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Goitrogenic foods consumed by schoolchildren in Ngargoyoso sub-district, Karanganyar regency, Central Java, Indonesia.

Yulia Lanti Retno Dewi
Department of Biology, School of Medicine, Sebelas Maret University.
Jl. Ir. Sutami 36 A Surakarta 57126, Indonesia.
Tel: 62-271-664178 E-mail: yulialanti@live.com

Abstract

Background

Iodine supplementation alone failed to eliminate endemic goiter in Ngargoyoso sub-district, Karanganyar, regency, Central Java, Indonesia. After six months iodine supplementation the total goiter rate was still >30%. It can be classified as severe endemic using WHO (2007) classification. Since goiter is a multi-factorial entity, other goitrogenic factors must be elucidated.

Objectives

The present study was designed to ascertain whether particular foods consumed by schoolchildren have any impact on the prevalence of goiter in Ngargoyoso sub-district, Karanganyar regency, Central Java, Indonesia.

Methods:

In the first phase of the study a list of food items were asked using a food frequency questionnaire to schoolchildren in Ngargoyoso sub-district, Karanganyar regency, Central Java, Indonesia. To be included in the list, food should meet the following criteria: (1) it has been cited in the literature; (2) it must be available in the study area; and (3) culturally acceptable. Seventeen food items met the criteria. The frequency was divided into six categories i.e. more than once a day, once a day, 3-6 times a week, 1-2 times a week, less than once a month, and never. Cumulative percentage of the first three categories was used as cut off i.e. >40%. It was assumed that beyond this point a particular food was eaten frequently in Ngargoyoso sub-district, Karanganyar regency, Central Java, Indonesia. In the second phase of the study those foods will be studied in vitro and in vivo using animals.

Results

Five hundred and fourteen schoolchildren in Ngargoyoso sub-district participated in the study: 229 students from year 3 and 285 students from year 5. There were 265 boys and 249 girls. Foods frequently eaten by schoolchildren in the study area were fermented soy bean cake (80.9%), tofu (79.8%), onion (72.2%), tomato (64.2%), cassava leaves (60.1%), cabbage (59.1%), cassava (49.2%) and broccoli (44.0%).

Conclusion

Onion, tomato and broccoli are consumed in small amounts, therefore three food items need further investigation in the second phase of the study i.e. soybeans, cassava and cabbage.

Keywords: goitrogenic food, schoolchildren, food frequency questionnaire, total goiter rate.

1. Introduction

Ngargoyo sub-district is an Iodine Deficiency Disorders (IDD) endemic area in Central Java province, Indonesia. The Total Goiter Rate (TGR) among schoolchildren is very high. Last survey in 2010 reveal that TGR was 51.9% (Suprapto et al. 2010). Recently, we carried out a supplementation trial using iodine in oil and iodine in drinking water for six months. Although it reduced TGR to 38.5% in iodized oil group and 34.35% in iodized water group (Suprapto & Dewi, 2012), the prevalence of goiter is still unacceptably very high. According to WHO (2007) classification the study area can be classified as severe endemic (>30%). It seems that iodine supplementation alone failed to eliminate endemic goiter in this area. Interactions between food, environment and heredity has been known for a long time (Greenwald, 1960). The report of Chesney, et al (1928) probably was the first acceptable

experimental evidence relating diet with goiter (Greer, 1957). Cabbage was responsible for producing goiter in rabbits. Greer and Astwood (1948) studied more than 60 food items and found that rutabaga was consistently the most active in its anti-thyroid effect. Since then, a lot of studies on goitrogenic substances in food has been carried out. Soybean was extensively studied for its goitrogenicity (Sharpless et al, 1939: Wilgus et al, 1941), its flavonoids content may be responsible for its anti-thyroid effects (Gaitan, 1989). Cassava has been extensively studied after findings on Idjwi Island (Delange and Ermans, 1971). Cyanogenic glucoside (linamarin) was responsible for its goitrogenicity (Delange, 1989). Gaitan and Cooksey (1989) summarized the pathogenesis of goiter by goitrogens acting directly to the thyroid gland. Foods contain thiocyanate (cassava) and isothiocyanate (cabbage) blocks iodide transport into thyroid gland, whereas onion containing aliphatic disulfides inhibits the process of organification. Excess of lithium and iodide blocks the release of active thyroid hormones into the circulation. All of these disturbances will increase the production of thyroid stimulating hormone (TSH) by hypothalamus. Subsequently, TSH induces thyroid hyperplasia as an adaptive mechanism. We suspect goitrogenic factors other than iodine deficiency after supplementing schoolchildren in Ngargoyoso sub-district, Karanganyar regency, Central Java, Indonesia with iodine alone and found the total goiter rate was still very high. The first phase of the present study was to identify particular foods consumed by schoolchildren in the study area, which have been known possess goitrogrenic effects.

2. Subjects and Methods

2.1. Research setting

Ngargoyoso sub-district is located on the high slope of Mount Lawu, Karanganyar regency, Central Java province, Indonesia, at an altitude of around 1000 meters above the sea level. The most remote area has not access for automobile. There are 30,000 people living in the sub-district, 3000 of them are schoolchildren who attend state-owned elementary school. Iodized salts are available in the traditional market at a higher price than the crystal one (un-iodized). Only 61% of households consumed iodized salts in 2010. Iodine supplementation both in oil (Yodiol™capsule) and in drinking water reduced TGR significantly in 2012. However, the goiter prevalence is still >30% and classified as severe endemic by WHO (2007) classification.

2.2. Subjects

Five hundred and fourteen schoolchildren from year 3 and year 5 were recruited in the study. It consisted of 265 boys and 249 girls. They were distributed in 21 state-owned elementary school spread over the sub-district.

2.3. Study protocol

List of students in the elementary school was used to identify the subjects. All schoolchildren from year 3 and year 5 were asked to fill a prepared food frequency questionnaire under the guidance of nutrition staff and teachers. The study was conducted between September 2012 and November 2012.

2.4. The Food Frequency Questionnaire

In the first phase of the study a list of food items were asked using a food frequency questionnaire to schoolchildren in Ngargoyoso sub-district, Karanganyar regency, Central Java, Indonesia. To be included in the list, food should meet the following criteria: (1) it has been cited in the literature; (2) it must be available in the study area; and (3) culturally acceptable. Seventeen food items met the criteria. The frequency was divided into six categories i.e. more than once a day, once a day, 3-6 times a week, 1-2 times a week, less than once a month, and never. Cumulative percentage of the first three categories was used as cut off i.e. >40%. It was assumed that beyond this point a particular food was eaten frequently in Ngargoyoso sub-district, Karanganyar regency, Central Java, Indonesia. In the second phase of the study those foods will be studied in vitro and in vivo using animals.

2.5. Statistical analysis

All statistical analysis was performed using SPSS for Windows, release 17.0 (Chicago, IL, USA).

2.6. Ethical considerations

The study was approved by the Ethical Review Committee, School of Medicine, Sebelas Maret University.

The students, the teachers and the Headmasters were informed about the nature of the study and agreed to participate in the study.

3. Results

Five hundred and fourteen schoolchildren in Ngargoyoso sub-district participated in the study: 229 students from year 3 and 285 students from year 5. There were 265 boys and 249 girls. Table 1 shows the food items and the frequency of consumption. Foods frequently eaten by schoolchildren in the study area were fermented soy bean cake (80.9%), tofu (79.8%), onion (72.2%), tomato (64.2%), cassava leaves (60.1%), cabbage (59.1%), cassava (49.2%) and broccoli (44.0%).

4. Discussion

Ngargoyoso sub-district is a severe IDD endemic area in Centrral Java, Indonesia. The total goiter rate after six months iodine supplementation was >30% (Suprapto & Dewi, 2012). It seems that endemic goiter in this area could not be eliminated using iodine alone. Indeed, goiter is a multi-factorial disease where iodine deficiency is thought to be the permissive factor. Other environmental factors may play a role. Foods which are consumed daily have a great potential in interfering iodine deficiency in this area. The role of dietary goitrogens has been known for decades. Cabbage was the first food incidentally observed in rabbits by Chesney et al (1928). Since then, a lot of studies on the goitrogenicity of foods were carried out. Soybean has been studied extensively for its anti-thyroid effects (Halverson et al, 1949). Cassava was blamed in Idjwi Island (Delange & Ermans, 1971). Millet was suspected in Sudan (Elnour et al, 2000). Gaitan & Cooksey (1989) summarized all environmental agents producing goitrogenic and/or anti-thyroid effects, many of them found in foods. People in Ngargoyoso sub-district rely their drinking water on natural spring wells, unfortunately it contains no iodine (Dewi et al, 2012). Consequently, plants grown in the area also lack of iodine. All food items included in the food frequency questionnaire are grown domestically, except broccoli and soybeans are imported. Thus, when considering the goitrogenicity of the listed food, lack of iodine in particular foods should be kept in mind. The results in Table 1 showed that foods frequently eaten by schoolchildren in the study area were fermented soy bean cake (80.9%), tofu (79.8%), onion (72.2%), tomato (64.2%), cassava leaves (60.1%), cabbage (59.1%), cassava (49.2%) and broccoli (44.0%). Soybean and broccoli were imported from outside sub-district. Cassava, onion, tomato and cabbage are grown in the sub-district, therefore, they also lack of iodine. Based on the results, goitrogenic substances suspected are thiocyanate, isothiocyanates, goitrin, disulfides and flavonoids. Suprapto et al (2010) found thiocyanate in casual urine of schoolchildren in Ngargoyoso sub-district, Central Java, Indonesia. Schoolchildren without goiter excreted in urine 1.51 (±0.73) µg/ml of thiocyanate, whereas schoolchildren with goiter excreted in urine 1.72 (±1.38) µg/ml of thiocyanate. Although cassava is not the staple food (it is rice) in Ngargoyoso sub-district, it is very popular and frequently consumed in the study area, therefore responsible for thiocyanate excretion in urine. Goiter also found in iodine sufficient area in Sudan, where pearl millet was regularly consumed by schoolchildren (Elnour et al, 2000). This group of researchers also found thiocyanate in the urine of schoolchildren with goiter. Despite high TGR in Ngargoyoso sub-district (51.9%), the mean of urinary iodine excretion was adequate: 187.14 (±64.3) µg/Lin non-goiter schoolchildren and 185.86 (±77.9) µg/Lin schoolchildren with goiter (Suprapto et al, 2010). It is suspected that other goitrogenic factors play a role in Ngargoyoso sub-district, Central Java, Indonesia. Nutritional status of schoolchildren was fairly below WHO (2002) standards (Suprapto & Dewi, 2012). Interactions between protein deficiency and thiocyanate on thyroid function has been established (Kreutler et al, 1978). Indeed, thiocyanate interferes with iodide uptake by thyroid gland, so that, iodine excreted in the urine (Gaitan, 1989). Soybean which is rich of isoflavones considered to be goitrogenic through inhibition of iodine uptake and a decrease in iodine organification in the thyroid gland (Konijn et al, 1973). Soybeans are not grown in the study area, but it is available in the traditional market in the form of fermented soybean cake and tofu. It is very popular, people like it and the price is affordable. Most people in the study area consumed soybean, only less than 2% said never eating them. In 2011 a survey of schoolchildren who enter year 1 of elementary school in the sub-district revealed that 99% of children were anemic (N= 500, cut off: Hemoglobin 11.5g/dl). WHO assumed that a half of anemia was caused by iron deficiency. It implies that iron deficiency quite prevalent in Ngargoyoso sub-district. Zimmermann et al (2000) found that iodine supplementation was not effective in anemic schoolchildren. Iron deficiency is thought to be goitrogenic. Indeed, adding iron into iodine supplementation program reduced the total goiter rate (Hess, 2002: Zimmermann et al, 2004). Iron deficiency reduces thyroid peroxidase (TPO) activity and consequently reduces thyroid hormone synthesis (Hess et al, 2002). Vitamin A deficiency also aggravates the effect of iodine deficiency in producing goiter. Vitamin A supplementation in iodine deficient children in Africa decreases thyrotropin stimulation of the thyroid and reduces the goiter rate (Zimmermann et al, 2007). No data available on vitamin A status of schoolchildren in Ngargoyoso sub-district, However, vitamin A supplementation for

children under five years of age is routinely provided by the health center staffs every six month. Untoro et al (1998) measured Selenium (Se) contents of egg yolk and egg white in free-living chicken in IDD endemic area of East Java, Indonesia. They concluded that Se deficiency might be an additional contributing factor for goiter. Selenium participates in thyroid metabolism through deiodinase enzymes that control the formation of T3 from T4 in different tissue and organs. Selenium also participates in glutathione peroxidase activity at the thyroid, protecting it from oxidative stress damage. However, its effect on goiter is still unclear (Thompson et al, 2009). Until today, there is no study on Selenium deficiency in Ngargoyoso sub-district, Central Java, Indonesia.

5. Conclusion

With micronutrient deficiencies, especially iron deficiency in Ngargoyoso sub-district, kept in mind, goitrogenic foods should be considered in the second phase of the study, both in vitro and in vivo are: soybeans, cassava and cabbage, because onion, tomato and broccoli only eaten in small amounts.

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Table 1. Food consumed by schoolchildren in Ngargoyoso sub-district, Karanganyar regency, Central Java province, Indonesia.

Food	>1/day	Once/day	3-6x/week	1-2x/week	<1/month	Never
Cassava	14%	12.6%	22.6%	17.9%	14.4%	18.5%
Sun-dried cassava	9.1%	8.2%	7.2%	8.0%	10.3%	57.2%
Creeping edible tuber (gadung)	7.0%	7.6%	6.6%	5.6%	5.3%	67.9%
Bamboo shoot	8.4%	9.1%	10.9%	9.9%	12.1%	49.6%
Cassava leaves	14.2%	15.8%	30.2%	19.8%	9.1%	10.9%
Cabbage	15.0%	17.5%	26.7%	19.6%	10.3%	10.9%
Papaya leaves	10.5%	9.7%	11.7%	10.3%	10.5%	47.3%
Petai cina (kind of bean)	6.8%	7.2%	6.0%	8.2%	8.4%	63.2%
Leucaena glauca (lamtoro)	9.5%	7.2%	11.1%	9.5%	8.4%	54.3%
Fermented soybean cake (tempe)	29.0%	23.3%	28.6%	14.2%	3.5%	1.4%
Tofu	28.6%	25.1%	26.1%	14.8%	3.7%	1.8%
Lime	13.4%	10.3%	11.3%	13.4%	12.1%	39.5%
Small star-fruit (belimbing wuluh)	10.1%	8.6%	11.9%	11.1%	8.8%	49.8%
Broccoli	15.4%	12.8%	15.8%	15.0%	9.9%	31.1%
Tomato	22.6%	18.5%	23.2%	17.9%	9.7%	8.2%
Onion	27.6%	24.3%	20.2%	13.0%	4.9%	9.9%
Lettuce	13.2%	7.8%	9.3%	9.7%	6.0%	53.9%

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