Synergistic anti-obesity effects of red cabbage and chromium administration on obese rats

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Abstract

This research was conducted to evaluate synergistic effects of red cabbage leaves either powder or methanolic extract with or without chromium on obese rats by evaluation nutritional indicators, serum lipids profiles, antioxidant enzymes, and some hepatic marker. After induction of obesity in rats by feed in high fat diet for six weeks, obese rats were randomly classified into six groups (seven rats in each) that include positive control group (basal diet), cabbage powder (15% of cabbage powder in basal diet) group, chromium (basal diet and 4.5 µg/ kg body weight/d chromium) group, cabbage extract (basal diet and 20 mg/kg/ body weight /d of cabbage extract) group, cabbage powder + chromium (15% of cabbage powder in basal diet and 4.5 µg/ kg body weight /d chromium) group and cabbage extract + chromium (basal diet and 20 mg/kg/d of cabbage extract and 4.5 µg/ kg/d chromium) group. The experiment period was 60 days after induction of obesity. The obtained results recorded that administration of cabbage powder with chromium or cabbage extract with chromium could lower body weight gain (BWG) and feed intake (FI) and elevate feed efficiency ratio (FER) compared to positive obese control group. All treated groups showed improvement in both serum and liver lipids profiles and liver function enzymes appeared prominently in cabbage powder with chromium and cabbage extract with chromium groups compared with positive control group. It is recommended to administer red cabbage leaves or its extract with chromium as a diet for patients with obesity

Key wards: red cabbage – chromium - obesity – rats- blood lipids - antioxidants.

INTRODUCTION

Obesity is a dangerous health problem that results from an imbalance of energy intake and energy expenditure associated with abnormal excessive body fat and dramatic metabolic disorders such as non-alcoholic fatty liver disease, dyslipidemia, type 2 diabetes as well as coronary heart disease **(Michalakis *et al*., 2013)**. Consumption of high-fat diet is related with inflammation, insulin resistance, oxidative stress, variations in liver chemistry and structure, and elevation risk of liver damage **(Kim *et al*., 2010 and Lee *et al*., 2021)**.

Weight reduction needs pharmaceutical interventions, caloric restriction and elevates physical activity. Surgery for severe obesity and anti-obesity drugs need more money and may have negative side effects **(Fried *et al*., 2008 and Baetge *et al*., 2017)**.

Chromium is a trace element, essential for the maintenance of normal metabolism of lipids and carbohydrate. Some animals and clinical studies proved that chromium has a positive significant effect in reducing body weight **(Pittler *et al*., 2003)**. Chromium is essential cofactor to enhance the effects of insulin on target tissues and inhibit increase in inflammatory markers and oxidative stress levels in cultured monocytes exposed to high glucose levels **(Jain *et al*., 2007, Jain *et al*., 2010 and Chang *et al.,* 2021)**.

Epidemiological and animal studies have shown that vegetable-rich diet is related with lower incidence of cancer, cardiovascular disease, and metabolic diseases so it is a cheap way to improve health and life **(Navaro *et al*., 2017)**.

Red cabbage is belonging to *Brassicaceae* family, has more protective anthocyanin polyphenols phytonutrients that give the distinctive red color. Leaves of red cabbage also have antioxidant (vitamins), anti-inflammatory and other structurally diverse phytochemicals as glucosinolates and isothiocyanate precursors that prevent cancer. The hepatoprotective and neuroprotective effects of red cabbage are connected with high fiber, low calorie and rich source of anthocyanins **(Podsę-dek *et al*., 2006 and Majkowska-Gadomska and Wierzbicka, 2008).** Also, red cabbage has antioxidant capacity as it is rich in polyphenols, vitamins, minerals, anthocyanins and glucosinolates. Glucosinolates are transformed into isothiocyanates which lower inflammation. kaemferol and isorhamnetin in *Brassica juncea* L. leaves have antioxidant and protect against diabetes **(Leja *et al*., 2010, Draghici *et al*., 2013 and Jana *et al*., 2017)**

Therefore, this research was conducted to evaluate synergistic effects of red cabbage leaves either powder or methanolic extract alone or in combination with chromium on obese rats induced by high fat diet consumption.

MATERIALS AND METHODS

Materials

Forty two adult male white albino rats (Sprague Dawley Strain) weighing 120 ± 10 g, were obtained from Agricultural Research Center, Giza, Egypt. Red cabbage (*Brassica oleracea L. var. capitata f. rubra DC.*) was purchased from a local market in Banha. Chromium capsules drug produced by Arab company for pharmaceuticals and medicinal plants and purchased from

pharmacy of Banha city. Each capsule contains 200µg of chromium piclonate equivelant to 24.85 µg chromium. The human therapeutic dosage of the drug was 400µg daily. Chromium piclonate was dissolved in water to obtain the rat dose (4.5 µg/ kg) according to previous research of **Vincent (2006)**.

Methods

Cabbage leaves were washed in distilled water to remove any contaminants, cut into small pieces and dried at 45°C for 72 hours in hot oven, then grinded to powder. To obtain ethanolic leaf extracts, leaves of red cabbage were freeze-dried for three days, immersed in 80% (*v/v*) ethanol at 70°C with stirring for four hours and filtered through Whatman filter paper then concentrated using a rotary evaporator. Ethanolic leaf extracts were stored at 4°C till use according to **Zhang *et al.,* (2018)**.

Basal diet was prepared according to **Reeves *et al.*, (1993)**. The high fat diet is basal diet contain 400 g beef tallow in substitution of 50 g corn oil 100 g sucrose and 250 starch . Rats were adapted for a week under standardized conditions for animal facilities. Rats were fed on high fat diet for six week in order to induce obesity till their weight reached 250 ± 10 g **(Im et al., 2018)**.

Obese rats were randomly classified into six groups (seven rats in each) as follows.

1- Positive control group fed on basal diet and did not receive any treatment.
2- Cabbage powder group fed on basal diet supplemented with 15% of cabbage powder
3- Chromium group fed on basal diet and administered 4.5 µg/ kg/ bw/d chromium by oral stomach tube.
4- Cabbage extract group fed on basal diet and 20 mg/kg/ bw /d of cabbage extract by oral stomach tube.
5- Cabbage powder + chromium group fed on basal diet supplemented with 15% of cabbage powder and administered by 4.5 µg/ kg/ bw/d chromium by oral stomach tube
6- Cabbage extract + chromium group that fed on basal diet and 20 mg/kg/ bw/d of cabbage extract and 4.5 µg/ kg /bw/d chromium by oral stomach tube.

Food and water were provided *ad libtium*. Daily feed intake (FI) and weekly body weight gain (BWG) were maintained. Ethical guidelines were maintained during animal handling and permission. After 60 days, blood samples were obtained from orbital plexusby fine capillary tube then centrifuged at 3000rpm by centrifuge (Heraeus Sepetech,Germany). Liver from each rat were collected after sacrificing, washed with saline and kept in ice-cold buffered saline till analyses.

Serum cholesterol (CHO), triglyceride (TG), high density lipoprotein (HDLc) and very low density lipoprotein (VLDLc) were estimated as described by **Cohn *et al.*, (1988), Foster and Dumns (1973),** and **Friedewald *et al.*, (1972)**. Serum superoxide dismutase (SOD), catalase (CAT), glutathione transferase (GST), glutathione peroxidase (GPx) and malondialdehyde (MDA), were measured using the methods described by **Nandi and Chatterjee (1988), Claiborne (1985), Ellman (1959), Necheles *et al*., (1970) and Uchiyama and Mihara (1978),** respectively. Serum alanine&aspartate amino transferase (ALT& AST), alkaline phosphatase (ALP), gamma glutamyl transferase (γGT) and lactate dehydrogenase (LDH) enzyme activities were estimated using the kinetic methods of **Tietz *et al*., (1976).** Liver total lipids (TL), CHO and TG were measured as described by **Folch *et al*., (1957), Wease *et al*., (1975) and Zlatkis and Zak (1969)**, respectively.

Feed efficiency ratio (FER), Low-density lipoprotein cholesterol (LDL-C) and atherogenic index (CHO/HDLc) were calculated according to **Friedewald et *al.*, (1972) and Rosenfeld (1989),** respectively.

Statistical analyses:

Results were presented as means ± standard deviations (SD). Results were compared by one-way analysis of variance with Tukey post hoc analysis. Differences were significantly different at $P \leq 0.05$ according to **Abo-Allam (2003)**.

RESULTS AND DISSCUSION

Table (1): Nutritional indicators of obese rats.

Groups Variables	Positive control	Cabbage powder	Cabbage extract	chromium	Cabbage powder with chromium	Cabbage extract with chromium
BWG (g)	115.87± 7.56^{a}	90.55± 4.11^{b}	85.76± 4.11^{c}	95.77± 5.33^{b}	80.54± 3.27^{c}	67.70± 3.99^{d}
FI (g)	30.71± 3.14^{a}	24.35± 2.30^{b}	22.55± 2.11^{bc}	24.96± 2.14^{b}	19.35± 1.81^{c}	17.38± 1.30^{C}
FER	0.062± 0.002^{cd}	0.061± 0.003^{d}	0.063± 0.001^{c}	0.063± 0.005^{c}	0.069± 0.004^{a}	0.065± 0.007^{b}

Results are expressed as Mean ± SD

BWG: body weight gain, FI: feed intake, and FER: feed efficiency ratio

Mean values in each raw having different superscript were significantly different at p≤0.05

Table (1) showed the effect of red cabbage powder or extract in combination with or without chromium on body weight gain (BWG), feed intake (FI), and feed efficiency ratio (FER) of experimental rats after 60 days of treatment.

There was a significant increase in the BWG and FI of positive control rat group when compared to other groups. The body weight gain was significantly lower in cabbage powder and chromium groups, then cabbage extract and cabbage powder with chromium groups, lastly the lowest value was in cabbage extract with chromium group compared to positive obese control group. The feed intake was significantly lower in the treatment groups compared to positive obese control group. The lowest values of food intake were observed in cabbage powder with chromium and cabbage extract with chromium groups. FER was not significantly changed in cabbage powder; chromium and cabbage extract groups while FER was significantly increased in cabbage powder with chromium and cabbage extract with chromium compared to positive obese control group after 60 days of treatment.

The decline of body weight gain and feed intake is related to composition of red cabbage as it has high dietary fiber content which helps prevent colon cancer, elevation of cholesterol, diabetes and obesity **(Draghici *et al*., 2013)**. Quercetin and rutin are flavonoids in cabbage, could improve glucose tolerance and insulin resistance so reduce body weight in hyperlipidemic rats. Reduction of weight and fat mass without changes in lean body mass was observed in rutin and quercetin treatment **(Henagan *et al*., 2015 and Jovanovski *et al*., 2020)**. Chromium picolinate is oral treatment for reduction of body weight by increase lean body mass and lower of body fat with increasing of basal metabolic rate **(Pittler *et al*., 2003 and Molz *et al*., 2021)**.

Table (2): Serum lipids profile of obese rats.

Groups Variables	Positive control	Cabbage powder	Cabbage extract	chromium	Cabbage powder with chromium	Cabbage extract with chromium
CHO (mg/dl)	277.33± 39.77^{a}	199.33± 28.21^{b}	188.65± 26.12^{bc}	2.3.66± 30.14^{b}	185.60± 24.14^{bc}	178.41± 22.11^{c}
TG (mg/dl)	257.40± 41.11^{a}	188.71± 25.61^{b}	161.77± 18.14^{bc}	179.81± 21.16^{b}	160.71± 17.22^{bc}	150.14± 15.44^{d}
HDLc (mg/dl)	28.11± 2.17^{c}	39.66± 4.01^{ab}	43.11± 4.20^{a}	38.20± 3.81^{b}	41.55± 4.17^{a}	40.77± 4.13^{a}
LDLc (mg/dl)	197.74± 18.19^{a}	121.93± 12.11^{b}	113.19± 10.33^{c}	129.50± 11.71^{b}	111.91± 11.33^{c}	107.62± 10.15^{c}
VLDLc (mg/dl)	51.48± 6.11^{a}	37.74± 3.10^{b}	32.35± 3.12^{c}	35.96± 3.11^{bc}	32.14± 3.14^{c}	3.02± 3.01^{cd}
CHO/HDLc	9.86± 1.14^{a}	5.02± 0.67^{b}	4.37± 0.42^{c}	5.33± 0.66^{b}	4.46± 0.53^{c}	4.37± 0.57^{c}

Results are expressed as Mean ± SD

CHO: cholesterol, TG: triglyceride, HDLc: high density lipoprotein cholesterol, LDLc: low density lipoprotein cholesterol, VLDLc: very low density lipoprotein cholesterol , CHO/ HDLc: cholesterol/ high density lipoprotein cholesterol

Mean values in each raw having different superscript were significantly different at $p \leq 0.05$

In the present study, it was observed in table (2) that positive control group had the highest values of lipid profiles and CHO/HDLc and lowest value of HDLc among experimental groups as expected. Obese rats administered by cabbage powder or extract alone or in combination with chromium had significantly lower CHO and TG. Obese rats that administer basal diet with cabbage extract with chromium had the most prominent reduction of CHO and TG compared with positive control group. All the treated groups under this study showed significant increase HDLc and appeared more elevated in obese rats administered cabbage extract, cabbage powder with chromium and cabbage extract with chromium compared with positive control group. The obtained results showed significant decrease of LDLc, VLDLc and atherogenic index (CHO/HDLc) in all treated groups and appeared obviously in rats groups administered cabbage extract, cabbage powder with chromium and cabbage extract with chromium compared with positive control group.

Results of positive group were explained by previous studies that showed consumption of high fat diet had higher lipids profiles, hypertension, nonalcoholic fatty liver disease and hepatocarcinoma. Abnormally hyperlipidemia can lead to increase athrogenic index and increase various cardiovascular diseases such coronary heart disease and atherosclerosis **(Bray *et al*., 2004 and Panchal *et al*., 2011)**. On the other side, administration of glucosinolates in red cabbage (sulfur plant metabolites) and hydrolysis products (isothiocyanate & sulforaphane) could modify lipid metabolism in vitro and in vivo (**Choi *et al*., 2014 and Miyata *et al*., 2016)**. Most of the concerns regarding reductions in serum cholesterol, triglyceride, LDL-c, levels and increases in HDLc have observed in chromium supplementation **(Kobla and Volpe 2000)**. Administration of cabbage either powder or extract with chromium showed the most improvement of lipids profiles because red cabbage extract is rich in anthocyanin that prevents cardiac and hepatic oxidative stress and reduces cardiovascular risks in obese rats. Polyphenol extracts from red cabbage could reduce cholesterol level in hypercholesterolemia. Also, Polyphenols *in Brassica* vegetable have hypolipidemic, anti-inflammatory and anticancer properties **(Sankhari *et al*., 2012, Cassidy *et al*., 2013 and Jana *et al*., 2017).**

Table (3): Liver total lipids, cholesterol and triglyceride of obese rats.

Groups Variables	Positive control	Cabbage powder	Cabbage extract	chromium	Cabbage powder with chromium	Cabbage extract with chromium
TL(mg/g tissue)	45.11± 3.11^{a}	37.10± 2.96^{bc}	35.50± 3.11^{cd}	38.03± 3.07^{bc}	34.14± 3.33^{d}	32.43± 2.69^{d}
CHO(mg/g tissue)	5.87± 0.77^{a}	3.71± 0.41^{c}	3.17± 0.43^{c}	4.07± 0.36^{b}	3.22± 0.25^{c}	3.42± 0.33^{c}
TG(mg/g tissue)	2.57± 0.11^{c}	3.52± 0.22^{b}	4.31± 0.41^{a}	3.61± 0.29^{b}	4.07± 0.33^{a}	4.41± 0.35^{a}

Results are expressed as Mean ± SD
TL: total lipids CHO: cholesterol TG: triglyceride
Mean values in each raw having different superscript were significantly different at p≤0.05

Positive obese group had a significant increase of total lipids (TL) and cholesterol (CHO) and decrease of triglyceride (TG) in liver compared with treated groups. . On the other hand, rat groups that consumed cabbage extract, cabbage powder with chromium and cabbage extract with chromium had the lowest values of liver TL and CHO and highest value of liver TG compared with positive control group as shown in table(3).

These results were explained by **Panchal *et al*., (2011)** who reported that consumption of high fat showed elevated the accumulation of fat in the liver and dysfunction because of leakage of cellular enzymes in the blood. Consumption of cabbage powder or chromium separately could lower liver TL and CHO but increase in TG Chromium has an important role in proper meatabolic process and normal physiological function as lowering risk of cardiovascular diseases including reduction of total cholesterol, triglycerides, insulin and glucose elevate of HDL-cholesterol **(Pittler *et al*., 2003)**. Similar results were reported by **Hummel *et al*., (2007), Chen *et al*., (2009) and Chang *et al*., 2021)**.

Most of the concerns regarding the efficacy of red cabbage as antioxidant and prevent liver inflammation as cabbage is super foods rich in vitamin, minerals and antioxidants **(Kim *et al*., 2004)**. Phenolics in red cabbage are antioxidants that reduce the formation of free radicals so inhibit oxidation of low density lipoproteins and prevent atherosclerosis (**Duchnowicz *et al*., 2012**).

Table (4): Hepatic marker enzymes in serum of the experimental obese rats.

Groups Variables	Positive control	Cabbage powder	Cabbage extract	chromium	Cabbage powder with chromium	Cabbage extract with chromium
ALT (µ/l)	39.11± 3.51^{a}	29.77± 2.79^{b}	28.24± 3.10^{b}	31.41± 3.08^{b}	26.33± 2.96^{bc}	25.17± 3.11^{c}
AST (µ/l)	48.75± 5.69^{a}	38.98± 5.11^{b}	37.99± 4.14^{b}	41.14± 4.99^{b}	35.21± 4.07^{bc}	33.81± 3.11^{c}
ALP (µ/l)	80.41± 9.17^{a}	72.11± 8.40^{b}	70.44± 7.16^{b}	73.22± 7.99^{b}	71.31± 8.01^{b}	66.14± 6.19^{bc}
γGT(µ /ml)	6.33± 0.55^{a}	4.35± 0.41^{bc}	4.95± 0.37^{b}	4.90± 0.39^{b}	4.94± 0.41^{b}	4.75± 0.32^{b}
LDH (U/L)	250.88± 34.11^{a}	181.33± 19.96^{b}	178.55± 17.41^{bc}	190.14± 22.10^{b}	171.18± 18.55^{bc}	166.57± 17.18^{c}

Results are expressed as Mean ± SD

ALT: alanine amino transferase, AST: aspartate amino transferase, ALP: alkaline phosphatase, γGT: gamma glutamyl transferase , LDH: lactate dehydrogenase (LDH)

Mean values in each raw having different superscript were significantly different at $p \leq 0.05$

Positive obese group had a significant increase in hepatic markers (ALT, AST, ALP, γGT and LDH) in serum compared with all the treated groups. These markers are functional diagnostic of liver damage due to consumption of high fat diet. Accumulation of lipids in liver cells causes nonalcoholic hepatic steatosies and increase hepatic inflammation **(Bechmann *et al*., 2012)**. The obtained results in table (4) showed also reduction in levels of these markers (ALT, AST, ALP, γGT and LDH) in the treated group administration of red cabbage in the form of powder or extract with or without chromium however, no significant difference between the treated s rats groups and most favorable results were found in cabbage extract with chromium group compared with positive control group. Red cabbage contains flavonoids as isothiocyanates, anthocyanins and glutamine amino acid that have anti-inflammatory and anticancer **(Lee *et al*., 2018)**. Previous studies on anthocyanin and Zeaxanthin dipalmitate of red cabbage extract showed prevention hepatic oxidative stress in obese rat consumed high fat diet **(Sankhari *et al*., 2012 and Xiao *et al*., 2014)**.

Table (5): Serum antioxidant enzymes of obese rats.

Groups Variables	Positive control	Cabbage powder	Cabbage extract	chromium	Cabbage powder with chromium	Cabbage extract with chromium
SOD (µ/ml)	17.55± 1.81 ^{c}	27.33± 2.14 ^{ab}	23.24± 3.15	25.11± 2.33 ^{b}	30.03± 3.10 ^{a}	30.96± 3.24 ^{a}
CAT (µ/ml)	120.20± 10.42 ^{c}	190.71± 20.35 ^{b}	199.88± 20.33 ^{b}	189.41± 19.17	217.24± 25.19 ^{a}	241.32± 22.13 ^{a}
GST (µ/ml)	55.40± 4.59^{c}	82.17± 8.10^{ab}	88.33± 7.50^{ab}	80.11± 7.81^{ab}	91.44± 8.11^{a}	95.11± 7.22^{a}
GPX (µ/ml)	26.16± 2.14^{c}	58.22± 5.18^{ab}	60.33± 5.88^{a}	55.14± 4.25^{ab}	62.25± 6.07^{a}	63.11± 5.11^{a}
MDA (mmol/l)	11.25± 2.10^{a}	8.75± 1.35^{b}	7.39± 1.17^{bc}	8.80± 1.44^{b}	7.44± 1.22^{bc}	7.01± 1.30^{bc}

Results are expressed as Mean ± SD

SOD: Serum superoxide dismutase, CAT: catalase, GST: glutathione transferase, GPX: glutathione peroxidase, MDA malondialdehyde

Mean values in each raw having different superscript were significantly different at $p \leq 0.05$

The activity of antioxidant enzymes were shown in table (5). Positive obese rat had significantly lower levels of SOD, CAT, GST and GPX and significantly higher of oxidant MDA. However, all treated groups that consumed basal diets with red cabbage as powder or extract with or without chromium had significant increase in SOD, CAT, GST and GPX and significantly lower of MDA compared to positive control group. Furthermore, the best obtained results in improving antioxidant enzymes and reduction of oxidant were appeared obviously in rats groups administered cabbage powder with chromium or cabbage extract with chromium compared with positive control group.

Laboratory and clinical evidence indicated that obesity is related with elevated oxidative stress as hyperlipidemia increase production of reactive oxygen species by NADPH oxidase activation that increases lipid peroxidation **(Beltowski *et al*., 2000, Zhang *et al.,* 2005 and Amirkhizi *et al*., 2010)**. Vegetables are rich in natural antioxidants like vitamin C and E and phenolic compounds. Red cabbage is rich in kaemferol, isorhamnetin and acylated anthocyanins which have strong antioxidant activity and therapeutic properties **(Thakur *et al*., 2014 and Lee 2017)**. Red cabbage contains many vitamins (vitamin C, vitamin B5, vitamin B6 and vitamin B1), minerals (potassium, manganese, iron, and magnesium) and phytochemicals which are powerful

antioxidants **(Hassimotto *et al*., 2005)**. The obtained results showed significant positive relations between chromium consumption and elevation of antioxidant enzymes and that agreed with results of **Sahin *et al*., (2007)**.

These results, along with the observed improved lipid and antioxidants with reduction of body weight suggested that red cabbage powder or extract alone or in combination with chromium is beneficial for obesity caused by a high fat diet. The recommendation from this study is administration of red cabbage and chromium in regimen diet for lowering body weight and improving the status of diseases related to obesity. Further studies are needed to determine the mechanisms of action the red cabbage and chromium in the obtained effects.

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ملخص البحث

التاثيرات التأزرية المضادة للسمنة لتناول الكرنب الأحمر والكروم على الفئران البدينة

أجريت هذه الدراسة لتقييم التاثير التأزري لأوراق الكرنب الاحمر علي صورة مسحوق أو مستخلص ميثانولي مع وبدون الكروم علي الفئران المصابة بالسمنة عن طريق تقييم المؤشرات الغذائية و دهون السيرم والإنزيمات المضادة للأكسدة و بعض وظائف الكبد. وتم إصابة الفئران بالسمنة عن طريق تغذيتها علي وجبات عالية الدهون لمدة ستة أسابيع. تم تقسيم الفئران المصابة بالسمنة بشكل عشوائي إلى ست مجموعات "سبعة فئران في كل مجموعة" وهي المجموعة الضابطة الإيجابية المصابة بالسمنة والتي تناولت الوجبة الاساسية والمجموعة المعالجة بمسحوق الكرنب ١٥٪ من مسحوق الكرنب في الوجبة الأساسية والمجموعة المعالجة بالكروم مع الوجبة الاساسية بجرعة ٤.٥ ميكروجرام/كجم من وزن الجسم كروم والمجموعة المعالجة بمستخلص الكرنب مع الوجبه الاساسية بجرعة ٢٠ ملجم / كجم من وزن الجسم مستخلص الكرنب والمجموعة المعالجة بمسحوق الكرنب مع الكروم ١٥٪ من مسحوق الكرنب و٤.٥ ميكروجرام/ كجم كروم والمجموعة المعالجة بمستخلص الكرنب مع الكروم مع الوجبه الاساسية ٢٠ ملجم /كجم من وزن الجسم لمستخلص الكرنب و٤.٥ ميكروجرام/ كجم من الكروم. واستمرت الدراسة لمدة ٦٠ يوما بعد الاصابة بالسمنة. اسفرت نتائج الدراسة علي أن تناول مسحوق الكرنب مع الكروم أومستخلص الكرنب مع الكروم اظهر نقص معنوي في الوزن المكتسب والمتناول من الطعام ونسبه كفاءه الطعام بالمقارنة بالمجموعة الضابطه الإيجابية المريضة بالسمنة. كما أظهرت جميع المجموعات المعالجة تحسن معنوي في كل من مؤشرات الدهون في السيرم والكبد وتحسن معنوي في انزيمات كفاءه الكبد ومضادات الاكسده وكانت افضل النتائج في المجموعات المتناولة لمسحوق الكرنب مع الكروم و المتناوله لمستخلص الكرنب مع الكروم بالمقارنة مع المجموعة الضابطه الإيجابية. وتوصي نتائج الدراسة بضرورة تناول الكرنب الاحمرومستخلصه مع الكروم كنظام غذائي لمرضي السمنة لما له من تاثيرات ايجابية علي نقص الوزن وتحسين وظائف الكبد وخفض دهون الدم.

الكلمات المفتاحية : الكرنب الاحمر – الكروم – السمنة – الفئران – دهون الدم– مضادات الاكسدة