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Original article

Goitrogenic Content of Common Vegetables In Sub-Himalayan Tarai Region of Eastern Uttar Pradesh

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ABSTRACT

Endemic goiter and associated iodine deficiency disorders (IDD) are prevalent in sub-Himalayan Tarai region of Eastern Uttar Pradesh. The present study was undertaken to identify the role of dietary goitrogen in the etiology of endemic goiter during post salt iodization phase. Cyanogenic glucosides, glucosinolates and thiocyanate content of common vegetables viz., cabbage, cauliflower, radish, carrot, sweet potato , beans, consumed by the population of the region were measured. Thiocyanate content was found high in common plant foods of Tarai region and this observation suggest that in addition to iodine deficiency dietary intake of cyanogenic plant food having high thiocyanate content may play some role for the persistence of endemic goiter in the sub-Himalayan Tarai region during post salt iodization period.

KEYWORDS: Cyanogenic glucosides, Glucosinolates, Thiocyanate, Endemic goiter, Sub-Himalayan Tarai region.

INTRODUCTION

Although the relation of iodine deficiency to endemic goiter is well established, existence other factors such as goitrogens / anti-thyroid substances in foodstuffs, poor quality of drinking water, protein calorie malnutrition, etc may be involved in the etiology of goiter[1]. Cyanogenic glucosides, glucosinolates and thiocyanate are the goitrogenic/antithyroid constituents of cyanogenic plant that are often used as common plant food by men and animals. These goitrogenic constituents of cyanogenic plant affect thyroid hormone synthesis either by inhibiting iodide uptake or by interfering the activity of the enzyme thyroid peroxidase (TPO),i.e., by inhibiting the organification of iodide (I^- to I_2), or iodination of tyrosine in thyroglobulin and coupling reaction or by both the mechanisms in the thyroid gland [1,2] and thus iodine supplementation does not always results in complete eradication of endemic goiter and IDD [3].

Our earlier studies in a sub- Himalayan Tarai district namely Siddharthnagar of eastern Uttar Pradesh, suggested that endemic goiter and associated iodine deficiency disorders (IDD) are still prevalent in this region during post salt iodization phase and people of that region consume cyanogenic plant foods containing goitrogenic /anti-thyroidal substances [4,5].

There is no available information on goitrogenic content of common vegetables in sub-Himalayan Tarai region of Eastern Uttar Pradesh. Therefore in order to identify the goitrogenic content of common vegetables consumed by the population of sub-Himalayan Tarai region, cyanogenic glucosides, glucosinolates and thiocyanate content of six different common vegetables were measured.

MATERIALS AND METHODS

Selection of plant foods

Fresh samples of common vegetables viz., cabbage (*Brassica oleracea* var capitata*)*, cauliflower (*Brassica oleracea* var botrytis), radish (*Raphanus sativus*), carrot (*Daucus carota*), Sweet potato (*Ipomea batatas*), beans (*Phaseolus vulgaris*) consumed by the people of Tarai region were collected at random from different areas of the studied region for the measurement of three goitrogenic constituents namely cyanogenic glucosides, glucosinolates and thiocyanate.

Estimation of Cyanogenic Glucosides

Edible parts of fresh plants were hydrolysed by the enzyme glucosidase and the hydrocyanic acid thus liberated was trapped in sodium hydroxide. Cyanide content of trapped hydrocyanic acid was then determined quantitatively. Cyanogenic glucoside was measured following the method of Lambert *et al*. [6]

Estimation of Glucosinolates

The enzyme myrosinase (thioglucosidase) react with glucosinolates present in plant foods to generate thiocyanate. Following this principle glucosinolate (thioglucosides) was measured by the procedure of Gmelin and Virtanen [7]. Thiocyanate thus formed by the action of myrosinase was estimated by the method of Aldridge[8] as modified by Michajlovskij and Langer [9].

Estimation of Thiocyanate

The plant food was extracted with clean sand and water and refluxed subsequently. The extract containing thiocyanate was treated with trichloroacetic acid, followed by saturated bromine and arsenous trioxide (As_20_3) and allowed to react with pyridine- benzidine hydrochloride mixture. The intensity of the color thus developed was measured by using spectrophotometer (UV-1240 Shimadzu, Japan) following the method of Aldridge [8] as modified by Michajlovskij and Langer [9].

RESULTS

The mean cyanogenic glucosides, glucosinolates and thiocyanate content of common vegetables (both Brassica and non- Brassica family) of Tarai region has been depicted in Table 1.The glucoside content is highest in radish (1.75±0.14 mg/kg wet weight) followed by cauliflower (1.7±0.11 mg/kg wet weight) and cabbage (1.24±0.12 mg/kg wet weight) whereas it is lowest in Beans (0.94±0.13 mg/kg wet weight). Cyanogenic glucoside content in carrot and sweet potato is almost same (Fig 1). The glucosinolate content in different selected plant food of sub-Himalayan Tarai region has been shown in Fig.2.Glucosinolate content is also found to be maximum in radish and a little less in cauliflower and cabbage. Glucosinolate content in foods of *Brassica family* has been found to be much higher than foods of *Non-Brassica family*. Figure 3 shows the thiocyanate content in different selected plant food. The thiocyanate content was found high in all the selected plant foods collected from the studied sub-Himalayan Tarai region.

Table 1. Distribution of cyanogenic glucosides, glucosinolates and thiocyanate content (mg/kg wet weight) in the edible portion of selected plant food from Siddharthnagar of sub-Himalayan Tarai region in Eastern Uttar Pradesh

Plant foods	Cyanogenic glucosides	Glucosinolates	Thiocyanate
Brassica family			
Cabbage *(Brassica oleracea var.capitata)*	1.24±0.12	11.1±0.85	23.6±2.06
Cauliflower *(Brassica oleracea var.botrytis)*	1.7±0.11	12.05±0.07	42.3±3.26
Radish *(Raphanus sativus)*	1.75±0.14	12.25±0.35	19.16±1.72
Non-Brassica family			
Carrot (*Daucus carota*)	1.10±0.07	5.52±0.04	16.5±1.04
Sweet potato (*Ipomea batatas)*	1.07±0.05	5.12±0.18	20.5±0.70
Beans *(Phaseolus vulgaris)*	0.94±0.13	4.87±0.18	25.0±1.41

Values are mean±SD of 6 observations, expressed in terms of mg/kg wet weight

Figure 1: Cyanogenic glucosides content in selected plant food from Siddharthnagar of sub-Himalayan Tarai region in Eastern Uttar Pradesh

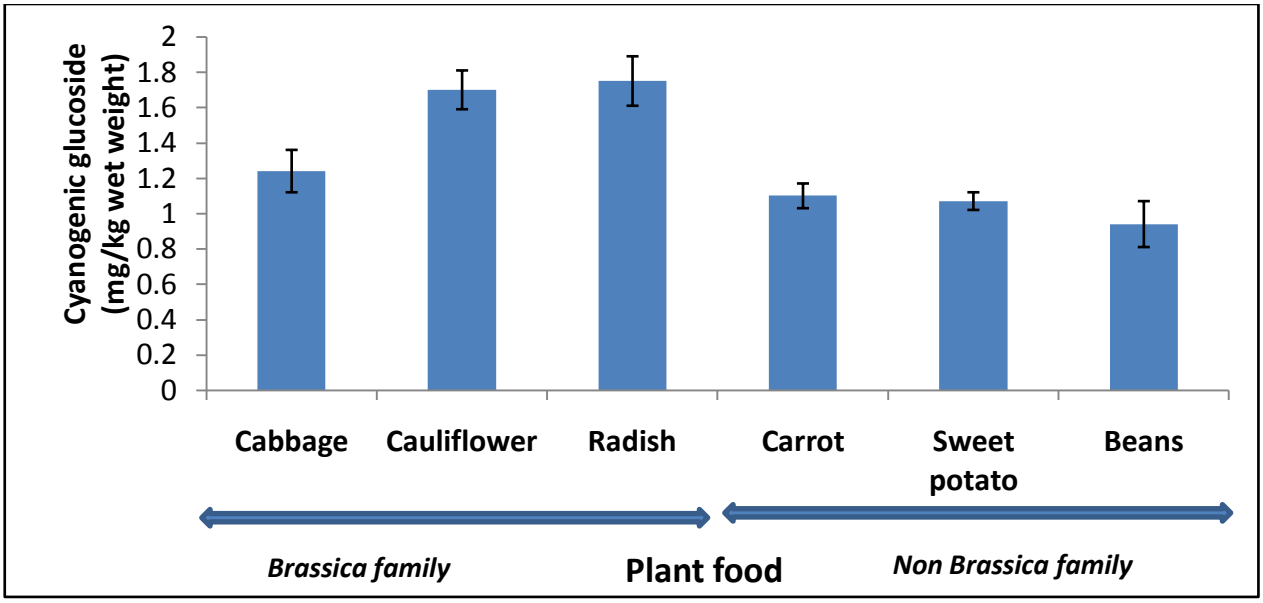


Figure 2: Glucosinolate content in selected plant food from Siddharthnagar of sub-Himalayan Tarai region in Eastern Uttar Pradesh

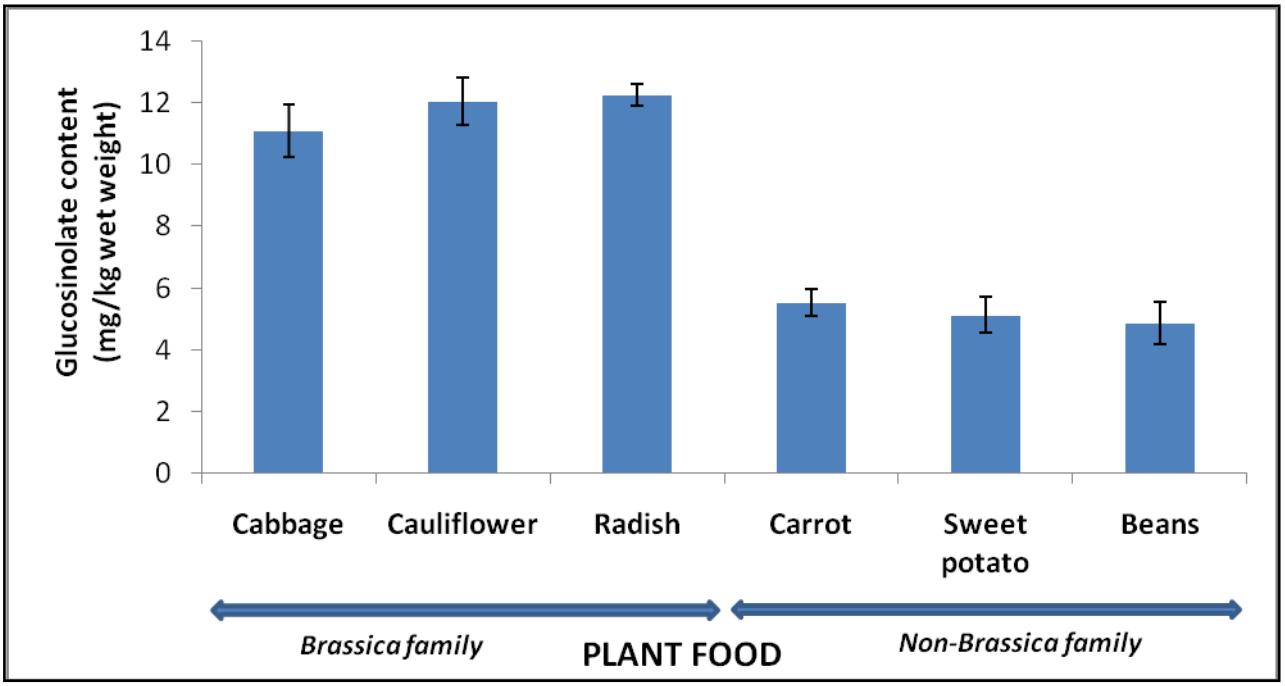
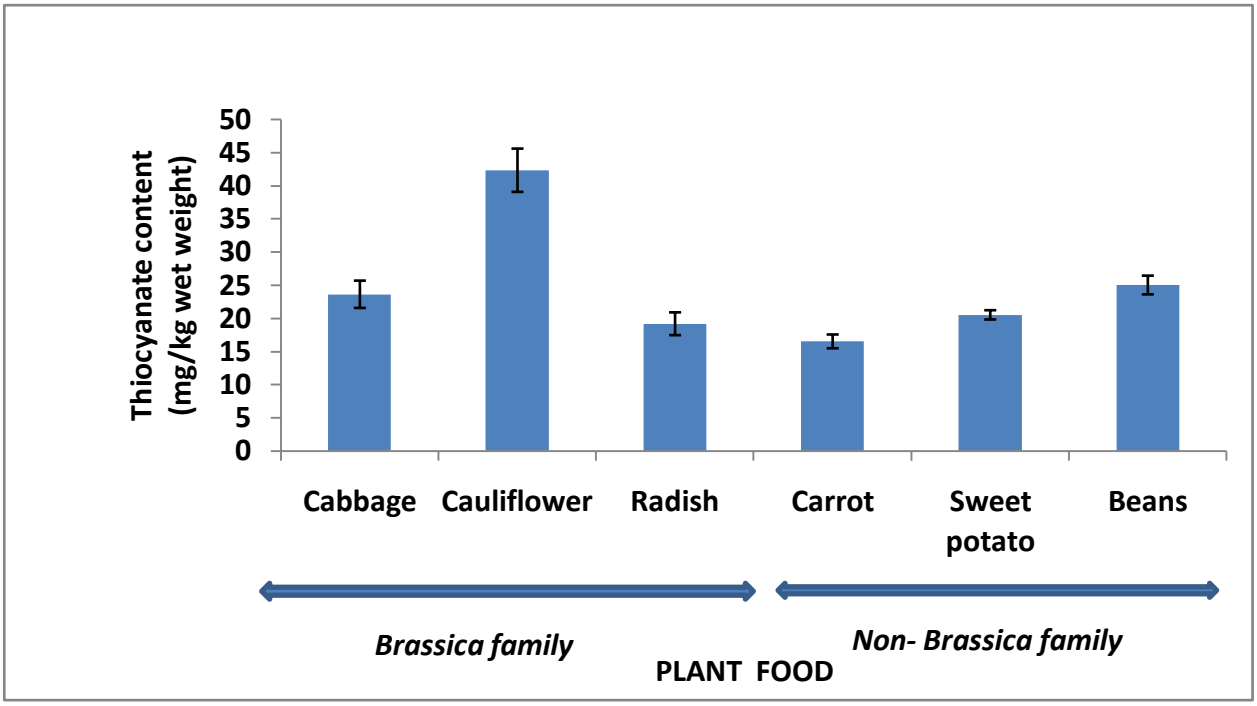


Figure 3: Thiocyanate content in selected plant food from Siddharthnagar of sub-Himalayan Tarai region in Eastern Uttar Pradesh



DISCUSSION:

In India, consumption of cyanogenic plant as evidenced by urinary thiocyanate level is considered as one of the etiological factors for the persistence of residual goiter in post salt iodization phase [10]. Cyanogenic glucosides are composed of an alpha-hydroxynitrile type agyclone and a sugar moiety (mostly D-glucose). They are formed in the cytoplasm but stored in the central vacuoles while the degradating enzymes are attached to the outside of the cell wall. The tissue level compartmentation of cyanogenic glucosides and their hydrolyzing enzymes prevents large scale hydrolysis in intact plant tissue [11]. The enzyme β-glucosidase hydrolyses cyanogenic glucosides to yield 2-hydroxynitrile (cyanohydrins) and the later is further cleaved into the corresponding aldehyde or ketone and hydrogen cyanide (HCN) by hydroxynitrilelyase [11]. Glucosinolates are amino acid derived natural plant products containing sulfur and nitrogen. They are thioethers, consist of a sugar entity, b-D-thioglucose; with an ester bond to an organic aglycone. Glucosinolates are uniform class of naturally occurring compounds found exclusively in the plant kingdom throughout the Capparales order and only in limited number of dicotyledonous families mostly in the Brassicaceae, Capparaceae, and the Caricaceae [12]. Michajlovskij and Langer [13] found that the thiocyanate content of the Brassica plants was highest in spring and varied little in relation to the regions where grown, but did show a variation from plant to plant within a single field. Astwood [14] found that thiocyanate ion acted as a goitrogen only when the iodine content of the diet is low.

The information on the systemic quantification of different goitrogenic / anti-thyroid components of the vegetables containing cyanogenic constituents of Indian origin is scanty. Thiocyanate content of cauliflower, cabbage, cassava, mustard, radish and turnip were analyzed by National Institute of Nutrition (NIN) and was found to contain thiocyanate at varying concentration. Chandra *et al.* [15] measured cyanogenic glucoside, glucosinolate and thiocyanate content of common plant food *viz* cauliflower, cabbage, mustard, turnip, radish etc of Indian origin, collected from

West Bengal and Tripura. Comparing the present results with the earlier findings of Chandra *et al*. [15] it has been found that cyanogenic glucoside and glucosinolate content in cabbage and cauliflower of sub-Himalayan Tarai region is trivial less but comparatively high in radish. However, the thiocyanate content in common plant foods (both Brassica and non-Brassica family) of Tarai region is much higher than foods grown in geographical areas at the sea level . Marked variations were noted in the observations apparently for differences in genetic backgrounds and ecological factors and also for presentation of data.

CONCLUSION

Thiocyanate content of common vegetables in the studied sub-Himalayan Tarai region is high. Therefore it has been concluded that in addition to biochemical iodine deficiency, consumption of goitrogenic plant food with high thiocyanate content may play some important role for the persistence of endemic goiter during post salt iodization phase in the sub-Himalayan Tarai region. Further studies are required to identify the role of dietary goitrogens in etiopathogenesis of goiter in this studied region.

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REFERENCES

1. Gaitan E. Goitrogen in food and water. Annu Rev Nutr1990;10: 21-39.
2. Stoewsand GS. Bioactive organosulfur in Brassica oleracea vegetables- a review. Food Chem Toxicol 1995;33: 537-43.
3. Gaitan E, Nelson NC, Poole GV. Endemic goiter and endemic thyroid disorder. World J Surg 1991; 15: 205-215.
4. Chandra AK, Bhattacharjee A, Malik T, Ghosh S : Etiological factors for the persistence of endemic goiter in selected areas of Siddharthnagar district in Eastern Uttar Pradesh, India. J Pediatr Endocrinol Metab. 2009; 22(4):317-25.
5. Chandra AK, Bhattacharjee A., Malik T and Ghosh S. Goiter Prevalence and Iodine Nutritional Status of School Children in a sub-Himalayan Tarai Region of Eastern Uttar Pradesh. Indian Pediatrics 2008; 45: 469-474.
6. Lambert JL, Ramasamy J, Paukestelis JV. Stable reagent for the colorimetric determination of cyanide by modified Koning reactions. Anal Chem 1975; 47: 916-8.
7. Gmelin R, Virtanen AI. The enzymatic formation of thiocyanate(SCN) from a precursors in Brassica species. Acta Chem Scand 1960; 14: 507-12.
8. Aldridge WN : The Estimation of Micro Quantities of Cyanide and Thiocyanate. Analyst London 70, 1945; Pp: 474-5.
9. Michajlovskij N, Langer P: Studien uber benzie hungen zwischen rhodanbildung and kropfbildender eigenschaft von nahrungsmitteln. In: Gehalt Einiger Nahrungs Mittel an Praformierten Rhodanid. Hoppe Seyless. Z Physiol Chem: 1958; Pp:26-30.
10. Marwaha RK, Tandon N, Gupta N, Karak AK,Verma K, Kochupilai N. Residual goiter in the post-iodization phase:iodine status, Thiocyanate exposure and autoimmunity. Clin Endocrinol 2003;59(6): 672-681.

11. Vetter J. Plant cyanogenic glycosides. Toxicon 2000; 38(1): 11-36.

12. Fahey JW, Zalcmann AT, Talalay P. The chemical diversity and distribution of glucosinolates and isothiocyanates among plants. Phytochemistry 2001; 56(1): 5-51.

13. Michajlovskij N. & Langer P. Studien uber Beziehungen zwischen Rhodanidbildung und kropfbildender Eigenschaft von Nahrungsmitteln, III. Zeitschrift. Journal of Physiologische Chemie 1959; 317: 30–33.

14. Astwood EB, Monte AG, Martin G.E. The antithyroid factor of yellow turnip. Science 1949; 109-631.

15. Chandra AK, Lahari D, Mukhopadhyay S, Tripathy S. Goitrogenic content of cyanogenic plant foods of Indian origin and their anti-thyroidal activity in vitro. Indian J Med Res 2004; 119: 180-185.

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