SOY & HEALTH

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Soy, Isoflavones, and Thyroid Function

More than 70 years of scientific inquiry surround the relationship between soybean intake and thyroid function. Recent concerns include the possible goitrogenic effects of soybean isoflavones. As increasing numbers of consumers embrace soyfoods, health professionals need to understand both the benefits and the potential challenges of soy consumption.

Research Highlights the Benefits and Challenges of Soy on Thyroid Function

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Introduction

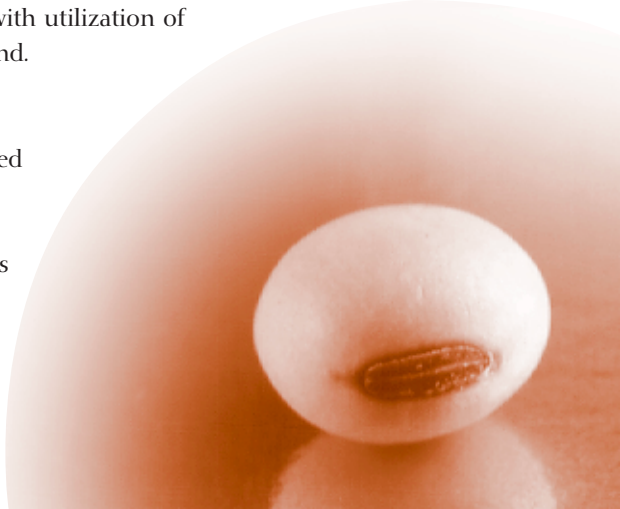
The thyroid gland is located in the lower part of the neck wrapped around the front of the trachea. The thyroid gland produces three hormones: calcitonin, which is involved in calcium regulation; and 3,5,3'–triiodothyroine (T3) and 3,5,3',5'–tetraiodothyronine (T4, thyroxine), commonly referred to as the thyroid hormones. Iodine is an essential component of both T4 and T3, contributing 65 percent and 59 percent of their molecular weights, respectively.

The normal thyroid weighs between 15 and 20 grams. However, in response to prolonged iodine deficiency, the thyroid gland can increase about fivefold to the size of a football, a condition recognized as goiter. The primary function of the thyroid gland is to produce thyroid hormones, which primarily function to regulate basic metabolic rate. When serum iodine levels are low or when the thyroid doesn't receive enough iodine, the anterior pituitary secretes more of a hormone called thyroid stimulating hormone (TSH). This excessive secretion of TSH compensates by increasing the size of the thyroid and thereby allowing it to work more efficiently.

The primary cause of goiter and hypothyroidism around the world is inadequate iodine intake. Approximately one billion people are considered to be iodine deficient worldwide.[1] The adult iodine RDA is 150 ug, so one teaspoon (about 4–5 g) of iodine is all a person requires in a lifetime. Yet, iodine deficiency is an immense problem in many regions in the world, especially in the Himalayas, the Andes, and in the central part of Africa. Fortunately, approximately 50 percent of the U.S. population uses iodized salt which is why the iodine intake of the U.S. population is considered adequate. Some subsets of the population, such as women of child–bearing age, still have marginal iodine intakes, however,[2, 3, 4] and thyroid problems can also develop in populations consuming adequate amounts of iodine. Thyroid abnormalities in these situations are often due to the presence of dietary goitrogens, such as glucosinolates in cruciferous vegetables, which interfere with utilization of iodine or functioning of the thyroid gland.

Soy – Early Research

The first report that soybeans produced goiter in *iodine-deficient* rodents was published in 1933.[5] Subsequent animal studies published in the 1930s and 1940s noted similar findings.[6, 7, 8] Iodine fortification of the diet largely eliminated this problem, although soy–fed animals are known to require



approximately twice as much iodine to prevent enlarged thyroids as animals not fed soy.[6, 9, 10]

Concerns about the goitrogenic effects of soy were heightened between 1959 and 1961, when reports documented 10 to 15 cases of goiter in infants fed soy flour–based infant formula.[11, 12, 13] However, this type of formula has not been used since the 1960s. Today, soy formula is based on soy protein isolate and is fortified with iodine. No reports in the scientific literature indicate any cases of goiter in infants due to consumption of soy protein isolate–based, iodized infant formula.

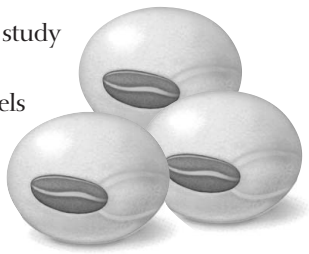
Limited data suggests that infants with congenital hypothyroidism who consume soy formula require about 25 percent more synthetic hormone than infants with congenital hypothyroidism on non–soy formulas.[14, 15] But this appears not to be a result of a direct effect on the thyroid gland, since fiber supplements, especially insoluble fibers such as wheat bran, also necessitate that patients increase their thyroid hormone medication.[16] Soy, like fiber, may interfere with the absorption of thyroid hormone in the case of medication, and/or interfere with the reabsorption of thyroid hormone by binding thyroid hormone as it undergoes enterohepatic circulation.

Are Soybean Isoflavones Goitrogens?

Many studies have attempted to identify the factors in soy responsible for goitrogenicity in animals, but with conflicting results. Recently, researchers at the National Center for Toxicology Research in Arkansas concluded that the isoflavones in soybeans are goitrogenic.[17, 18] Isoflavones belong to a very large class (L 4000) of phytochemicals – flavonoids – that are ubiquitous in the plant kingdom. In fact, researchers suggest that flavonoids are responsible for goiter associated with the consumption of large amounts of millet in certain developing countries.[19, 20, 21]

In vitro research clearly shows that genistein, the primary isoflavone in soy, is able to inhibit the activity of thyroid peroxidase, the enzyme involved in the synthesis of thyroid hormone.[17] More importantly, a recent study in rats found that dietary genistein inhibited thyroid peroxidase activity by up to 60 percent.[22] Despite inactivation of this enzyme, thyroid hormone levels were unaffected and the thyroid gland of genistein–fed rats was normal. The authors of this study concluded that soy could cause goiter, but only in animals or humans consuming diets marginally adequate in iodine, or who were predisposed to develop goiter.

Recent Human Studies



Adding to concerns about soy goitrogenicity, results from a three–month Japanese study published in 1991 suggest that, among a group of elderly subjects, the addition of 30 g/day of pickled soybeans to the diet significantly increased TSH levels (although levels remained within the normal range) and caused goiter or symptoms of hypothyroidism in about half of the study subjects.[23] However, several aspects of this study and its results raise questions about the validity of this research. First, the study presented no information on the iodine intake or status of the subjects. Second, the soy product was stored in rice vinegar, and authors of the study did not adequately describe the product itself, which makes comparisons with other studies difficult. The high incidence of gastrointestinal disturbances, such as constipation and diarrhea, among this soy–consuming study population suggests that this particular soy product may have been unusual for some reason. Third, the high incidence of goiter as a result of consuming a modest amount of soybeans (30 g/d) seems odd in a country where soy is a commonly consumed food. These findings suggest that the incidence of goiter in Japan should be very high – and it is not.[24, 25]

Fortunately, because of interest in the health benefits of soy, several recently conducted and well–designed studies have provided insight into the relationship between soy and thyroid function. These studies suggest that, at least in iodine–replete subjects, soy has little, if any, effect on thyroid function.

Recent work from the University of Minnesota indicates that the consumption of isoflavone–rich soy protein, at levels that were as much as 3–4 times the isoflavone intake in Japan, had little effect on thyroid hormone levels in either pre– or postmenopausal women over a three–month period.[26, 27] Ham et al did find that, in hypercholesterolemic men, soy protein consumption was associated with modest increases in some measures of thyroid hormones, but all values remained within the normal range.[28]

In addition, a recently conducted double–blind study six months in duration, that involved 38 postmenopausal women who were not on hormone therapy, found no differences in thyroid function, based on measures of thyroid stimulating hormone (TSH), total T4 and T3, between subjects given daily either a placebo or a soybean isoflavone extract that provided 90 mg (equal to approximately three servings of soy) of isoflavones.[29]

Conclusions

Overall, there appears little reason to think that either soy isoflavone supplements or soyfoods will exert adverse effects on thyroid function in healthy adults. Similarly, iodine–fortified soy formula does not appear to cause thyroid problems in infants. Arguably, in people who are predisposed to goiter, such as those with autoimmune disorders or a history of postpartum thyroiditis or neck irradiation, or consume marginally iodine–sufficient diets, consuming high levels of soy protein (>25 g/day) could conceivably be a risk factor for goiter. This may be relevant in as much as 10 percent of the female population.[30, 31] But, there is no reason to restrict soy intake even in these women since research suggests adequate iodine intake overcomes any theoretical goitrogenic effects of soy.

When counseling patients who consume large amounts of soy, it is important to make sure iodine intake is adequate. Of course, all individuals, regardless of their dietary pattern, need to consume sufficient amounts of iodine. Any concerns about the effect of soy on thyroid levels can be easily addressed by measuring thyroid hormone levels. The American Thyroid Association recommends that all people have their thyroid hormone levels checked every five years beginning at the age of thirty–five.[32]

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