

Goitrogenic foods and Thyroid gland

Dr. Tuhin Suvro Banerjee*

*Assistant Professor, Department of Physiology, A.B.N Seal College,
Cooch Behar, West Bengal

Corresponding author:

Tuhin Suvro Banerjee, PhD, Department of Physiology, A.B.N Seal College, Cooch Behar,
West Bengal, e-mail: tuhin.banerjee1@gmail.com

Abstract

Maintenance of physiology of human body is brought about by various organs, thyroid being one of them. Among the daily food that we consume in general, there are various compounds which disrupt thyroid physiology as well as alter the functional status of other organ system through their effects on thyroid gland. These compounds, known as Goitrogens, modulate thyroid functional status by interfering with the iodine uptake process by the thyroid follicular cells, leading to the enlargement of thyroid formation and formation of goitre. The goitrogens are broadly classified into two types, one is goitrogenic drugs, and the other is goitrogenic foods. The food substances that contain goitrogens are mainly the vegetables in the family *Brassicaceae*, commonly known as cruciferous plants, like cabbage, cauliflower, broccoli, mustard, radish, turnip, etc. The main constituents of these foods that affect the thyroid function are thiocyanates, isothiocyanates, cyanogenic glucosides, flavonoids, etc. The various drugs that cause goitre formation include environmental pollutants like potassium perchlorate, thiocyanate, etc. and others that are often used for the treatment of conditions such as cardiac arrhythmia, microbial infections, etc. include amiodarone, sulfadimethoxine, propylthiouracil, etc. The goitrogens alter thyroid gland physiology and disrupts the various organ systems that are regulated by the thyroid gland, including metabolism, growth, development and reproductive functions. This further causes the development of various health issues which need to be considered given the present scenario of goitre in present perspective of developing societies in India. These drugs and food which are a part of our day-to-day life, may actually be harmful when consumed irrationally and hence need to be dealt with carefully.

Keywords: Goitrogens, goitre, thyroid, hypothyroidism

Introduction

The environment is abundant in various components that are both beneficial as well as harmful for the living system. Such components often gain entry into the human system through food and water. Among these components the ones which are detrimental to the thyroid gland leading to disruption in normal thyroid function and formation of goitre are often referred to as “Goitrogens” (1).

Thyroid gland, located in the neck region, is one of the most important endocrine glands of an organism which regulates various metabolic processes as well as other organ systems. The thyroid gland is regulated by the pituitary gland through thyroid stimulating hormone (TSH). TSH stimulates the thyroid gland to synthesise and secrete thyroid hormones triiodothyronine (T₃) and thyroxine (T₄). T₃ is more potent than T₄. The synthesis of thyroid hormones requires

iodine which is incorporated into the thyroid follicular cells by the sodium-potassium symporter (NIS) present of the basolateral membrane of the cells (2). A decrease in serum thyroid hormone level under normal conditions stimulates pituitary gland to produce TSH which in turn increases thyroid hormone synthesis and secretion. Similarly, an increase in serum thyroid hormone level under normal conditions inhibits pituitary secretion of TSH which in turn decreases thyroid hormone synthesis and secretion, thus regulating thyroid hormone synthesis through feedback mechanism (3). However, in pathological conditions when there is reduced synthesis and secretion of the thyroid hormones by the thyroid gland, under influence of pituitary TSH, there is a compensatory hypertrophy of the thyroid gland or enlargement of thyroid and goitre formation (4).

Vegetables and fruits are important constituents of our daily food. Thus, human beings and animals often consume foods that are rich in goitrogens. These foods and components have often found to contain beneficial components that facilitate various body functions. However, they contain some components which are detrimental to the thyroid gland. Hence, these foods are often referred to as goitrogens. These goitrogens have been found to be more harmful causing thyroid dysfunction when consumed in raw form than in cooked form (3).

Types of goitrogens

There are various foods which have been found to contain goitrogenic properties. These include cruciferous vegetables like Cassava, Soybeans (and soybean products such as tofu, soybean oil, soy flour, soy lecithin), pine nuts, Peanuts, Flax seed, Millet, Strawberries, Pears, Peaches, Spinach, Bamboo shoots, Sweet potatoes, Vegetables in the genus *Brassica*, Bok choy, Broccoli, Brussels sprouts, Cabbage, Canola, Cauliflower, Chinese cabbage, Choy sum, Collard greens, Horseradish, Kai-lan (Chinese broccoli), Kale, Kohlrabi, Mizuna, Mustard greens, Radishes, Rapeseed (Yu choy), Rapini, Rutabagas, Tatsoi, Turnips (4).

Besides these vegetables there are several chemicals which have been used as medicine for treatment of various pathological conditions but have been found to contain goitrogenic properties. These include PTU (propylthiouracil), perchlorate, thiocyanate, amiodarone, lithium, etc (4).

Mode of action of goitrogens

The main components of different goitrogens that leads to the enlargement of thyroid and subsequent thyroid dysfunction may be classified into two main components, one is flavonoids and the other is isothiocyanates. Flavonoids and related compounds as well as thiocyanates all are found to interfere at various different levels causing thyroid dysfunction.

Thiocyanates, cyanogenic glucosides and glucosinolates as well as flavonoids have been found to affect thyroid hormone synthesis in the thyroid gland by either of the following mechanisms (4);

- a) Interfering with activity of thyroid peroxidase (TPO) enzyme
- b) Inhibiting iodide uptake by the thyroid follicular cells
- c) Inhibiting organification of iodine

d) Inhibiting the iodination of tyrosine in thyroglobulin and coupling reaction

In case of the drugs and chemical components which have been found to contain goitrogenic potential have various modes of action depending upon the component (5).

Perchlorate: This chemical may be profoundly available in the environment as a pollutant and disrupts thyroid function simply by inhibiting iodine uptake by the thyroid gland.

Bisphenol-A: This chemical binds to the thyroid receptors and act as antagonist on gene expression.

Polychlorinated Biphenyls: They have been found to interfere with the circulating levels of thyroid hormones.

Amiodarone: It is often used as an antiarrhythmic medication which contains iodine as a main component. Prolonged consumption has been found to bring about oxidative stress in target organs.

Propylthiouracil (PTU): It is used as a medication for the treatment of hyperthyroidism and Grave's disease. It acts by inhibiting conversion of T_4 to T_3 .

Lithium: Lithium had been used in treatment of psychiatric diseases. It has been found to interfere with thyroid function by increasing intrathyroidal iodine content through inhibiting the coupling of iodotyrosine residues to form iodothyronines (T_4 and T_3).

Thiocyanate: Components of cyanogenic plants include cyanogenic glucosides and glucosinolates. Thiocyanate and isothiocyanate are the respective metabolites of these components of the cyanogenic plants. Thiocyanate acts by inhibiting iodide transport, increase iodide efflux from thyroid gland, decrease iodine organification and inhibiting TPO as well as iodination of tyrosine. However, isothiocyanate have been found to react spontaneously with amino groups to form thiourea that interferes in thyroid gland with organification of iodide and formation of thyroid hormone and this action cannot be antagonized by the iodide.

Flavonoids: They are polyphenolic compounds and have been found to inhibit TPO activity, decreasing thyroid hormones levels thus increasing TSH and causing goitre (5). They have also been found to affect the availability of thyroid hormones to target tissues, by inhibiting deiodinase activity or displacing T_4 from transthyretin (3).

Conclusion

The daily diet as well as medication that are consumed by general population thus has been found to contain many of the components that are goitrogenic in nature. These components when consumed in raw and in excess causes disruption of the thyroid function leading to disorders of other organ systems too. Hence, it may be concluded that these food substance and medications that contain goitrogenic substances should be consumed precautiously so that the thyroid gland physiology and functional status remain euthyroid.

References

1. E Gaitan. Goitrogens in food and water. Annual Review of Nutrition. 10 (1990) 21-39.

2. WL Green. Mechanism of action of antithyroid compounds. In The Thyroid. Ed Werner SC, Ingbar SH, 4th ed. New York, Harper & Row Publishers, (1978) NY 41-45.
3. S Sundaresan, B Nambisian, A Easwari. Bitterness in cassava in relation to cyanoglucoside content. Indian Journal of Agricultural Science. 57 (1987) 37-40.
4. MC de Souza Dos Santos, CF Gonçalves, M Vaisman, AC Ferreira, DP de Carvalho. Impact of flavonoids on thyroid function. Food Chemistry and Toxicology. 49 (2011) 2495-2502.
5. D van der Heide, J Kastelijn, JP Schröder-van der Elst. Flavonoids and thyroid disease. Biofactors. 19 (2003) 113-119.