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The effect of fucus vesiculosus on the function and structure of the thyroid gland of male rats treated with propylthiouracil

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Abstract

Background: Fucus vesiculosus is one of Laminariales that belong to the family of seaweed. It has a long history of use as food and medication due to its biological properties

Aim: The study has been conducted to identify the preventive role and positive effects of the seaweed focus vesiculosus and its role to minimize the side effects of Propylthiouracil on the function and structure of the thyroid gland.

Materials and Methods: In this study, 60 white male rats have been used. The sample is divided into five groups in addition to the control group. All groups are equal in number where each group includes ten rats. The control group has been given distilled water. The first treatment (T1): fucus vesiculosus of 35 mg/ kg concentration of body weight is given, (T2): propylthiouracil (PTU) of 15 mg/kg concentration of body weight is dosed, (T3): fucus vesiculosus of 35 mg/ kg concentration of body weight is given for three weeks then (PTU) of 15 mg/kg concentration is dosed for the other three weeks, (T4): propylthiouracil (PTU) of 15 mg/kg concentration of body weight is dosed for three weeks then focus vesiculosus of 35 mg/ kg concentration of body weight is given for three weeks and in (T5) fucus vesiculosus and (PTU) are dosed conjunctions with the same concentration for 42 days.

Results: The study results, after analyzing them statistically, showed that there is a significant increase ($P<0.05$) at the level of MDA in the group treated by Fucus vesiculosus and the group treated by (PTU). Hormone tests results show that there is a significant increase ($P<0.05$) in the level of (T3 and T4) hormones and a decrease in TSH hormone in the group treated by fucus vesiculosus while there is a decrease in the level of thyroid gland hormones and an increase in TSH in the group treated by (PTU) and (T3). For (T4), it shows an increase in the three hormones, (T5) showed an increase in T3 hormone and a decrease in T4 and TSH. The tissue examination of thyroid gland sections of (T1) shows that there are no tissue deformations with good response to fucus vesiculosus that causes the growth of several follicles. As for other treatments (T2, T3, T4, and T5), there are morbid changes in the thyroid gland tissues as clear deformation in the follicle structure, a decrease follicle size, an increase in epithelial cells and a decrease in colloids. Also, hemorrhage and necrosis can be noted.

Conclusion: The study concludes that dosing animals with fucus vesiculosus by 35 mg/kg concentration of body weight has a clear influence on improving the function and structure of thyroid gland on the contrary to (PTU) of 15 mg/kg concentration of body weight that has a negative impact on the function and structure of thyroid gland.

Keywords: Fucus Vesiculosus; Thyroid Gland; Propylthiouracil

INTRODUCTION

Fucus vesiculosus is one of Laminariales that belong to the family of seaweed. It has a long history of use as food and medication due to its biological properties. It is considered one of the natural antioxidant, which prevents free radicals [1]. It prevents tumors, motivates Lipase enzyme, minimizes cholesterol level, maintains blood sugar levels, activates and enhances heart metabolism, a natural source of Iodine, Potassium, Magnesium, Calcium and basic vitamins of cells [2]. Also, it includes several carbohydrates like Fucoidan, Laminine, Laminarin, and Alginates [3].

Propylthiouracil (PTU) is a thyroinhibitory medication used to treat hyperthyroidism by preventing iodine oxidization [4]. Moreover, this medication effects on the thyroid gland hormones or those in the bloodstream where it prevents producing thyroid gland hormone by deoxidization of iodine. It prevents Thyroxin (T4) and Triiodothyronine (T3) formation. The common side effects are timidity, nausea, vomiting, burn, taste loss, numbness, headache, allergy, hair whitening, aplastic anemia, and leukopenia. Also, other symptoms include agranulocytosis and infections of the throat, digestive system, and skin with fever and decrease of blood platelets, which have an important role in blood coagulation [5]. The thyroid gland is one of the most important glands in the body. It is the only one that produces hormones and reserves in the same gland for the time of need. The gland cells are the only one that able to absorb iodine [6]. The thyroid gland produces hormones as Thyroxin (T4) and Triiodothyronine (T3) that are derivatives of amino acid Tyrosine in response to Thyroid stimulating hormone (TSH) that secreted from anterior pituitary gland [7]. Thyroid gland maintains levels of body metabolism where its hormones influence on producing and metabolism of lipid. Any disorder of gland hormones leads to dyslipidemia [8]. So, the study has been conducted to identify the preventive role and positive effects of the seaweed focus vesiculosus and its role to minimize the side effects of Propylthiouracil on the function and structure of the thyroid gland.

MATERIALS AND METHODS

The study includes (60) male rats of (Rattus norvegicus) type. Each rat weight ts (170-180 gr.) and appropriate conditions are maintained, (20-21 C°), light (14 hrs), dark (10 hrs) and animals are given water and feed along the period of experimentation (42 days). The animals are divided into five groups in addition to the control one. All groups are equal in some animals, (10) for each.

- Control group: it is given distilled water.
- (T1) dosed fucus vesiculosus of 35 mg/ kg concentration of body weight,
- (T2): propylthiouracil (PTU) of 15 mg/kg concentration of body weight is dosed
- (T3): fucus vesiculosus of 35 mg/ kg concentration of body weight is given for three weeks then (PTU) of 15 mg/kg concentration is dosed for the other three weeks.
- (T4): propylthiouracil (PTU) of 15 mg/kg concentration of body weight is dosed for three weeks then fucus vesiculosus of 35 mg/ kg concentration of body weight is given for three weeks.
- (T5) fucus vesiculosus and (PTU) are dosed conjunctions with the same concentrations for 42 days.

Hormones Measurement: The concentration of thyroid hormones and TSH is measured by using a test kit made by a British company (ABO) by ELISA technique. The examination depends on the reaction between antibodies in the indicator enzyme and hormone antigens in the serum. MDA: Malondialdehyde is estimated by using the methods of [9]. Tissue Study: an Optical microscope with (400 x) zoom is used to examine gland sections, and measures are taken using ocular micrometer after calibration with micrometer stage according to the steps described by [10], and their efficiency is identified by (11) and [12].

Preparing tissue Sections: Thyroid gland sections are prepared according to(13) method.

Statistical Analysis: The results are analyzed statistically to recognize the significant differences among the studied standards of the groups. The significant differences are identified by the level (P<0.05) using (SPSS 2010). Also, the analysis includes getting the mean and standard error. The group's significant differences are identified by using (ANOVA).

RESULTS

Hormone Study:

1- T3 hormone level in serum

The results show (figure 3-4) that there is a significant increase (0<0.05) in the concentration of T3 nanogram /ml in the group treated with Fucus vesiculosus (T1) and the group treated with propylthiouracil (PTU) for three weeks then with Fucus vesiculosus for the rest of weeks (T4). There is a significant decrease in the group dosed with propylthiouracil (PTU) only (T2) and the group that is given Fucus vesiculosus for three weeks then (PTU) for the rest of weeks (T3), the group gave Fucus vesiculosus and propylthiouracil (PTU) together (T5) and compare it with the control group.

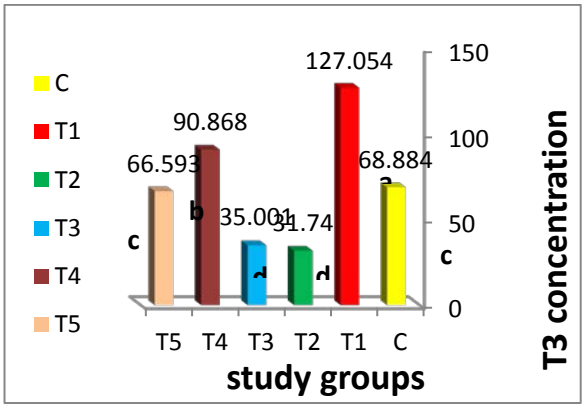

Figure (1) Fucus vesiculosus and propylthiouracil (PTU) effects and the interchange between them on T3 hormone concentration (nanogram.ml.) in mature male rats

2- T4 hormone level in serum

The results of statistical analysis of T4 concentration (nanogram /ml) show (figure 4-4) that there is a significant increase in the group given Fucus vesiculosus of (T1), the group treated with propylthiouracil (PTU) for three weeks then with Fucus vesiculosus for the rest of weeks (T4) and compared to the control group. There is a significant decrease (0<0.05) in the group dosed with propylthiouracil (PTU) only (T2) and the group that is given Fucus vesiculosus for three weeks then (PTU) for the rest of weeks (T3), the group given Fucus vesiculosus and propylthiouracil (PTU) together (T5) and compare it with the control group.

3- TSH Level in blood serum

The results of statistical analysis of TSH concentration show (figure 5-4) that there is a significant decrease in TSH (nanogram /ml) for the group given Fucus vesiculosus in (T1), there is a significant increase of TSH in the group treated with propylthiouracil (PTU) only (T2), the group is given Fucus vesiculosus for three weeks then (PTU) for the rest of weeks (T3) and the group dosed PTU for the first three weeks then Fucus vesiculosus for the rest of the period (T4). There is no significant difference in the group given propylthiouracil (PTU) and Fucus vesiculosus together (T5) and compared to the control group.

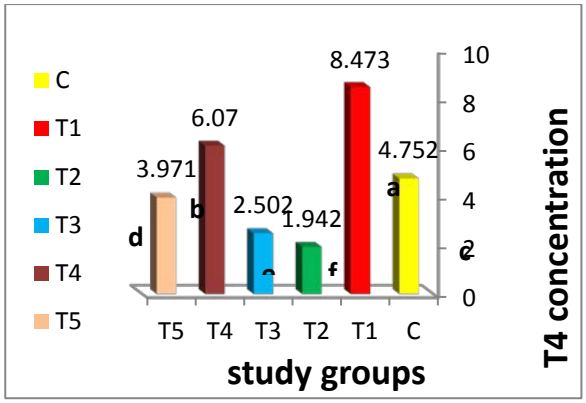

Figure (2) Fucus vesiculosus and propylthiouracil (PTU) effects and the interchange between them on T4 hormone concentration (nanogram.ml.) in mature male rats

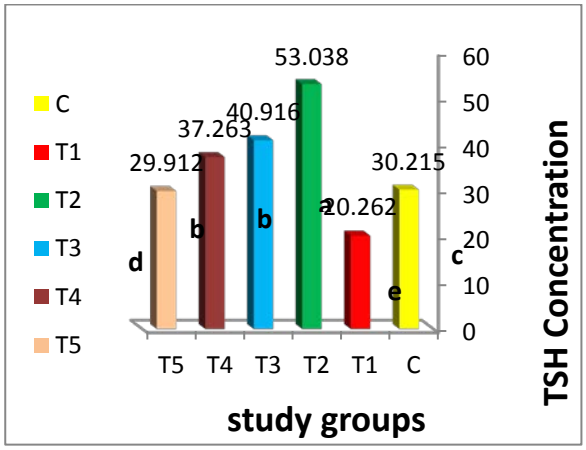

Figure (3) Fucus vesiculosus and propylthiouracil (PTU) effects and the interchange between them on TSH hormone concentration (nanogram.ml.) in mature male rats

4-MDA in blood serum

The study results show (figure 2-4) that there is a significant increase (P<0.05) of TSH(nanogram /ml) for the group given Fucus vesiculosus in (T1), the group dosed propylthiouracil (PTU) (T2), the group dosed PTU for the first three weeks then Fucus vesiculosus for the rest of the period (T4) and compare it with the control group where there are no significant differences in (T3) in which the group gave Fucus vesiculosus for three weeks then (PTU) for the rest of the period (T3) and the group given Fucus vesiculosus and PTU together for 42 days.

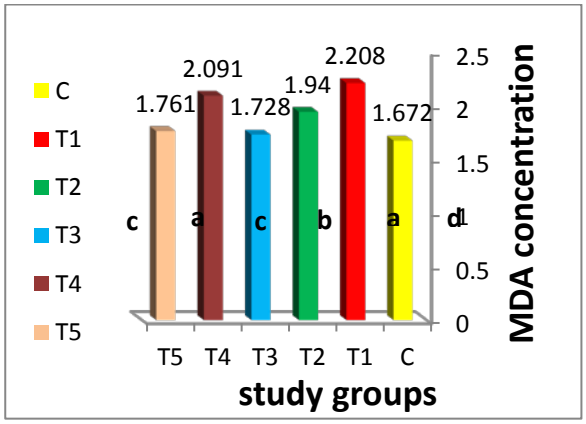

Figure (4) Fucus vesiculosus and propylthiouracil (PTU) effects and the interchange between them on MDA hormone concentration (nanogram.ml.) in mature male rats

Morbid tissue changes

The present study results show that there are morbid tissue changes in the thyroid gland of male rats that are treated with Fucus vesiculosus and propylthiouracil (PTU). When examining tissue sections of the thyroid gland of the control group dyed with hematoxylin and eosin. The natural structure of gland tissues shows that it includes rounded or oval follicles lined with cubic epithelial cells. Also, these follicles are full of colloid, which shows the natural activity (figure 5). The animals in the first treatment (T1) that are given fucus vesiculosus for 42 days with 35 mg/ kg concentration of body weight, the tissue examination of thyroid gland sections of (T1) show that there are no tissue deformations with good response to fucus vesiculosus that causes the growth of several follicles of different sizes that do not contain colloid or have colloid. This is an indication of the natural function of the thyroid gland. Then the tissues are compared with the control group, which showed that there approximate similarity for the normal tissues of the control group (figure 6). As for other treatments (T2, T3, T4, and T5), there are clear deformations and changes in the thyroid gland tissues and in the follicle structure or their number, a decrease follicle size, an increase in epithelial cells and a decrease in colloids. Also, hemorrhage and necrosis can be noted (figure 7, 8, 9, 10).

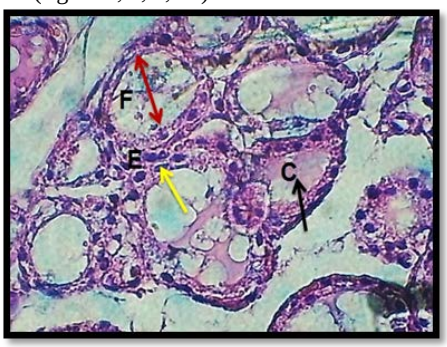

Figure (5) cross-section of the thyroid gland of the control group shows follicles size (F), colloid (C) and follicles epithelial cells (E) hematoxylin and eo

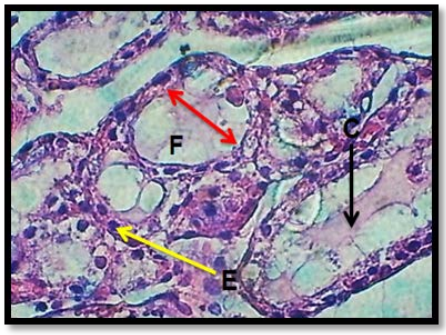

Figure (6) cross-section of the thyroid gland of the group treated with fucus vesiculosus shows follicles size (F), colloid (C) and follicles epithelial cells (E) (hematoxylin and eosin 400x)

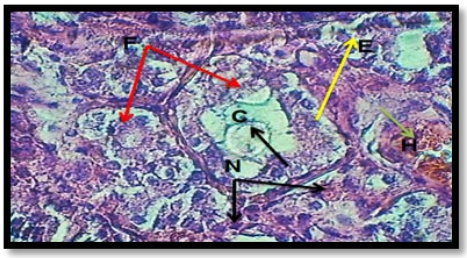

Figure (7) cross-section of the thyroid gland of the group treated with PTU shows small size of follicles (F), an increase of epithelial cells (E), less colloid (C), hemorrhage (H) and necrosis (N). (Hematoxylin hematoxylin and eosin 400x)

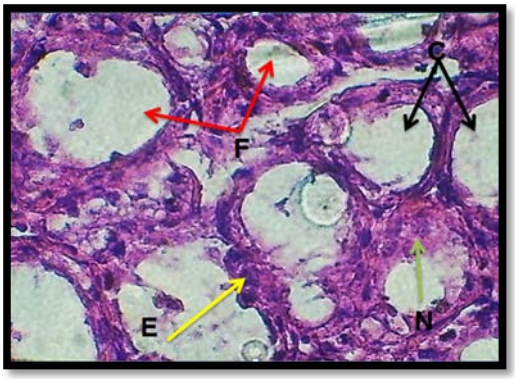

Figure (8) cross-section of the thyroid gland of the group treated with fucus vesiculosus for three weeks then PTU for the other three weeks. It shows a small change of follicles (F), an increase of epithelial cells (E), less colloid (C) and necrosis (N). (hematoxylin and eosin 400x)

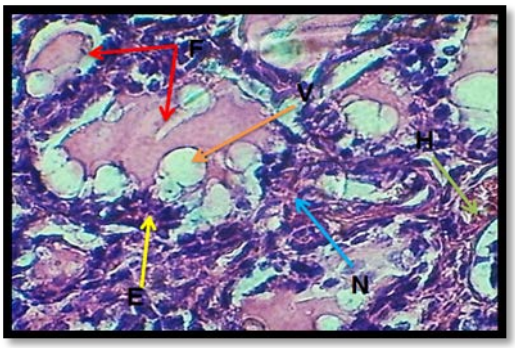

Figure (9) cross-section of the thyroid gland of the group treated with PTU for three weeks then fucus vesiculosus for the other three weeks. It shows a reduction in the size of some follicles (F), an increase of epithelial cells (E), clear cavities (V), hemorrhage (H) and necrosis (N). (hematoxylin and eosin 400x)

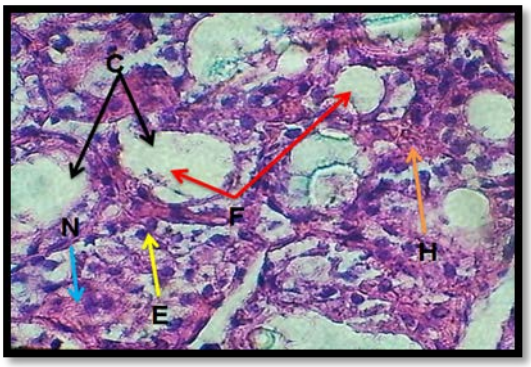

Figure (10) cross-section of the thyroid gland of the group treated with PTU and fucus vesiculosus together. It shows small size of follicles (F), no colloid (C), an increase of epithelial cells (E), hemorrhage (H) and necrosis (N). (hematoxylin and eosin 400x).

DISCUSSION

The study results show that there is an increase in T3 and T4 hormones level in the blood serum of rats that are treated with fucus vesiculosus.Also, there is an increase in T3 and T4 hormones level in the blood serum of rats that are treated with PTU for three weeks then fucus vesiculosus for the rest of period in comparison with the control group. The increase of T3 hormone might be due to Fucus vesiculosus, which maximizes the transformation of T4 into T3 in blood after losing one iodine atom in a process called (deiodinase), or because T3 is more active hormone than T4 by (3-5) times. Also, it is a low affinity with plasma proteins, so it diffuses easily outside blood vessels more

than T4 [14, 15] and these results agree with the present study results. But the study results do not agree with [16-18] studies which noted the decrease of T3 and T4 values. The increase of T3 and T4 in this study is attributed to other interaction of medications especially those include iodine, which effect on the structure and function of thyroid gland hormones [19]. The study findings reveal that there is a decrease in TSH level in blood serum of rats that given fucus vesiculosus. The possible reason of TSh decrease could be the inhibition of negative feedback because of the high concentration of T3 and T4, which are shown in this study, prevent secretion of TSH from pituitary gland. This result agrees with [20]. But [21] referred to a significant increase in TSH level.

The present study results reveal that there is a significant decrease in T3 and T4 levels in blood serum of rats treated with PTU only in T2 and the group treated with fucus vesiculosus for three weeks then PTU for the other three weeks in T3, the group given fucus vesiculosus and (PTU) together in T5. The reason for T3 and T4 is attributed to PTU that leads to disorder of thyroid gland and inhibits thyroid peroxidase and 5- deiodinase and these are basic enzymes to make thyroid hormones [22-24]. The inhibition of making these enzymes decrease the levels of thyroid hormones diffusion and eventually increases of TSH hormone. This increase of TSH stimulates thyroid gland growth, and this leads to its enlargement. This result agrees with what [25-28].

The results also show that there is a significant increase in TSH level in the blood serum of rats treated with PTU and the group given fucus vesiculosus for three weeks and PTU for the rest of the period and the group given PTU then focus vesiculosus. There is no significant difference in the group given focus vesiculosus and PTU together. The reason for TSH increase is that PTU participates in releasing TRH and TRH stimulates anterior pituitary gland to release high levels of TSH [29]. So, the high level of TSH leads to decrease T3 and T4 in blood serum and this result agrees with [30-31] or PTU effects on basic enzymes to make thyroid gland hormones [22] and increases TSH. This result agrees with [22, 25].

The study findings show that there is a significant increase in MDA level in the rats treated with Fucus vesiculosus), the group gave PTU in and the group treated with PTU for three weeks then fucus vesiculosus for the rest of period.But there is no significant difference in (T3 and T4) when compared with the control group. The increase of MDA in T1 and T4 that generates free radicals that have a role in oxidization of lipid in cells membranes because unsaturated lipid acids on the cell membranes are the targeted areas of free radicals since they contain a double bond and this reaction produces MDA in a process called lipid peroxidation [32]. This result agrees with [20].But this result does not agree with [33]. While the study results, which shows a high level of MDA in the T2 group given PTU. This result agrees with what [34-37] who referred that the increase of MDA is due to carbimazole, antithyroid, which causes oxidative stress. The examination of tissue sections taken from animals thyroid glands in T1, which are given fucus vesiculosus show there are no deformations or changes in these tissues. This result agrees with [18, 20, 38, 39]. The reason is that fucus vesiculosus rich of biological compounds as a polysaccharide, polyphenolic, antioxidants and phlorotannins in addition to mannitol, align, iodine and fucoidan [40-43]. Many studies have referred to fucus vesiculosus contains fucoidan, which is polysaccharide and includes superoxide and hydroxyl root that inhibit lipid peroxide the reason for tissue changes [42, 45, 45].

When examining tissue sections taken from thyroid gland for the treatments (T2, T3, T4, and T5), there are clear changes in the thyroid gland tissues as the change in the follicle size, colloids amount, hemorrhage and gaps. [27, 29, 46] noted that PTU deforms and changes thyroid gland tissues. There is enlargement of follicle cells and a decrease of colloids. Though fucus vesiculosus in T3, T4, and T5, PTU is more eff ective on thyroid tissues or the tissue damage may be attributed to oxidative stress because PTU stimulates oxidative stress [47] showed that treatme nt with PTU stimul ates oxidativ e stress in ra ts cerebellum, which leads to tissue damage and programmed death of cells. Also, oxidative stress stimulates cells in thyroid gland to grow and enlarge it. Eventually, it has Derbyshire neck, a decrease of T3 and T4 and increase of TSH [48].

CONCLUSION

The study concludes that dosing animals with fucus vesiculosus by 35 mg/kg concentration of body weight has a clear influence on improving the function and structure of thyroid gland on the contrary to (PTU) of 15 mg/kg concentration of body weight that has a negative impact on the function and structure of thyroid gland.

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