditure in the individual animal and so the stores of energy in body fat are enlarged, particularly in adipose tissues. This enlargement involves both or either an increase in the number of adipocytes (hyperplasia) and their size (hypertrophy).

The treatment with omega-3 fatty acid caused a significant decrease in body weight, which elevated as a result of obesity induced by high fat diet. These data are parallel line with previous study [22],which reported that n-3 PUFA rich fish oil promotes weight loss in animals and in humans .

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