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The Effect of Bladder wrack algae on biomarkers of Obesity among experimental Rats

Magda K El-Shaer., Abeer N Abd El_Rahman., Rehan F Saleh
Nutrition and Food Science Dept., Faculty of Home Economics, Menofia University., Egypt

Abstract

This study was done to find out the effect of Bladder wrack (*Fucus Vesiculosus*) algae (BWA) on biomarkers of obesity among experimental rats. Thirty-six adult albino rats (weighting 140 ±10 g) were divided into 2 main groups, the first group is the negative control group (n= 6 rats) was fed on standard diet and the second main group is experimental group (n= 30 rats) and this group was fed on high fat diet (20% animal fat) for four consecutive weeks to induce obesity, then was further subdivided into 5 subgroups (n= 6 rats each group); the 1st group (positive control group) was fed on the standard diet; the 2nd group (2.5% BWA powder) was fed on standard diet plus 2,5% of BWA powder; the 3rd group (5.0% BWA powder) was fed on standard diet plus 5.0% of BWA powder; the 4th group (1 ml alcoholic extract of BWA) was fed on standard diet plus 1 ml injected with a dose of BWA extract; and the 5th group (2 ml alcoholic extract of BWA) was fed on standard diet plus 2 ml injected with a dose of BWA extract. The intervention continued for 28 consecutive days. By the end of the experiments period, body weight gain, feed efficiency ratio, feed intake and relative organs weight were estimated. Also, blood samples were collected for determination of serum liver enzymes (AST, ALT and ALP), blood lipid profile (TG, TC, LDL, HDL, VLDL), and Atherogenic Index (AI). Also, heart sections were obtained for histopathological examinations. The results showed that weight gain of rats treated with BWA powder and injected extract were significantly lower than control group. Also, liver enzymes and blood lipids biomarkers showed significant decrease when compared with control

group. The level of HDL of treated rats increased significantly than corresponding values of control group. In conclusion, moderate amounts of Bladder wrack algae either powder or extract improved the obesity biomarkers among experimental rats. Therefore, we recommended those tested *Fucus vesiculosus* by a moderate amount to be included in our .daily diets and drinks .

Keywords: *Fucus vesiculosus* , Cholesterol , Triglycerides, HDL, Weight, Atherogenic Index, Liver Enzymes.

Introduction

Obesity is defined as accumulation of excess fat in body,which is associated with adverse health outcomes. Obesity has become a global problem affecting all societies and age groups **(Somasundaram *et al.*, 2014).** The prevalence of obesity has increased at an alarming rate over the past 2 decades to the extent that it could be considered a pandemic. There are 2 main types of regional obesity in terms of fat distribution and the risk for development of disease. This pattern is associated with significant risk of hypertension, cardiovascular disease and non-insulin-dependent diabetes mellitus **(Abolfotouh *et al.*, 2000).** both overweight and obesity, and thus a BMI of 25 or higher, are associated with reductions in brain size, which increases the risk of dementia, the most common form of which is Alzheimer disease **(Kanazawa *et al.*, 2005).**

Bladder wrack algae (*Fucus vesiculosus*) contains: Iodine, algin, mucilage, bromine, sodium, potassium, lutein, zeaxanthin, chlorophyll, cellulose, mannitol, silicon, essential fatty acids, vitamin C, B-vitamins, beta-carotene, zinc, magnesium, selenium, manganese, iron, phosphorus, iodide, oleic acid, polyphenols, protein and fiber **(Dean-Green, 2012).** Several nutraceutical products have been developed from *Fucus vesiculosus*, a brown edible seaweed, rich in dietary fiber and polyphenolic antioxidants (phlorotannins). raw Fucus powder exhibited significantly higher antioxidant capacity than the commercial fucoidans and commercial antioxidant extracts. Polyphenols (phlorotannins) seem to be the main contributors to Fucus' antioxidant capacity in both raw powder and commercial fucoidans (**Díaz-Rubio *et al.*, 2009).**

Fucus vesiculosus is administered orally and topically. Oral uses include auxiliary measure for weight loss, treatment of gastritis, pyrosis,

reflux oesophagitis and hiatus hernia, the prevention of atherosclerosis, viscous blood and hypercholesterolemia, the management of constipation, colitis, asthenia, fatigue, mineral deficit, anemia, hair loss and leg cramps, an adjuvant for menopausal complaints, fibrocystic breasts, prostate complaints, growth deprivation, arthritis, arthrosis, gout and lymph edema (**Barnes *et al.*, 2007).** *Fucus vesiculosus* is used as a natural source of iodine. The iodine content gives some plausibility to a possible stimulating effect on the thyroid gland. There is the connotation of an increased burning of fat **(Verhelst, 2010).** *Fucus vesiculosus* treatment prevented the rats from becoming obese and the biochemical and physical parameters were maintained to normal levels **(Korukanti *et al.*, 2013).**

Materials and methods

Plant materials: *Fucus vesiculosus* were obtained from (Harraz market. Cairo, Egypt). It grinded to soft powder was gristed to a powder. 10g of the powder was soaked in 90 ml of ethanol alcohol (80%), shaken for 10 minutes and then allowed to stay at room temperature for 72 hours. The mixture was then filtered using a filter paper and the filtrate evaporated to dryness on water bath at 60ºC. The ethanolic extract was kept in air tight bottle in a refrigerator at 4°C until use and served as the stock crude extract, and kept in dusky Stoppard glass bottles.

Rats and diets: Male albino rats weighing 140±10 g. were obtained from Animal house at the Research Institute of Ophthalmology in Giza were used in this study. Animal fats were obtained from a butchery in Shebin el-Kom . basal diet constituents were obtained from El-Gomhoria Company for trady Drug Chemicals and medicals, Cairo, Egypt.

Chemicals: The basal diet was prepared according to the following: protein (10%), vitamin mixture (1%), mineral mixture (4%), choline chloride (0.2%), methionine (0.3%), cellulose (5%), and the remained is corn starch (69.5%) according to **AIN, (1993).** The vitamin mixture component and salt mixture were formulated according to **(A.O.A.C,1990).** Obesity was induced in normal healthy male albino rats by feeding on high fat diet (HFD) 20% of animal lipids (cheap fat) supplemented in the basal diet and used as appositive control group.

Experimental Design:

Thirty six male albino rats were housed in healthy condition (21-23ºC) and fed on basal diet for one week before starting the experiment for acclimatization, after this, rats were divided into two main groups: the first main group (6 rats) fed on basal diet as a negative control (ve-).

The second main group (30 rats) was fed on high fat diet (20% animal lipid) supplemented in the basal diet for (4) weeks to induce obesity, then classified into five sub groups as follow:

(1): obese rats induced by fed on high fat diet (20% animal lipids) supplemented in the basal diet, as a positive control (ve+).

(2): obese rats fed on *Fucus vesiculosus* powder by 2.5% / 1kg diet.

(3): obese rats fed on *Fucus vesiculosus* powder by 5% / 1kg diet.

(4): obese rats injected with *Fucus vesiculosus* alcoholic extract by 1ml/kg Body weight per day.

(5): obese rats injected with *Fucus vesiculosus* alcoholic extract by 2ml /kg Body weight per day.

During the experimental period **(28days),** the diet consumed was recorded every day and body weight was recorded every week. The body weight gain **(B.W.G. %),** feed efficiency ratio **(F.E.R),** and organ/ body weight% were determined according to (**Chapman *et al*., 1959).**

At the end of the experimental (4 weeks), rats were fasted for 12-h then scarified. Blood samples were collected from the portal vein into dry clean centrifuge tubes for serum separation, blood samples centrifuged for 10 minutes at 3000 rpm to separate the serum according to **Drury and Wallington, (1980).** Heart of sacrificed rats were kept in 10% formalin solution till processed for histopathological examination.

Serum lipid profile assay

Cholesterol, TG, H.D.L-c, L.D.L-c and V.L.D.L-c were determined according to **Allain *et al*., (1974)**, **Fassati and Prencipe, (1982)**, **Lopez, (1977)** and **Lee and Nieman, (1996)** respectively**.** Low density lipoprotein cholesterol and very low density lipoprotein cholesterol was calculated according to the following equation:

LDL-Cholesterol = Total cholesterol-(HDL-c + TG/5)

VLDL-c = TG/5**.**

Liver functions assay:

Glotamic oxalic transaminase (GOT), Glotamic pyrofic transaminase (GPT) and alkaline phosphatase (ALP) were determined

according to the methods described by **Bergmeyer and Harder, (1986), Kachmar and Moss, (1976) and Varley *et al*., (1980)** respectively.

Statistical Analysis:

The obtained data were written as mean ± standard deviation (S.D) by ANOVA test at (P≤0.05) according to **SAS , (2006).**

Results and discussion

Effect of *Fucus vesiculosus* powder and Alcoholic extract on feed intake g/day/rat, body weight gain (BWG %) and Feed Efficiency Ratio (FER) of obese rats

Data in Table (1) indicated that rats fed on high fat diet had increased the mean value of FI 19.79 ± 0.80(g/d/rat) as compared to control negative group 18.94± 0.11(g/d/rat) .Obese rats treated with *Fucus vesiculosus* powder (2.5 and 5%) and Alcoholic extract (1ml and 2ml) showed lower values in FI as compared with the control positive group .The values were 19.65 ± 0.05, 19.40± 0.08, 19.34 ± 0.09 and 19.34 ± 0.091(g/d/rat), respectively.With regard to BWG% result revealed that the positive control group had observed increases in BWG% comparing with control negative .Also, rats which treated with the levels of *Fucus vesiculosus* powder (2.5 and 5%) and Alcoholic extract (1ml and 2ml) showed decreases in mean values of BWG% comparing with control positive group. The best results of FI were records for group 5(obese rats injected with fucus alcoholic extract by 1ml) , BWG% and FER were records for group 4 (obese rats treated with fucus powder 5%).

Table (1) : Effect of Fucus on feed intake (g/day/rat) , body weight gain (BWG %) and Feed Efficiency Ratio (FER) of obese rats

Groups	B.W.G (g/day/rat)	% of change of control(+)	F.I (g/day/rat)	% of change of control(+)	FER	%of change of control(+)
(1) Control (-)	**11.36^{a}± 0.98**	**-60.67**	**18.94^{c}± 0.11**	**-4.29**	**1.13^{d} ± 0.158**	**-70.72**
(2) Control (+)	**28.89^{b} ± 2.78**	**---**	**19.79^{a} ± 0.80**	**---**	**3.86^{a} ± 0.37**	**---**
(3) Fucus powder2.5**%**	**13.68^{b} ± 0.81**	**- 52.64**	**19.65^{b} ± 0.05**	**-0.70**	**1.68^{b} ± 0.15**	**- 56.47**
(4)) Fucus powder**5%**	**11.54^{b} ± 0.40**	**- 60.5**	**19.40^{b}± 0.08**	**- 1.97**	**1.28^{c} ± 0.005**	**- 66.83**
(5) Fucus injection **1ml**	**12.28^{b} ± 1.03**	**- 57.49**	**19. 3^{b} ± 0.05**	**- 2.47**	**1.44^{bc} ±0.13**	**- 62.69**
(6) Fucus injection **2ml**	**13.24^{b} ± 0.93**	**-54.17**	**19.34^{b} ± 0.09**	**-2.27**	**1.46^{bc} ±0.147**	**-62.17**
L.S.D(P≤0.05)	**2.37**	**---**	**0.143**	**---**	**0.348**	**---**

Values are mean ± SD. Values in the same column sharing the same superscript letters are not statistically significantly different (p≤ 0.05)

These results concurred with the finding of **Korukanti *et al*., (2013)** they reported that *Fucus vesiculosus* treatment prevented the rats from becoming obese and the biochemical and physical parameters were maintained to normal levels, the body weight significantly increased due to the accumulation of fat in the body and the *Fucus vesiculosus* exhibited its protective nature in rats by preventing their weight gain.

Effects of *Fucus vesiculosus* powder and Alcoholic extract on Total Cholesterol (T.C) , Triglycerides (T.G) and Atherogeric index (AI)v and Atherogeric index (AI) of obese rats

Findings presented in Table (2) illustrate the effects of *Fucus vesiculosus* on T.C, T.G and A.I for obese rats. It could be noticed for T.G, that the highest mean value was in the control (+) group which fed on basal diet and the lowest mean was in the group injected with *Fucus vesiculosus* Alcoholic extract by 1ml compared to control (+) group . There were significant differences between all groups. For T.C, it could be showed that the highest mean value in the control (+) group which fed on basal diet and the lowest mean was in the group fed on Fucus powder 5% compared to control (+) group . For AI, it could be showed that the highest mean value in the control (+) group which fed on basal diet and the lowest mean was in the group injected with Fucus Alcoholic extract by 1ml .

Table (2): Effect of fucus on Total Cholesterol (T.C) , Triglycerides (T.G) and Atherogeric index (AI) of obese rats

Groups	T.G (mg/dl)	% of change of control(+)	T.C (mg/dl)	% of change of control(+)	AI (ratio)	%of change of control(+)
(1) Control (-)	**77.18^{e}±3.22**	**-67.44**	**113.41^{d}±7.96**	**-30.38**	**0.3^{d}±0.01**	**-81.13**
(2) Control (+)	**237.06^{a}±17.11**	**---**	**162.9^{a}±7.16**	**---**	**1.59^{a}±0.26**	**---**
(3) Fucus powder 2.5**%**	**185.08^{b}±5.32**	**- 21.92**	**133.5^{b}±7.36**	**-18.04**	**0.9^{b}±0.08**	**-43.39**
(4) Fucus powder **5%**	**151.58^{c}±3.16**	**- 36.05**	**115.51^{c}±4.45**	**-29.09**	**0.59^{c}±0.02**	**-62.89**
(5) Fucus injection **1ml**	**87.32^{e}±0.54**	**- 63.16**	**120.68^{c}±1.72**	**-25.91**	**0.42^{c}±0.01**	**-73.58**
(6) Fucus injection **2ml**	**107.87^{d}±5.74**	**-54.49**	**139.85^{b}±2.87**	**-14.14**	**0.45^{c}±0.02**	**-71.69**
L.S.D (P≤0.05)	**14.43**	**---**	**11.08**	**---**	**0.21**	**---**

Values are mean ± SD. Values in the same column sharing the same superscript letters are not statistically significantly different ($p \leq 0.05$).

These results are supported by the results published by (**Huang *et al*., 2010**) they reported that the effects of fucoidan polysaccharide sulfuric acid ester (FPS) on the serum lipid levels of hyperlipidemic rats, serum TC, TG, and LDL-C levels were lowered by the FPS.

(**Patel, 2012).** Also, reported that seaweeds are well-explored for various bioactive compounds such as secondary metabolites, dietary fiber, minerals, lipids, proteins, omega-3 fatty acids, essential amino acids, polysaccharides and vitamins. These compounds impart numerous bioactivities.The activities of lipoprotein lipase, hepatic lipoprotein and lecithin cholesterol acyltransferase were also enhanced. Above findings corroborate that the SP from seaweeds are ideal option for effective abatement of the lipid abnormalities.

Also, agree with **Derosa *et al*., (2019)** they reported that Feeding of cafeteria diet caused a significant increase in the serum levels of TC, LDL, TG and VLDL and significant decrease in HDL levels, as compared to normal diet fed rats. In contrast, *Fucus vesiculosus* treatment significantly inhibited the increase in serum levels of TC, LDL, TG and VLDL and decrease in HDL level.

Andre *et al*., (2020) they found that the in vitro results suggest that the preparation of *F. vesiculosus* as a soup could have hypercholesterolemia lowering effect. The ocean sample extract Separation of Bioactive Metabolites by Solid Phase Extraction (SPE) purified at 0.25 mg/mL and the cholesterol at 5 mM in Hank's Balanced Salt Solution (HBSS) were added to the apical side of the cells and a control was prepared only with cholesterol in the same concentration. After 6 h into contact with the cells, the cholesterol on the basolateral compartment and inside the cells was quantified by high-performance liquid chromatographic using a diode-array detector (HPLC-DAD). Comparing the permeation of the cholesterol in the presence of the extract with the cholesterol permeation in the control, a reduction of 45.3 ± 4.4% in the cholesterol permeation in the presence of the extract was observed.

Effect of fucus on high density lipoprotein cholesterol (HDL.c), low density lipoprotein cholesterol (LDL.c) and very low density lipoprotein cholesterol (VLDL.c) of obese rats

Data in Table (3) showed the mean values of HDL, LDL and VLDL of obese rats treated with fucus powder by (2.5% and 5%) / 1kg diet and injected with *Fucus vesiculosus* Alcoholic extract by (1ml and 2ml) /kg Body weight per day. For HDL, it could be noticed that the highest mean value was in the group injected with Fucus Alcoholic extract by 2ml . and the lowest mean was observed in control (+) group which fed on basal diet. There is no significant differences between groups (6) and control (-) group. For LDL, It could be noticed that the highest mean value was found in control (+) group which fed on basal diet which was had 14.09±1.03 (mg/dl) while the lowest mean was occurred in the group which injected with *Fucus vesiculosus* Alcoholic extract by 1ml (9.7±0.18 mg/dl) as compared to control (+) group. There were significant differences between all groups except group 5 and group (6). In case of VLDL, the highest mean value was in control positive group which was 47.41±3.42mg/dl and the lowest mean was in the group injected with *Fucus vesiculosus* alcoholic extract by 1ml which had 17.4±0.31 (mg/dl).

Table (3): Effect of fucus on high density lipoprotein cholesterol (HDL.c), low density lipoprotein cholesterol (LDL.c) and very low density lipoprotein cholesterol (VLDL.c) of obese rats

Groups	HDL.c mg/dl	%of change of control(+)	LDL.c mg/dl	%of change of control (+)	VLDL.c mg/dl	%of change of control(+)
(1) Control (-)	89.57^{a}±7.16	129.66	11.87^{d}±0.53	- 15.75	15.43e±0.64	- 67.45
(2) control (+)	39^{e}±5.26	----	14.09^{a}±1.03	----	47.41a±3.42	----
(3) Fucus powder 2.5%	54.47^{d}±3.94	39.66	12.2c±0.46	- 13.41	37.01b±1.06	-21.93
(4) Fucus powder 5%	70.38^{b}±2.26	80.46	11.62d±0.24	- 17.53	30.31c±0.63	- 36.06
(5) Fucus injection 1ml	62.95^{c}±1.70	61.41	9.7e±0.18	- 31.15	17.46e±0.31	- 63.17
(6) Fucus injection 2ml	76.79^{b}±3.63	96.89	13.66b±0.67	-3.05	21.57d±1.15	-54.50
LSD (P≤0.05)	7.70	----	1.12	----	2.89	----

Values are mean ± SD. Values in the same column sharing the same superscript letters are not statistically significantly different ($p \leq 0.05$).

These results in the same line with **Chater *et al*., (2016)** who proved that water extract of *A. nodosum* contains both polysaccharide and polyphenol while the ethanol extract contains rich polyphenol fraction only but later inhibits lipase more efficiently to prevent cholesterol absorption. They reported that concentrates from *F. vesiculosus* were considerably more intense lipase inhibitors than *A. nodosum* and *Pelvetia* canaliculata extracts.

These results agree with those of (**Murray *et al*., 2018)** they found that Taking a polyphenol-rich brown seaweed extract for 12 weeks will result in a reduction in fasting LDL cholesterol levels, compared with placebo.Taking a polyphenol-rich brown seaweed extract for 12 weeks will result in a reduction in fasting total cholesterol, TG, glucose and insulin levels and an increase in HDL cholesterol levels. It will result in a reduction in proin-flammatory markers and improvement in cognitive function, compared with placebo.

Also, **Hameed *et al*.**, (**2019)** administered that *fucus vesiculosus* for four weeks indicated the levels of CHO,TG,LDL and VLDL were decreased , while the level of HDL was increased .

(Ganesan *et al*., 2019) they demonstrated that high molecular weight (MW) polysaccharides from brown seaweed react with LDL cholesterol whereas low molecular weight acts on triacylglycerol and HDL cholesterol, which leads to reduction.

Effect of fucus on Serum alkaline phosphatase(ALP), Serum Glotamic Pyrofic Transaminase (GPT) and Serum Glotamic Oxalic Transaminase (GOT) of obese rats

Data in table (4) showed that control negative group was significantly lower in serum level of GOT which was 77.84±5.01u/l when compared with control positive group 215±2.23 u/l. Rats treated with fucus showed a lower values in serum level of GOT as compared to the positive control group. With regard to serum levels of GPT and ALP, results revealed that positive control group had observed increase in serum GPT and ALP which were 127.97±4.55 and 413.26±17.07u/l respectively comparing with negative control group (44.43±3.25and 238.43±19.43u/l). Groups which treated with fucus powder and Alcoholic extract decreased serum levels of GPT and ALP as compared to (-ve) group. The best serum ALP was group 6 (injected with Fucus

alcoholic extract by 2ml) ,while GOT andGPT were recorded for group 4 (obese rats fed on Fucus powder 5%).

Table (4): Effect of fucus on Serum GOT, GPT, and ALP (U/L)

Groups	ALP (U/L)	%of change of control(+)	GPT (U/L)	%of change of control(+)	GOT (U/L)	%of change of control(+)
(1)Control (-)	238.43^{d}±19.43	-42.30	44.43^{e}±3.25	- 65.28	77.84^{e}±5.01	- 63.78
(2) control (+)	413.26^{a}±17.07	----	127.97^{a}±4.55	----	215^{a}±2.23	----
(3) Fucus powder2.5%	348.5^{b}±2.52	-15.67	73.94^{b}±2.85	- 42.22	155.7^{b}±1.8	-27.58
(4) Fucus powder 5%	256.43^{c}±13.9	-37.94	51.07^{d}±1.37	- 60.09	85.17^{d}±0.38	- 60.38
(5) Fucus injection 1ml	246.89^{cd}±11.09	-40.25	62.21^{c}±2.54	- 51.38	89.88^{d}±1.84	- 58.19
Fucus (6) injection 2ml	327.09^{b}±7.12	-20.85	76.79^{b}±1.9	-39.99	111.04^{c}±1.12	-48.35
LSD(P≤0.05)	26.19	----	4.88	----	4.6	----

Values are mean ± SD. Values in the same column sharing the same superscript letters are not statistically significantly different ($p \leq 0.05$).

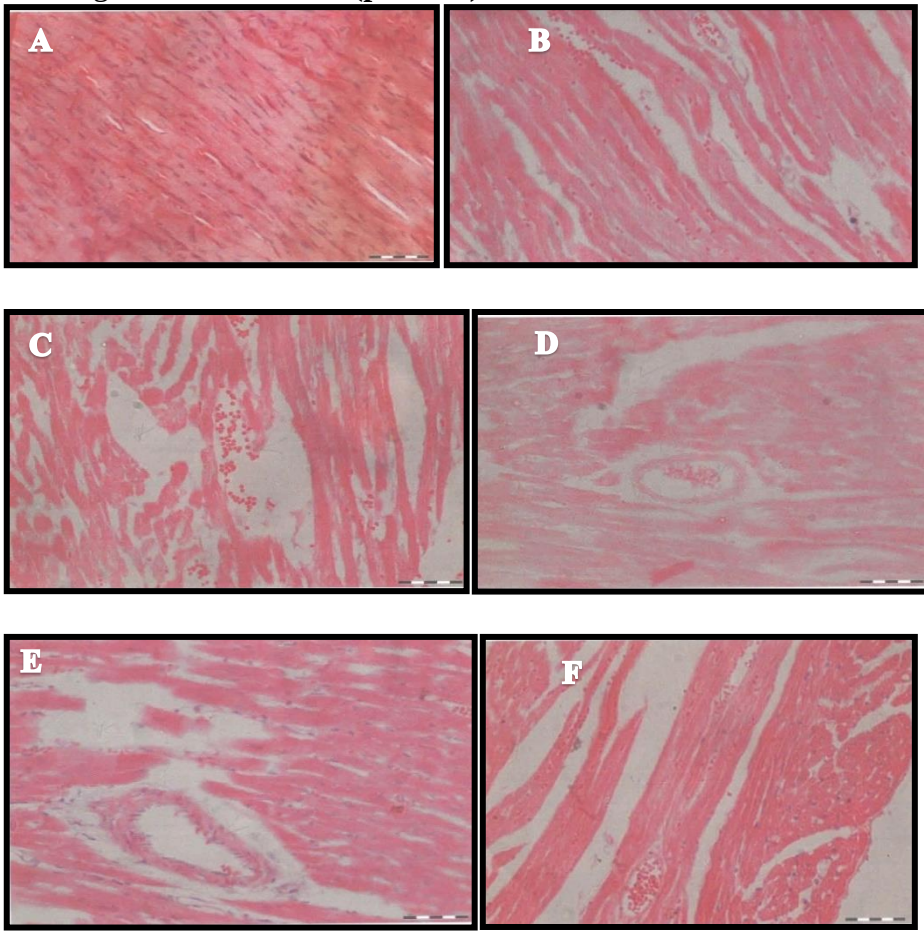
These results were agreed with those of **(Hayashi *et al.*, 2008)** they examined the effect of fucoidan on acute liver failure induced by single injection of CCl_4. Intraperitoneal injection of mice with CCl_4 increased biochemical markers of liver injury., serum AST and ALT had increased. Intravenous administration of fucoidan attenuated this elevation of serum AST and ALT. Notably, injection of 50 mg/kg fucoidan restored serum AST and ALT to normal levels.

Also, **Li *et al.*,(2016)** found that the effects of fucoidan from *Fucus vesiculosus* on concanavalin A (ConA)-induced acute liver injury in mice. Pretreatment with fucoidan protected liver function indicated by ALT, AST by suppressing inflammatory cytokines, such as tumor necrosis factor alpha (TNF-α) and interferon gamma (IFN-γ). research results, ALT, AST decreased after fucoidan from *Fucus vesiculosus* pretreatment .

These results are supported by the results published by **(Gabbia *et al.*, 2020)**, They found that administration of *F. vesiculosus* and *A. nodosum* led to significant reductions in microvescicular steatosis and plasma biochemical and lipid parameters, such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total and conjugated bilirubin, and triglycerides.

Histopathological examination of heart

Microscopically, light micrograph of heart negative control group **(1)** shows the longitudinally arranged muscle fibers **(photo A).** However, L .M of heart positive control group **(2) showing** mild oedema **(photo B).** Moreover, L.M of heart of group **(3)** showing hemorrhagic changes and oedema in-between the fibers **(photo C).** Moreover, L.M of heart of group **(4)** showing congestion and oedema **(photo D).** while, L.M of heart of group **(5)** showing in-between the cardiac fibers and thickening of the wall of capillary **(photo E).** However, L.M of heart of group **(6)** showing moderate oedema **(photo F).**



Conclusion

The selected algae in the present study were effective in protecting rats against obesity. These results supported our obese is that tested algae contain several important compounds which are able to inhibit obesity process. Therefore, data recommended the selected algae by a moderate amount to be included in our daily diets or drinks.

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تأثير التغذية بطحلب الفوكس الحويصلى على الفئران المصابة بالسمنة

ماجدة كامل الشاعر, عبير نزيه أحمد , ريحان فتحى صالح
قسم التغذية وعلوم الأطعمة - كلية الاقتصاد المنزلى - جامعة المنوفية- شبين الكوم –مصر

المستخلص العربي

أجريت هذه الدراسة لمعرفة تأثير طحلب الفوكس الحويصلى على الفئران المصابة بالسمنة. تم تقسيم ستة وثلاثين فأرًا بالغًا من الفئران البيضاء، وزنها 140±10جم إلى مجموعتين رئيسيتين احداهما المجموعة الضابطة السالبة والتى تم تغذيتها على العليقة فقط (6 فئران) بينما تم تغذية المجموعة الثانية (30 فأر) على غذاء عالي الدهون (20٪ دهون حيوانية) للاصابة بالسمنة، ثم تصنيفها إلى 5 مجموعات فرعية (6 فئران في كل مجموعة) واحدة منهم تركت كمجموعة ضابطة موجبة، وأربع مجموعات أخرى 2 منهم تغذى على مسحوق (فوكس حويصلي) بنسبة 2.5٪ و5٪، وتم حقن المجموعتين الآخرتين بمستخلص كحولي للفوكس الحويصلى بنسبة 1 مل و2 مل لمدة 28 يوم.وفى نهاية التجربة تم وزن الفئران،وحساب نسبة كفاءة التغذية،والمتناول من الطعام، ووزن الأعضاء النسبي كما تم تقدير كلا من ، وظائف الكبد (الجلوتاميك أوكساليك ترانس أمينيز و الجلوتاميك بيرو فيك ترانس أمينيز و الألكالين فوسفاتيز) ودهون الدم (الدهون الثلاثية , والكولستيرول الكلى و الليبوبروتينات عالية الكثافة و الليبوبروتينات المنخفض الكثافة و الليبوبروتينات منخفض الكثافة جدا ومعامل تصلب الشرايين)، وهستوباثولوجى القلب.وقد أظهرت النتائج المتحصل عليها للفئران البدينة أن الفوكس الحويصلى أظهرت انخفاضًا معنويًا في كلا من الوزن، ونسبة كفاءة الغذاء، والمتناول من الغذاءوايضا اظهرالنتائج انخفاض معنوى فى باقى التحليلات المشار اليها سابقا , ما عدى نتائج الليبوبروتين العالى الكثافة حيث اظهرت النتائج انهناك زيادة معنوية بالمقارنة مع المجموعةالضابطة الموجبة. لذلك، نوصى بأستخدام الفوكس الحويصلى بكمية معتدلة ليتم تضمينهم في وجباتنا الغذائية والمشروبات اليومية.

الكلمات المفتاحية:الفوكس الحويصلى ,السمنة,الوزن المكتسب,دهون الدم,معامل تصلب الشرايين.