Evaluation of antiobesity activity of *Fucus vesiculosus*

Vishnu Priya Korukanti, Himabindu Ponnam, Butchi Raju Akondi

**ABSTRACT**

**Background and Aim:** The drug *Fucus vesiculosus* is used in alternative system of medicine and homoeopathy, for the treatment of obesity. But in homoeopathic literature survey, we found no substantial pharmacological evidence to prove its safety and efficacy. So, the study was taken up on this drug and evaluated it on different animal models (diet-induced and chemical-induced models) of obesity.

**Material and Methods:** Obesity was induced in adult female Wistar albino rats (100-120 g) by feeding the rats with cafeteria diet for 42 days in diet-induced model and by administration of single intraperitoneal injection of Triton X-100 in chemical-induced model. In the diet-induced model, weight of the animals was measured every week and parameters like total cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL), very low density lipoprotein (VLDL) and high density lipoprotein (HDL) were measured on 0, 21 and 43 days. Further, locomotor activity was assessed for all the animals on 43rd day. On the same day, the rats were sacrificed by cervical dislocation and their organ and fat pad weights were recorded. In the chemical-induced model, the above parameters were assessed on day 0 and day 8.

**Results:** Feeding cafeteria diet for 42 days resulted in significant increases in the body weight, TC, TG, LDL and VLDL levels and a reduction in the HDL level. Further, the locomotor activity was found to be reduced significantly. Treatment with *Fucus vesiculosus* significantly protected the cafeteria diet fed animals from all these changes and helped to maintain normal locomotor activity. Similar results were observed in chemical-induced obesity model also.

**Conclusion:** *Fucus vesiculosus* treatment prevented the rats from becoming obese and the biochemical and physical parameters were maintained to normal levels. So, the drug *Fucus vesiculosus* can be taken up for further research on human subjects.

**Keywords:** Antiobesity activity, Fucus vesiculosus, Diet induced obesity model, Chemical induced model

**INTRODUCTION**

*Fucus vesiculosus* is a seaweed commonly known as bladder wrack and is generally found on coasts of the North Sea, the western Baltic Sea, and Atlantic and Pacific oceans. *Fucus vesiculosus* is used in homoeopathic system of medicine for treatment of obesity. But in our literature survey, we found no substantial pharmacological evidence to prove its safety and efficacy. So, we have taken up this drug and evaluated it on diet and chemical models of obesity in rats.

Obesity is a chronic medical illness in which excess body fat accumulates in the body. The excess fat
may have adverse effects on health, in which it may reduce the life expectancy or increases the health problems.\[^1\] The normal amount of body fat (expressed as percentage of body fat) is between 25 and 31\% in women and 18 and 24\% in men, and those who have more than the given limit can be called as obese. Generally, body fat is necessary for storing energy, heat insulation and shock absorption. The fundamental cause of obesity is an energy imbalance between calories consumed and calories expended. The regulation of energy balance requires a mechanism for sensing the level of energy stores in body fat and relaying the information to controlling sites in the hypothalamus. Integration of information in the hypothalamus and determination of energy balance through control of food intake and energy expenditure helps to maintain normal weight.\[^2\] The most common method of measuring obesity is by calculating Body Mass Index (BMI). It is calculated by dividing body weight (kilograms) by height (meters) squared. If obesity is left untreated, it leads to complications such as Type 2 diabetes, gout, dyslipidaemia, osteoarthritis, hypertension, obstructive sleep apnoea etc.\[^3\]

The drugs Phentermine and Orlistat are approved by the US Food and Drug Administration (FDA) specifically for obesity. The drugs Bupropion, Metformin, Topiramate and Zonisamide are approved for other indications but have been found to exhibit a significant weight loss effect.\[^4\] Bariatric surgery is an option when diet, exercise and drug therapy have not produced satisfactory outcomes.\[^5\] All the drugs and methods described above have serious adverse drug reactions and are not suitable old-age patients. So, there is a need for devolvement of drugs for the treatment of obesity, and alternative systems of medicine provide leads for the same.

**MATERIAL AND METHODS**

**Animals**

Forty-eight female Wistar albino rats\[^4\] (100-120 g) were procured from Sanzyme Limited, (Hyderabad, India) and maintained in an air-conditioned room with a normal night and day cycle (temperature 21-25°C and humidity 45-65\%). Rats were fed with normal pelleted diet and water *ad libitum*. The rats were allowed to acclimatise to the laboratory environment for a week before the start of the experiment. All experimental procedures were conducted in conformity with the guidelines of Institutional Animal Ethics Committee (approval number: 16/SPIPS/IAEC/12) for the care and use of animals and they were strictly followed throughout the study.

**Chemicals and Reagents**

Triglycerides (TG) kit, total cholesterol (TC) kit and high density lipoprotein (HDL) cholesterol kit were purchased from Coral Diagnostics Ltd, Mumbai, India and Triton X-100 was procured from Sigma-Aldrich Bangalore, India. *Fucus vesiculosus* mother tincture was procured from Dr. Willman Schwabe Pvt Ltd, Mumbai, India subsidiary of Schwabe International Ltd, Mumbai, India, Germany. Regular rat feed was supplied by Mahaveer Agencies, Hyderabad, India.

**Experimental Procedures**

The induction of obesity was carried out using two established methods\[^4\] as follows.

**Diet-induced model**

In this method, rats were fed with cafeteria diet for 42 days. The cafeteria diet consists of three diets: (a) condensed milk (8 g) + bread (8 g); (b) chocolate (3 g) + biscuits (6 g) + dried coconut (6 g) and (c) cheese (8 g) + boiled potato (10 g).\[^6\] The calorific value of the diet is given in Table 1.

**Grouping of Animals (six rats in each group)**

In the diet-induced model, cafeteria diet group was fed with cafeteria diet and the other group received the test drug (0.1 ml of the *Fucus vesiculosus* mother tincture) along with cafeteria diet after half an hour of feeding. Control group animals received normal saline. The treatment was continued for 42 days.

**Table 1: Calorie value of cafeteria diet**

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Calorie value (kcal/100 g)</th>
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<tbody>
<tr>
<td>Condensed milk</td>
<td>335</td>
</tr>
<tr>
<td>Bread</td>
<td>230</td>
</tr>
<tr>
<td>Chocolate</td>
<td>550</td>
</tr>
<tr>
<td>Biscuit</td>
<td>360</td>
</tr>
<tr>
<td>Dried coconut</td>
<td>660</td>
</tr>
<tr>
<td>Cheese</td>
<td>320</td>
</tr>
<tr>
<td>Boiled potato</td>
<td>80</td>
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</tbody>
</table>

**Grouping of animals (six rats in each group)**

<table>
<thead>
<tr>
<th>Treatment</th>
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<tbody>
<tr>
<td>Control</td>
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<tr>
<td>Cafeteria diet</td>
</tr>
<tr>
<td>Cafeteria diet+drug</td>
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</tbody>
</table>

Chemical-induced model
The rats were given single intraperitoneal (IP) injection of freshly prepared solution of Triton X-100 (100 mg/kg) in physiological saline solution after overnight fasting for 18 hours. After 72 hours of injection, one of the induced groups was treated with the test drug.\(^7\)

Grouping of Animals (six in each group)
In the chemical-induced model, the drug treatment was given for 7 days after induction with Triton X-100 and the control group received normal saline solution for 7 days.

<table>
<thead>
<tr>
<th>Grouping of animals (six in each group)</th>
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<tbody>
<tr>
<td>Group I</td>
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<tr>
<td>Normal control</td>
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<tr>
<td>Group II</td>
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<tr>
<td>Cafeteria diet</td>
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<tr>
<td>Group III</td>
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<tr>
<td>Cafeteria diet+drug</td>
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<tr>
<td>Group IV</td>
</tr>
<tr>
<td>Triton X-100</td>
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<tr>
<td>Group V</td>
</tr>
<tr>
<td>Triton X-100+drug</td>
</tr>
</tbody>
</table>

Estimation of Physical Parameters

Estimation of body weight
The rats of different groups were weighed initially on day 1 and then after 7 days regularly for a period of 42 days.\(^8\)

Evaluation of locomotor activity
It was recorded on day 43 for all the groups using photoactometer. The intact time in the instrument was 5 minutes.\(^8\)

Estimation of biochemical parameters
The blood was collected on 43\(^{rd}\) day in diet-induced model and on 8\(^{th}\) day in chemical-induced model by retro-orbital puncture method and serum was separated using centrifugation. Then, the biochemical parameters such as TC, TG and lipoproteins were estimated. TC was assessed by cholesterol oxidase/phenol + aminophenazone method,\(^9\) TG by glucoseoxidase/phenol + aminophenazone method\(^9,10\) and HDL by polyethyleneglycol/cholesterol oxidase-phenol + aminophenazone method.\(^9,11\) Low density lipoprotein (LDL)\(^9\) was calculated by using the formula: TC – (TG/5) – HDL cholesterol, and very low density lipoprotein (VLDL)\(^9\) by using the formula: TG/5.

Determination of organ and fat pad weights
The animals were sacrificed by cervical dislocation on 43\(^{rd}\) day in diet-induced model and on 8\(^{th}\) day in chemical-induced model, and then different organs (kidney, heart, liver and spleen) and fat pads mesenteric, uterine, ovarian and perirenal fat pads were removed and weighed. To collect the fat pads, the entire uterus and ovaries or testes were removed from their attachments to the pelvic floor. Entire intestinal loop was also removed from its attachment to the root of the mesentery and then straightened and unwound for the dissection of the mesenteric fat pad.

Statistical Analysis
The results are expressed as mean ± standard error of mean (SEM). Comparisons between the treatment groups and control were performed by analysis of variance (ANOVA) followed by Bonferroni’s multiple comparison test. In all tests, the criterion for statistical significance was \(P < 0.05\).

RESULTS

Effect of Fucus Vesiculosus on Body Weight in Cafeteria Diet Fed Rats
The diet-fed rats showed significant increase in body weight when compared to normal control group of rats [Figure 1]. But in Fucus vesiculosus (0.1 ml of the Fucus vesiculosus mother tincture) treated groups, the weight of the animals was not significantly changed when compared to normal control group animals.

Effect of Fucus Vesiculosus on Locomotor Activity in Cafeteria Diet Fed Rats
Cafeteria diet showed a significant decrease in locomotor activity due to the weight gain when compared to normal control rats [Table 2]. Drug treatment (0.1 ml of the Fucus vesiculosus mother tincture) to the test group did not significantly alter the locomotor activity and the values almost resembled those of normal control group rats.

![Figure 1: Effect of Fucus vesiculosus on body weight in Cafeteria diet fed rats](http://www.ijrh.org)
Effect of *Fucus Vesiculosus* on the Weights of Different Organs in Cafeteria Diet Fed Rats

Feeding the rats with cafeteria diet increased the weight of the organs significantly [Table 3]. Liver showed the maximum increase in weight when compared to other organs like spleen, heart and kidneys. The drug *Fucus vesiculosus* (0.1 ml of the *Fucus vesiculosus* mother tincture) significantly prevented the increase in weight of the liver.

Effect of *Fucus Vesiculosus* on The Weights of Different Fat Pads in Cafeteria Diet Fed Rats

The weight of the fat pads was significantly increased in diet-induced group of rats. But fat pads remained normal in *Fucus vesiculosus* treated groups [Table 4].

Effect of *Fucus Vesiculosus* on the Biochemical Parameters in Cafeteria Diet Fed Rats

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 levels [Tables 5-7].

Effect of *Fucus Vesiculosus* on the Biochemical Parameters in Triton X-100 Treated Rats

Treating the rats with Triton X-100 caused a significant increase in the serum levels of TC, LDL, TG and VLDL and significant decrease in HDL levels, when compared to control rats. In contrast, *Fucus vesiculosus* (0.1 ml of the *Fucus vesiculosus* mother tincture) treatment significantly inhibited the increase in serum levels of TC, LDL, TG and VLDL and decrease in HDL levels [Tables 8 and 9].

DISCUSSION

Two models of obesity, namely diet-induced model and Triton X-100–induced model, were employed to prove the effectiveness of the drug *Fucus vesiculosus* in the treatment of obesity. In the diet-induced model, cafeteria diet, which consists of high calorie value and high fat content, was administered to rats to induce obesity.[9] In general, it has been reported that rodents fed with high-fat diet are an excellent model of obesity where dietary environment is a major contributor[13] and it can be easily correlated with the obesity caused by diet in humans.[14] In the chemical-induced model, Triton X-100 was administered to rats at a dose of 100 mg/kg in IP route[10] and the lipid profile was significantly increased due to the action of Triton X-100 on serum lipoprotein lipase by some unknown mechanism. In the cafeteria diet model, the physical parameters such as body weight,[15] locomotor activity, and organ and fat pad weights and the biochemical parameters such as TC, TG, HDL, LDL and VLDL levels were measured.

Body weight is the predominant physical parameter in obesity in which the weight of an individual is increased to a great extent. After feeding the rats with cafeteria diet for 42 days, the body weight significantly increased due to the accumulation of fat in the body[9,15] and the drug *Fucus vesiculosus*...
exhibited its protective nature in rats by preventing their weight gain.

Locomotor activity \([4]\) was decreased in obese rats due to the increased body weight. The activity was measured using photoactometer. The intact time in the instrument was 5 minutes and the number of crossings of the animals for 5 minutes in the instrument was measured. The activity was almost unaltered in the treated group when compared to obese rats. It was due to the protective nature of the drug \(Fucus vesiculosus\).

Another physical parameter measured was organ and fat pad weights. Organs such as liver, kidney, heart and spleen were weighed. The weight of liver was significantly increased due to the accumulation of fat around the organ and the drug \(Fucus vesiculosus\) prevented the increase in weights of the organs in rats. Fat pad is a fatty tissue occurring in and around bony joints. It acts as a cushion helping to protect the joints from mechanical damage. On consuming high-fat diet, the extra fat accumulates around the mesenteric, ovarian, uterine and perirenal fat pads, which are easily prone for the accumulation of fat, and the weight increases. The drug \(Fucus vesiculosus\) protected the rats by preventing the weight gain of the fat pads.

Changes in biochemical parameters, especially in lipid profile, are the predominant changes caused in obese people. In obesity, the levels of TC, TG,
LDL and VLDL increases and the level of HDL, which is called as good cholesterol, decreases. Elevated serum levels of TG, cholesterol and LDL are the major risk factors for the premature development of cardiovascular diseases like atherosclerosis, hypertension, coronary heart disease, etc. Increase in plasma lipid levels, mainly TC, TG and LDL, along with decrease in HDL are known to cause hyperlipidaemia which is the reason for initiation and progression of atherosclerosis impasse.[16] Due to the intake of high-fat diet, TC and TG levels increase in the blood. The LDL and VLDL syntheses increase by the liver and it helps in the transportation of TC and TG into blood and to the tissues, whereas the HDL levels decrease due to its decreased synthesis by the liver in obesity. The rats receiving the drug *Fucus vesiculosus* did not have decreased levels of HDL and increased levels of TC, TG, LDL and VLDL.

In Triton X-100 model, the biochemical parameters such as TC, TG, HDL, LDL and VLDL levels were measured. The increased levels of TC, TG, LDL and VLDL and decreased levels of HDL can be addressed as hyperlipidaemic condition. The rats receiving the drug *Fucus vesiculosus* did not have increased TC, TG, LDL and VLDL levels and decreased HDL levels. The drug *Fucus vesiculosus* protected the rats by preventing changes in lipid profile.

**CONCLUSION**

*Fucus vesiculosus* was found to be beneficial when tested on two different animal models, i.e. diet-induced and chemical-induced models. Diet-induced animal model typically mimics the obesity gained through high-calorie diet in human beings. *Fucus vesiculosus* prevented the rats from becoming obese, when given along with high-calorie diet. Biochemical and physical parameters were also maintained at normal levels. Chemical-induced animal model typically represents hyperlipidaemia in the human beings without weight gain. When hyperlipidaemic animals were treated with *Fucus vesiculosus*, the levels of HDL, LDL and VLDL were brought back to normal. So, the drug *Fucus vesiculosus* can be taken up for further research on human subjects.

**REFERENCES**


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Korukanti, et al.: Antiobesity activity of Fucus vesiculosus

**Fucus vesiculosus**

**प्रश्नमूलि और जेवयः** मोटापे के हलाज के लिए फूकस वेसीक्यूलोसस दवा का होमोपैथी में प्रयोग किया जाता है। परन्तु हमारे साहित्य सर्वेक्षण में, हमारे पास इसकी सुश्का औरक्रमण को रिट्रा करने के लिए कोई प्यात औरक्रमण नहीं मिला है। अतः हमने इस दवा को मोटापे के विभिन्न प्यु मॉडलों (आहार प्रेरित और रासायनिक प्रेरित मॉडलों) पर मुक्यांकन के लिए प्रयोग किया है।

**सामग्री एवं विधि** आहार-प्रेरित मॉडल को 42 दिनों के लिए कैंवेटरिया मोटन खिलाने से और रासायनिक प्रेरित मॉडल को ट्राइटन (एक्स-100) के एक इंट्रापेरीटीनियल इंजेक्शन संग में वायसक महिला विस्तर अन्नीनो चूहों में (100–120 ग्राम) मोटापा उत्पन्न किया गया। आहार प्रेरित मॉडल में, जानवरों का हर हफ्ते वजन किया गया और 0.21 और 43 दिन पर खुल कोलेस्ट्रॉल, ट्राइग्लिसरिड्स, कम घनत्व वाले लिपिडोट्रॉन्त (एल्डीएल), बहुत कम घनत्व वाले लिपिडोट्रॉन्त (एएलडीएल) एवं उच्च घनत्व वाले लिपिडोट्रॉन्त (एडीएल) जैसे मामलों का मुक्यांकन भी किया गया। इसको अलावा, 43 वें दिन पर, सभी जानवरों की गतिशील कियां का मुक्यांकन किया गया। इसके अलावा, 43 वें दिन पर, सभी जानवरों की गतिशील कियां का मुक्यांकन किया गया।

**परिणाम:** 42 दिनों के लिए कैंवेटरिया आहार खिलाने से शरीर के वजन, खुल कोलेस्ट्रॉल, ट्राइग्लिसरिड्स, एल्डीएल और एडीएल शरीर में महत्त्वपूर्ण वृद्धि और एडीएल शरीर में कमी देखी गई। इसके अलावा, गतिशील कियां में भी कमी देखी गई। इस प्रकार फूकस वेसीक्यूलोसस दवा के साथ उपचार से कैंवेटरिया आहार खिलाने जाने वाले जानवरों को इन समय परिवर्तनों से सुश्का मिली और गतिशील कियां को सामान्य बनाये रखने में मदद मिली। इसी तरह दिनों के परिणाम साहित्य प्रेरित मोटापे के मॉडल में भी देखे गये।

**निष्कर्ष:** फूकस वेसीक्यूलोसस उपचार ने चूहों का मोटन होने से बचाया और रासायनिक एवं शारीरिक मामलों को सामान्य रूप से पर बनाया रखा। अतः फूकस वेसीक्यूलोसस दवा को आगे चलने वाली विषयों पर अनुसंधान के लिए प्रयोग किया जा सकता है।

**खोजशब्द:** प्रश्नमूलि गतिशील, फूकस वेसीक्यूलोसस, आहार प्रेरित मोटापा मॉडल, रासायनिक प्रेरित मॉडल।