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**Faculty of Specific Education  
Home Economics Department  
(Food and Nutrition Sciences)**

**Possible role of beetroot extract in lowering overweight in male rats**

**A thesis submitted in partial fulfillment of the requirements for  
the degree of Doctor of Philosophy in Specific Education**

*In*

**Home Economics  
(Food and Nutrition Sciences)**

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## **Declaration**

I hereby declare that no part of this dissertation has been submitted to Alexandria University or to any other University in Egypt or abroad as part of the requirements to obtain another degree. Furthermore, Alexandria University code of ethics and rules of academic integrity have been followed.

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## LIST OF ABBREVIATIONS

ACP	acid phosphatase
AIN	American Institute of Nutrition
ALP	alkaline phosphatase
ALT	alanine aminotransferase
AST	aspartate aminotransferase
BMI	Body mass index
BRE	Beetroot extract
BRJ	Beetroot juice
BVE	Beta vulgaris extract
Beta vulgaris L.	Beta vulgaris Linnaeus
BVr	Beta vulgaris rubra
BW	Body weight
BWG	Body weight gain
CAT	Catalase
CBC	complete blood count
CDC	Centers for Disease Control Prevention
CHO	carbohydrate
CKD	chronic kidney disease
(COX-2)	cyclooxygenase-2
CPF	Chlorpyrifos
cv	central vein
DBP	diastolic blood pressure
DNA	Deoxyribonucleic Acid
FBW	Final body weight
GGT	$\gamma$ -glutamyl transferase
GPX	Glutathione Peroxidase
GSH	glutathione reduced
GST	glutathione S-transferase
H <sub>2</sub> O <sub>2</sub>	Hydrogen Peroxide
HCT	Hematocrit
HDL-	High-density lipoprotein cholesterol
HFD	High-fat diet
HGB	Hemoglobin concentration

hp	Hepatocytes
IBW	Initial body weight
LDL-	Low-density lipoprotein cholesterol
MCH	mean corpuscular hemoglobin
MCHC	mean corpuscular hemoglobin concentration
MCV	mean corpuscular volume
MDA	Malondialdehyde
MPV	mean platelet volume
NAFLD	nonalcoholic fatty liver disease
NCDs	Noncommunicable diseases
NDEA	N-nitrosodiethylamine
NF- $\kappa$ B	Nuclear Factor Kappa B
NHANES	National Health and Nutrition Examination Survey
NO	Nitric Oxide
O $\cdot$ -2	Superoxide Anions
PCOS	Polycystic Ovary Syndrome
PCT	Plateletcritin
PCV	Packed cell volume
PDW	Platelet Distribution Width
PLT	platelet count
RBC	red blood cell count
RBL	red beetroot leaves
RBR	red beetroot extract
RDWCV	Red Cell Distribution Width
RDW-SD	Red Cell Distribution Width fL
RNS	reactive nitrogen species
ROS	reactive oxygen species
RT	renal tubules
SBP	systolic blood pressure
SOD	superoxide dismutase
TAC	total antioxidant capacity
TAG	triacylglycerol
TBARS	thiobarbituric acid reactive substances
TNF- $\alpha$	Tumor necrosis factor alpha

vLDL-c	Very low-density lipoprotein-cholesterol
WHO	World health organizations

## ABSTRACT

Overweight is an important health problem, which has led to reduce life expectancy. It increases the risk of many serious diseases. Diet rich in bioactive compounds such as antioxidants provide natural protection against overweight and its complications.

Beetroot has a high nutritive value and is a rich source of vitamins A, B, K, E, C and folic acid besides several minerals such as calcium, manganese, magnesium, potassium, sodium, iron, copper and selenium, it also has antioxidants and anti-inflammatory compounds, making it a promising therapy option for a variety of ailments. Therefore, the present study conducted to assess the mitigating effects of beetroot extract against overweight and its complications in heart, kidney and liver of male rats.

The experimental work was designed to cover pretreatment (2 months), treatment (2 months) periods, Sixty Wistar male rats weighing 120-140 g (12 weeks old) were randomly assigned to two groups. The basal diet was fed to the first major group of 30 rats, which was subsequently separated into three subgroups. The second major group of 30 rats was fed a high-fat diet (HFD) (the basal diet 80% plus 20 % fat (tallow 10% + corn oil 10%)), for eight weeks before being separated into three subgroups. Six groups of rats were created (each group had 10 rats). The first group received no treatment (control), the second received 15 ml/kg b.wt, beetroot extract (BRE), the third received 30 ml/kg b.wt, (BRE), the fourth no treatment (overweight), the fifth overweight + 15 ml/kg b. w BRE, and the sixth group overweight + 30 ml/kg b. w (BRE). Rats fed (HFD) daily only during the pretreatment period (daily for 2 months); while (BRE) (15,30 ml/kg b.wt) were given orally gavage once daily during the treatment period (daily for 2 months). In comparison to the control group, biochemical analyses showed that a (BRE) significantly reduced the increase in final body weight, body weight gain, body weight, and relative weight of the heart, kidneys, and liver. It also improved heart, kidney and liver function, antioxidants, lipid profile, and haematological parameters. The findings were corroborated by a histopathological examination of the heart, kidney and liver. Beetroot extract can help to lowering overweight in male rats.

*Keywords:* Overweight; Beetroot extract (BRE); Male rats; Body mass index (BMI); High-fat diet (HFD); Oxidative stress; liver, heart and kidney histopathological.

# 1- INTRODUCTION

Nowadays, overweight is a global epidemic condition that has become more prevalent in recent decades. **(M Shatla et al.,2019; WHO,2020; F Miky et al., 2022)** Moreover overweight is a significant public health issue in Egypt and its consequences that transcend beyond health to damage citizens' productive potential. This has a negative impact on the Egyptian economy's overall fundamentals. Furthermore, there is a contemporary political interest in encouraging people's health and well-being, as evidenced by the recent "100 Million Seha" enormous effort, which weighed and measured millions of Egyptians. According to the World Health Organization's (WHO's) "100 million Seha" and Global Health Estimates for 2019, the total population is 100,400,000, the total number of Noncommunicable Disease (NCDs) fatalities is 492,500 (86%), and the probability of early death from (NCDs) is 28%. **(Sedky et al.,2021; WHO,2022)** Overweight affected more than 1.9 billion individuals worldwide, including more than 155 million children (aged 5 to 19). **(WHO, 2021; F Miky et al., 2022)** In Egypt, Overweight prevalence increased from 4% to 7% and is expected to increase. In Cairo, it was 11%. In Alexandria, It was 16.8% among governmental students (6–12 years old). **(Hamed et al.,2019)**

The prevalence of overweight in Egypt among young adults is high, particularly among females. bad dietary habit (fast food consumption and missed breakfast) and lack of physical activity were likely to be the predictors of this alarming issue, Genetics, illnesses and medications may lead to weight gain. **(Genena and Salama,2017; WHO,2022)**

Overweight is a chronic or non-communicable disease that increases metabolic syndrome risk factors and increases the risk for overweight-related co-morbidities including non-insulin-dependent diabetes mellitus, hypertension, dyslipidemia, cardiovascular disease, atherosclerosis, musculoskeletal disorders, nonalcoholic fatty liver disease, obstructive sleep apnea, several forms of cancer (such as breast, colon, and prostate), pulmonary and osteoarticular. **(Jagannathan et al.,2019; M Shatla et al.,2019)**

This tendency will almost certainly continue to fuel the worldwide overweight epidemic for decades to come, affecting population health, posing infrastructure issues as governments try to fulfil increased health-care demands, and driving up global health-care spending. **(Purnell, 2018)** Obesity and overweight will be abolished by 2025, according to (WHO's) "Global Action Plan for the Prevention and Control of NCDs 2020-2025."Obesity epidemiology data should be monitored on a frequent basis, according by (WHO). **(WHO, 2020)**

Despite the rising prevalence of overweight, effective long-term treatments for obesity are still in short supply. **(Whiting et al., 2013)**. Unfortunately, for many obese and overweight people, weight reduction from these treatments is frequently followed by weight gain. **(Anderson et al., 2001)**. On the other hand, anti-obesity and overweight medicines, have been linked to a variety of side effects, including headaches, stomachaches, vomiting, and heart attacks **(Park et al., 2007)**.

Plant flavonoids have been the subject of numerous research to see if they can help reduce the risk of overweight and its effects. (Andersen et al., 2010) Recent research suggests that various vegetables and herbs can decreasing cholesterol, reduce the generation of reactive oxygen species (ROS) and increase the resistance of plasma lipoprotein to oxidation, which may contribute to their efficiency in avoiding atherosclerosis. (Rosenson et al., 2004; Ou et al., 2006; Jones et al.,2021)

Red beet (*Beta vulgaris* L. ssp. *europaea* Krass. var. *atrorubra* Krass.) is a biennial, cross-pollinated plant of the Amaranthaceae family (Chenopodiaceae Vent.); more often known as beetroot, is a Mediterranean native that is widely cultivated in Europe, America, and Asia. The roots and leaves of the beet have long been used in traditional medicine to cure a range of diseases, including liver and kidney disorders. It is also used in the treatment of cancer as a specific diet. (Al-Dosari et al., 2011; Wootton-Beard et al.,2014; Zayachkovskaya et al., 2021). Beetroot extract is also said to be one of the most effective ways to prevent lung and skin cancers. Beetroot juice has a high total antioxidant capacity and total polyphenol content, and contains numerous substances such as phenolic acids, flavonoids, nitrate (NO<sub>3</sub>-), betalains, vitamins A, C, B2, B6, B12, K, E, and several minerals such as Mn, Ca, K, Mg, Fe and Na. Furthermore, beetroot is made of around 90% sucrose in terms of accessible carbohydrate (CHO). (Wootton-Beard et al.,2014; Jones et al.,2021; Silva et al.,2021)

The present study is designed to assess whether the Beta vulgaris extract (BVE) has possible role in lowering overweight in male rats, in order to back up the claims of its folkloric use to lower cholesterol levels and overweight.

## **Aim of the work**

The present study aimed to

Assess the role of red beetroot extract (BRE) to treatment overweight and its complications in male rats via

- Chemical analysis and nutritive value of red beetroot extract.
- Body weight and relative organs weights of male rats.
- Plasma lipid profile of male rats.
- Liver function in liver and plasma.
- Kidney function in plasma.
- The antioxidant enzymes activities and oxidative stress in plasma, heart, kidney, and liver of male rats.
- The hematological parameters of male rats.
- The histological changes in heart, kidney and liver of male rats.