

ABSTRACT

Excess dietary fructose intake has been associated with an increase in metabolic disorders. Traditionally, these disorders are managed by physical exercise, lifestyle modification, and by conventional drug therapy. A significant proportion of the population also depends on the therapeutic/prophylactic properties of natural plants for their medical problems. The tree *Moringa oleifera* is well recognized for its medicinal and nutritional properties. The plant is said to possess antiobesity, antilipidaemic, antidiabetic and hypotensive effects amongst other medicinal properties.

Most previous studies that explored the effects of *Moringa oleifera* on metabolism used adult male experimental animal models without considering adult female and young growing animal models, despite the increasing prevalence of metabolic syndrome in females and growing children. This study thus investigated the impact of a methanolic extract of *Moringa oleifera* leaves on fructose-induced metabolic dysfunction in growing Sprague Dawley rats of both sexes.

One hundred and two (102), 21 day old, weaned male and female pups were randomly allocated to six groups that were sex matched. All groups received standard commercially sourced rat chow *ad libitum* throughout the study. In addition, Group I (negative control) received tap water for drinking and plain gelatine cubes. Group II received 20% fructose solution as drinking fluid and plain gelatine cubes. Group III received 20% fructose solution as their drinking fluid and 400 mg.kg⁻¹ body weight of methanolic extract of *Moringa oleifera* leaves suspended in gelatine cubes. Group IV received 20% fructose solution as their drinking fluid and 100 mg.kg⁻¹ body weight of fenofibrate (positive control) suspended in gelatine cubes. Group V received 400 mg.kg⁻¹ body weight of the methanolic leaf extracts of *Moringa oleifera* in gelatine cubes and had plain drinking water. Group VI received 100 mg.kg⁻¹ body weight of fenofibrate in gelatine cubes and had access to plain drinking water.

After 10 weeks of the interventions, the rats were euthanased by anaesthetic overdose following an overnight fast; and samples of blood and tissue were collected. The outcomes of the interventions on growth performance, morphometry of the gastro-

intestinal tract organs, circulating metabolites, adiposity, liver lipid accumulation and general health markers were assessed.

Data were expressed as mean \pm standard deviation and analyzed by one-way or two-way analysis of variance (ANOVA) depending on the variables. The statistical significance of analyzed values was set at $\leq 5\%$.

Administration of 20% fructose solution significantly elevated hepatic lipid content in both sexes ($P < 0.0001$) and the concentration of circulating triglycerides in female rats ($P < 0.0001$) compared with negative controls. These lipid elevations were prevented by the administration of 400 mg.kg⁻¹ body weight of methanolic extract of *Moringa oleifera* leaves and by 100 mg.kg⁻¹ body weight of fenofibrate ($P \leq 0.05$). The effect of fenofibrate was more pronounced than that of *Moringa*. Fenofibrate treated groups (both sexes) had hepatomegaly ($P < 0.0001$), higher fasting blood glucose (FBG) ($P < 0.0001$), higher alkaline phosphatase activity in plasma ($P < 0.05$) and lower ($P < 0.05$) epididymal fat relative to tibial length (males) compared with the other treatment groups. The plasma triglycerides and cholesterol levels were higher in females than in males ($P < 0.05$). The absolute and relative visceral fat pad masses were also higher in females ($P < 0.05$). There were no significant differences in the hepatic lipid content and creatinine levels between the two sexes ($P > 0.05$). However, male rats had significantly higher levels of FBG, liver enzymes (ALT and ALKP), blood urea nitrogen (BUN), urea to creatinine ratio and higher organ morphometry than their corresponding females ($P < 0.0001$).

No adverse effects were observed with fructose or *Moringa* on growth, organ morphometry, determinants of metabolic dysfunction and surrogate markers of general health. However, hepatomegaly was observed in fenofibrate treated groups ($P < 0.0001$).

In the present study, sex differences were observed in the metabolic responses of growing Sprague Dawley rats to a high-fructose diet. In addition, the methanolic extract of *Moringa oleifera* leaves was beneficial in preventing the hypertriglyceridaemia and abnormal deposition of hepatic lipids in high-fructose fed animals. However, the extract was not effective in preventing fructose-induced visceral obesity in male animals. The use of methanolic leaf extracts of *Moringa oleifera* should be further explored as a possible

candidate prophylactic intervention in the fight against the global epidemic of diet induced metabolic dysfunction.