**Assessment of the effect of thiocynate in iodine disorders (IDD) in Calabar South and Obanliku Local Government Areas, Cross River State, Nigeria**

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**Abstract**

The aim of this study was to assess the implication of thiocyanate in iodine deficiency disorders (IDD) in Obanliku and Calabar South local government areas, Cross River State. Data was analyzed using atomic Spectroscopy and high-performance Liquid chromatographic methods. High range concentrations of thiocyanate (SCN) (0.1165 ± 0.0092 to 0.4870 ± 0.000 mg/dl) and low iodine (12.07 ± 0.000 to 52.22 ± 5.699 mg/dl) were recorded in Obanliku. A low concentration of thiocyanate (0.013 ± 0.000 to 0.192 ± 0.000 mg/dl) and high iodine (48.180 ± 2.065 to 59.630 ± 0.000 mg/dl) was recorded in Calabar South. The concentration of thiocyanate in girls of 9-20 years was a bit higher than in boys of the same age range. There was an increase in thiocyanate with respect to age, most especially in females. The highest concentration of thiocyanate (0.4870 ± 0.000 mg/dl) was recorded in 50-60 years of age in Obanliku. Assessment of thiocyanate in these populaces has shown that it is the major thyroid inhibitor in iodine synthesis in humans. ANOVA shows a significant difference (P < 0.05) in the thiocyanate concentrations in Obanliku and Calabar South. ANOVA also indicates a significant difference (P < 0.05) in the concentrations of iodine in Obanliku and Calabar South. Therefore, we recommend that Iodine be adequately consumed in food in the northern region of the state to prevent ataxic polyneuropathy (goitre). The fermentation period of cassava should be increased beyond 48 hours to reduce cyanogenic glycoside. Non-governmental Organizations (NGOs) and individuals should mount aggressive campaigns to sensitize and educate the peasant farmers, cassava millers and traders on the risks involved in consuming high cyanide concentrations in foods.

**Key words**: Thiocyanate; Cyanide; Iodine Deficiency Disorder (IDD); Ataxic Polyneuropathy (goitre); Thyroid.

***Introduction***

Thiocyanate is a ubiquitous metabolite in man and animals, consuming plants containing cyanogenic glycosides and thioglycosides or glucionates (Chandra 2015). Iodine has been present in the earth’s crust since its origin and is an essential constituent of thyroid hormone requires in trace amounts (Chandra 2015). Iodine is essential for thyroid hormone synthesis while thiocyanate prevents thyroid hormone synthesis. As a result, thyroid’s physiological rather functional status is very much dependent on the balance between these ions because of their similar ionic volume and charges and competition at different steps in thyroid hormone-biosynthesis**.** In the thyroid gland iodine is an indispensable constituent for synthesizing the thyroid hormone, thyroxine (T4) and triiodothyronine (T3) which are essential for normal growth and physical and mental development in humans and animals. The most familiar effect of iodine deficiency is goitre (enlargement of the thyroid gland), with a number of physiological disorders on the foetus, neonate, child, adolescent and the adult in the whole population collectively termed iodine deficiency disorders (IDD) (James, 1999).

The role of iodine deficiency as an environmental determinant in the development of endemic goitre is established. However, many environmental agents interfere with thyroid gland morphology and function, acting directly on the gland or indirectly by altering the regulatory mechanism of the thyroid gland. The pseudo halide thiocyanate impairs the uptake and utilization of iodine, by the thyroid gland (SCN-) (Chandra *et al.,* (2009). Thiocyanate is formed from cyanogenic substances. It is metabolized in thyroid gland. The role of thiocyanate ion in the homeostasis of the thyroid is a provocative issue where IDD persists despite adequate iodine intake and the consumption of cyanogenic plant food is relatively high (Chandra *et al*., (2008). Both iodine and thiocyanate enter the body/thyroid gland through food and water. Thiocyanate in relatively higher concentration regulates the uptake, efflux, organification of iodide, thyroid peroxidase activity and thyroid hormone biosynthesis. In addition, the retaining capacity of iodide in the thyroid gland and body also depends on thiocyanate concentration. In other words, the excretion of iodine is related to thiocyanate concentration.

In Nigeria, especially Cross River State Northern Senatorial District, the consumption of cyanogenic food (thiocyanate precursor) such as Garri, Chips, Fufu/Akpu, Tapioca and Cassava flour is relatively high and many regions are environmentally iodine deficient therefore, the people are at the risk of iodine deficiency disorders (IDD). Pregnant, lactating and women of the childbearing age group are the most vulnerable group to IDD because the neuronal development of the fetus and neonate are greatly affected even in mid to moderate iodine deficiency Chandra *et al*., (2006). In the semi-arid region, the consumption of cyanogenic food is the cause for the development of goitre and associated iodine deficiency disorders (IDD) Lakshmy *et al*., (1995). Studies have shown that cassava, a staple diet in most regions, has definite anti-thyroid action in humans and animals, resulting in the development of endemic goitre and cretinism. This action is due to the endogenous release of thiocyanate (SCN) from linamar, a cyanogenic glucoside contained in cassava. Although cassava is consumed on a large scale within the tropics, goitre and cretinism are not found in all populations where cassava is the staple food.

One possible explanation for cassava's lack of goitrogenic action in some populations may be that they have a high iodine intake (Delange et al., 1980). The development of goiter is critically related to the balance between dietary supplies of iodine and thiocyanate. Under normal conditions, the urinary excretion of iodine (UEI) and thiocyanate (UESCN) or UEI/ UESCN or I/SCN is higher than 7. Endemic goiter develops when it reaches a critical threshold of about 3 and becomes hyperendemic, complicated by endemic cretinism when it is lower than 2 Delange *et al*., (1980). Cassava contains high cyanide. Cyanide in trace amounts is almost ubiquitous in the plant kingdom and occurs mainly in the form of cyanogenic glucosides and glucosinolates (thioglucosides); both are nitrogen containing secondary metabolites that share a number of common features. They derive biogenetically from amino acids and occur as glycosides stored in vacuoles. They function as prefabricated defense compounds that are activated by the action of a β-glucosidase in case of emergency, releasing the deterrent (toxic cyanide from cyanogens or isothiocyanates) from glucosinolates (Conn, 1981).

When herbivores and other organisms wound the cyanogenic plants, the cellular compartments are broken down, and the cyanogenic glucosides come in contact with an active β-glucosidase having broad specificity, which hydrolyses them to yield 2-hydroxy nitrile (cyanohydrin) that is further cleaved into the corresponding aldehyde or ketone and HCN by a hydroxy nitrile lyase. HCN is highly toxic for animals and microorganisms due to its inhibition of cytochrome oxidases (respiratory chain) and binding to other enzymes containing heavy metal ions. The lethal dose of HCN in man is 0.5-3.5 mg/kg after oral administration and death of animals or man reported after the consumption of plants with cyanogenic glycosides, whose concentrations can be up to 500 mg HCN/100 g seeds. Normally 50-100 mg HCN/100g seeds and 30-200 mg/100 g leaves have been reported (Teuscher, 1994).

Animals can rapidly detoxify small amounts of HCN by rhodanese. A number of herbivores can tolerate HCN at rest in lower concentrations Seigler (1991). Cyanogens are active and potent chemical defense compounds. HCN is toxin for plants which synthesize them. To prevent autotoxicity, a detoxification pathway exists - HCN combines with L-cysteine to yield 3-cyano-alanine by β- cyanoalanine synthase, cyanoalanine is hydrolyzed by β-cyanoalanine hydrolase to L-aspargine. β- cyanoalanine synthase occurs in all plants but is likely more in strongly cyanogenic species (Conn, 1981). There is a cycle of iodine in nature. Most iodine is present in oceans. It was present during the primordial development of earth, but wind, rivers and floods carried large amounts into the sea. Iodine occurs in the deeper layers of the soil and is found in oil-well effluents. Water from deep wells can provide major source of iodine. In general, the older and explored soil surface the more likely it is to be leached of iodine. The dietary source of iodine is the food crops grown in these regions and drinking water. Meat, fish and dairy products are also the main sources of iodine. In the sea, fish and seaweeds contain high amounts of iodine (Umenwanne, 2000). Supplementations of iodine through salt, water, and bread are the additional sources of iodine, especially in the deficient area (Hetzel, 1989).

Cross River State of Nigeria was in the goiter-endemic or goiter belt of Nigeria before Universal Salt Iodization (USI) was introduced in 1996 (Sabina, 2008). Thiocyanate is produced in cassava, the major staple food in Africa and the world. Goiter, an indicator of chronic iodine deficiency, is a major public health problem for populations living in iodine-deficient environments (Ihenkoronye *et al*., 1985). Based on her geographical location, Cross River State of Nigeria encompasses regions of environmental and nutritional iodine deficiency and sufficiency. While the state's northern region belongs to the mountainous belt with poor soil and food iodine content, the southern region is close to the sea with the potential of environmental iodine sufficiency. Both clinical and epidemiological studies have shown that endemic goitre and its sequelae such as toxic multinodular goitre tend to be more prevalent among individuals living in areas with environmental iodine deficiency, especially women folk (Ekpechi 1967; Vanderpas 2006; Okpara *et al*., 2017). Low or excessive food intake with thiocyanate causes giotre in people (Ekpechi, 1967). This study aimed to assess thiocyanate as a precursor of iodine deficiency disorders (IDD) in Obanliku and Calabar South local Local Government areas of Cross River State.

***Literature Review***

Meat, fish and dairy products are also the main sources of iodine. Sea fish and seaweeds contain high amounts of iodine (Umenwanne, 2000). Supplementations of iodine through salt, water, and bread are the additional sources of iodine, especially in the deficient area (Hetzel, 1989). Smith and Malcolm (1930) researched the urinary Sulphur and thiocyanate excretion in cyanide poisoning. In their study, they monitored the changes in urinary sulphur and nitrogen excretion in rabbits on a constant diet, subjected to hydrocyanic acid vapour in closed cages, over some weeks. The neutral sulphur was relatively and absolutely increased on cyanide administration, the increase is approximately accounted for the excretion of thiocyanate. The rise in neutral Sulphur excretion was usually accompanied by a corresponding fall in organic Sulphate Sulphur, which equalled or surpassed the rise. The cyanide solution administered to rabbits by slow intravenous injection was recovered in the urine as Thiocyanate, in proportions varying from 61-100 percent, with an average of 72 percent of the amount injected. When Thiocyanate was injected as such, from 64 to 100 percent, with an average of 80 percent recovered in urine. They believed that the increase in urinary excretion of neutral or un-oxidized sulphur in cyanide poisoning is due primarily to the detoxication process rather than to depressed oxidation. They suggested that if thiocyanate formation is not the only method of cyanide detoxication, other processes are very secondary in importance to it.

Mowang *et al.,* (2017) studied the cyanide content of some cassava produce sold in Calabar, Cross River State. In their research, the yellow garri concentration of cyanide across months recorded no significant differences (p>0.05). The same in the white garri recorded no significant difference like- wise, the starch recorded no significant difference (p>0.05). But there was a significant difference (p<0.05) in the concentration of cyanide in yellow garri, white garri and edible starch, across months. The cyanide concentration in white garri was higher than yellow garri and edible starch. The cyanide concentration in these cassava products was in the order of edible starch <yellow garri <white garri. The results, however, were below WHO/FAO standard for cyanide in food. Sabina *et al*., (2008) studied the adequacy of Dietary Iodine in Two Local Government Areas of Cross River State in Nigeria in their study revealed that the Cross River State of Nigeria was in the goiter-endemic or goiter belt of Nigeria before the introduction of Universal Salt Iodization (USI) in 1996.

After several years of availability and consumption of iodized salt in Nigeria, it has become necessary to revisit some of these previously goitre endemic areas to measure the effect of USI on iodine nutrition, especially since goitre has not completely disappeared. This study was therefore initiated to assess the current iodine status of the population in relation to the USI programme in the state. Primary school children aged 8-12 were recruited from ten schools in two Local Government Areas (LGA) in the Cross River State, using a simple random sampling technique. Casual, on-the-spot urine samples were collected from the children and analyzed for urinary iodine using the ammonium sulphate method. Salt samples were also collected from the children's households in the study and analyzed for iodine content using titrimetric method. Four hundred school children participated in this study, 200 (50%) were males and 200 (50%) were females. One hundred and eighty-eight (47%) were 12 years old, while 95 (23.8%), were 11 years old, 80 (20%) were 10 years old, 32 (18%) were 9 years old and 5 (1.2%), were 8 years old. Median urinary iodine in these school children was 65Ã‚Âµg/l. Ninety-nine (24.75%), had a median urinary iodine of 100-299 Ã‚Âµg/l consistent with adequate iodine intake, while 136 (34.0%) had a median urinary iodine of 50-99 Ã‚Âµg/l suggesting mild iodine deficiency. Only 92 (23%) of the children had a mean urinary iodine level less than 20 Ã‚Âµg/l, which is consistent with severe iodine deficiency, while 73 (18.25%) of them were moderately deficient (20- 49 Ã‚Âµg/).

However, the analysis of the table salt from the households showed that 74% consumed salts with adequate iodine content of greater than 15ppm. In conclusion, the apparent contradiction between the adequacy of table salt iodization and urinary iodine levels suggests the possible existence of factors such as improper use of table salt, poor handling by the retailers, high goitrogen content in the diets and cooking methods. Fao (1990) revealed that symptoms of acute cyanide intoxication appear four or more hours after ingesting raw or poorly processed cassava, such as vertigo, vomiting and collapse. More so, chronic low-level cyanide exposure is associated with the development of goiter with tropical atomic neuropathy, a nerve-damaging disorder that renders a person unsteady and uncoordinated. Severe cyanide poisoning, particularly during famines, is associated with outbreaks of a debilitating irreversible paralytic disorder called konzo and, in some cases death. In their work, Oluwole & Oludiran (2013), normative concentrations of urine thiocyanate in cassava-eating communities in Nigeria. They opined that exposure to cyanide is a major public health problem where highly cyanogenic cassava foods are consumed. They estimated that thiocyanate (SCN), the biomarker of exposure to cyanide, is present in several foods and is produced endogenously. Concentrations of urine thiocyanates were measured in endemic and non-endemic areas of ataxic polyneuropathy in Nigeria.

Cassava food consumption in the endemic area was twice that of non-endemic regions. Exposure to cyanide is a major public health problem where highly cyanogenic cassava foods are consumed. Geometrical mean (95% CI) urine SCN was 20 µmol/l (18-24) for no consumption of cassava foods, 56 µmol/l (49-64) for daily consumption, 56 µmol/l (48-65) for twice daily consumption and 85 µmol/l (62-117) for thrice daily consumption. 95th percentile reference limit was 125 µmol/l for no consumption of cassava food but 360 µmol/l for thrice daily consumption. Urine SCN is a useful biomarker of exposure to cyanide from cassava foods. There is a strong ecological association between exposure to cyanide and endemicity of ataxic polyneuropathy. Yukiko *et al*., (2004) investigated the accumulation of cyanide and thiocyanate in haemodialysis patients.

In this study, they used high-performance liquid chromatography to measure cyanide in erythrocytes and thiocyanate in plasma in H3HD patients and in a group of 46 healthy controls that included 15 current smokers. They also measured the level of cysteine and sulfate to clarify the metabolic conversion of cyanide of thiocyanate in uremic patients. Then they used stepwise regression analysis to analyze the factors that determine erythrocyte cyanide and thiocyanate. They found that mean cyanide and plasma thiocyanate were significantly greater in HD patients than in non-smoking controls; however, cyanide was far below lethal concentrations in dialysis patients. Thiocyanate was six to seven times greater in HD patients than in non-smoking controls and decreases in thiocyanate in controls, but a negative correlation in HD patients. An inverse relationship between thiocyanate and BUN was also observed in patients. They include that the elevation of thiocyanate in patients undergoing dialysis is probably secondary to both limited efficiencies of HD and deranged metabolism of cyanide and thiocyanate and because thiocyanate is the preferred substrate from MPO, it may play a role in uremic complications including cardiovascular events.

Machly and Swenson (1970) investigated cyanide and thiocyanate levels in blood and urine of workers with low-grade exposure to cyanide. Their study was aimed at determining the concentrations of free cyanide in the blood and urine, as well as the levels of “free” thiocyanate and “total” thiocyanate in the urine of 140 volunteers. They identified four main categories of volunteers, which are: non- smokers, not exposed to cyanide, non-smokers exposed to various levels of cyanide in their occupation and smokers who were also exposed to cyanide. In their findings, the cyanide concentration in the blood did not show a clear relationship to either smoking or moderate occupational exposure; the levels were found to lie between 2.0 and 15.0 of free cyanide per 100ml of blood, with an average of 5.4mg for all categories of volunteer. They found out that the individual concentrations of free CN and CNS in the urine varied considerably and could not be used for detecting induced chronic exposure to cyanide at the concentrations encountered in the atmosphere. On the other hand, the average values varied in a regular pattern for each of the four categories identified. They discovered that smoking had a greater effect on the values obtained than the influence of atmospheric cyanide. They opined that concentrations CN’ and CNS’ in the urine are not appropriate tools for individual routine control of minor occupational exposure to cyanides because of the great variations caused by other factors.

However, non-smokers exposed to moderate cyanide levels in the air and any individual exposed to high cyanide levels slow higher than average values of CN and CNS in their urine. They concluded that the cyanide values they reported may be useful for the evaluation of analytical results from individual cases where poisoning from cyanide in the atmosphere is suspected. Harrison *et al*. (2009) reported that cyanide is a potent toxic agent in cigarette smoke, which is metabolized to thiocyanate through sulfureting with thiosulfate by mitochondrial rhodanse. It has been shown that urinary and/or serum thiocyanate levels among smokers are substantially higher than non-smokers.

Buratti *et al*., (1997), while working on the validation of urinary thiocyanate as a biomarker of tobacco smoking, described thiocyanate ion (SCN) as a major detoxication product of cyanides which is converted to SCN by a thiosulphate sulphur transferase, mainly in hepatic mitochondrial and identified factors that cause man exposure to low-level cyanide as dietary intake of cyanogenic glucosides, tobacco smoking, drug administration and occupational exposure to organic intrigues. In their research, they determined the urinary SCN concentration through a commercial kit to analyze cyanide in water. The collected spot urine samples at 7:30h and 12:30h from 99 healthy male white collar office smokers (non-smokers n=72; smokers n=27). Comparison of SCN excretion values did not show any significant difference between the morning 24 µmol/l and was statistically different from that of smokers (92 µmol/l) (P < 0.001). In smokers, median levels of SCN increased with the intensity of tobacco smoking and SCN individual excretion rose in relation to the number of cigarettes smoked daily. In the group of investigated subjects, SCN excretion correlated with urinary cotinine, a well- known biomarker of tobacco consumption (Jain, 2016). When they applied this assay as a smoking habit screening test, with a cut-off value of SCN-38 µmol/l adopted to discriminate between non- smokers and smokers, the following smoker track down predictive values resulted in 93% negative for non-smokers and 96% positive for smokers.

Potter *et al.,* (2001) studied urinary thiocyanate levels as a biomarker for generating inorganic cyanide from benzyl cyanide in the rat. In their study, they developed a colorimetric procedure for determining thiocyanate in rate urine over the concentration range of 7-7000 micro (g). They applied this procedure to determining thiocyanate after its oral administration to male and female rats. The mean percentage urinary recoveries of sodium thiocyanate given by oral gavage at 10 and 100mg/kg were 60 and 39% per male rats and 89 and 73% for females over 3 days. Most of the elimination occurred in the 0-48h period post-dosing but significant amounts were still excreted in the 48-72h period. From these results, they concluded that the recoveries of urinary thiocyanate were such that this union was suitable for use as a biomarker for the release of cyanide from organonitrites such as benzyl cyanide. Also, benzyl/cyanide (150 mg/kg) administered orally to rats led to markedly increased urinary thiocyanate levels for male rats. This was equivalent to 54% of the dose for females, and this was 65% over 3 days. When adjusted for incomplete recoveries of the marker, thiocyanate and these values equated to 61 and 89% respectively. They concluded that this validated essay could be used to assess cyanide release from topically applied fragrance organonitrites.

Eminedoki *et al*., (1994) studied thiocyanate levels of mainly dietary origin in serum and urine from a human population sample in Port Harcourt, Nigeria. They opined that thiocyanate levels were determined in serum and urine samples obtained from a human population sample of healthy non- smoking volunteers (aged between 14 and 30 years) of both sexes known to eat garri-based meals at least once daily. The samples collected before the test meals showed a wide variation, ranging between 39.20+/-1.95 to 160.95+/-9.78 to 294.01+/-14.70 µmol/l of urine. For each volunteer, the serum and urine thiocyanate were affected by the test meals. Average increase of 18 and 20% were observed for serum and urine thiocyanate following a garri-based meal. On average, a rice-based meal produced a 10% decrease in serum and urine thiocyanate. No significant effect on sex or age on the thiocyanate levels was observed. Dorea and CollNutrs (2004) studied maternal and thyroid status during breast-feeding. They investigation revealed that cyanogenic glucosides are naturally present in plant foods especially in staple foods (cassava) which are consumed by millions of people in tropical countries. Existing metabolic pathways rapidly metabolize residual cyanide (CN) to thiocyanate (SCN). SCN adverse effects are commonly observed in relation to cigarette smoking. In their study, they also found out that breast feeding effectively protects infants from the anti-thyroid effects of eventual or chronic maternal exposure to CN exposure in food (Cassava) or recreation habits (Cigarette smoking). SCN goitrogenic effects occur secondary to iodine deficiency in special circumstances of high consumption of incomplete detoxified cassava and insufficient protein intake. They concluded that only during inadequate protein nutrition can SCN aggravate endemic iodine-deficient disorder (IDD).

Yong *et al.,* (2017) Investigated the concentration of thiocyanate ions in row cow milk from China, New Zealand and the Netherlands. Their study revealed that thiocyanate ions are natural component of cow milk which may be artificially augmented to activate the lactoperoxidase milk preservation system. They present a survey of thiocyanate levels in raw milk and propose a naturally occurring baseline concentration of thiocyanate in milk, which is the basis for market supervision. They concluded that the baseline concentration of thiocyanate in raw cow milk was statistically calculated and rounded to 9.0 mg/kg. Thiocyanate in milk at this level does not present a food safety concern. Cultivators can produce as little as 20 milligrams of cyanide (CN) per kilogram of fresh roots. While bitter ones may produce more than 50 times (1g/kg). Their studies also reported that cassava contains naturally occurring, but potentially toxic compounds called cyanogenic glycosides, which release hydrogen cyanide (HCN) due to enzymatic hydrolysis following maceration of the plant tissue. Cassava grown during drought is especially high in these toxins.

***Methodology***

**Study Area**

The study was conducted in Obanliku and Calabar South Local Government Areas of Cross River State, Nigeria. It has an area of 1,057 Km2 and a population of 110, 324 at the 2006 census. Obanliku lies within 6.53440N, and 9.32290E. At the same time, Calabar South is one of the Local government areas in Calabar City, the State capital of Cross River State, Nigeria. Calabar South lies on lat. 4o 57´ N & Longitude 8o19´E.

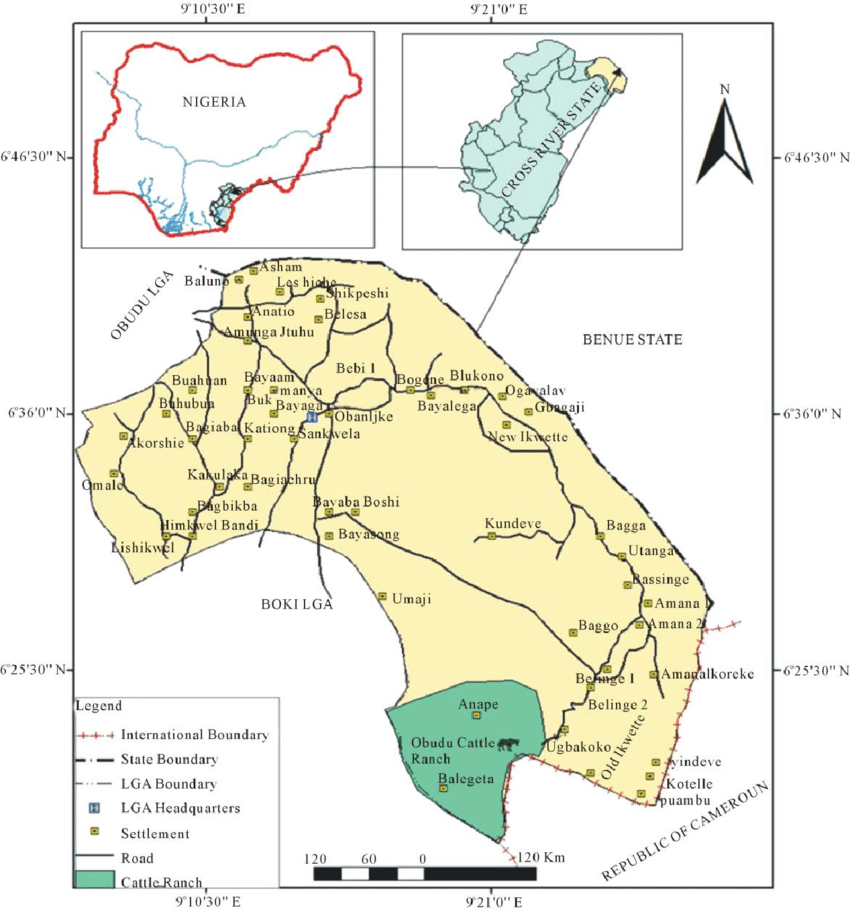


Figure 1: Map of Obanliku Local Government Area

Source: Cartography lab, Dept. of Geography and Environmental Science, University of Calabar

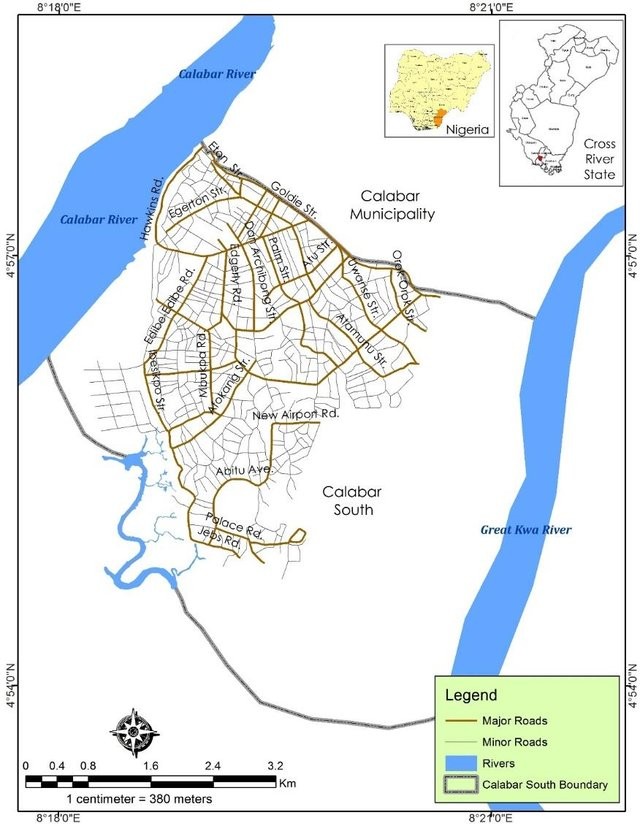


Figure 2: Map of Calabar South Local Government Area

Source: Cartography lab, Dept. of Geography and Environmental Science, University of Calabar

### Sample Collection

Three hundred (300) urine samples were collected in the two regions. One hundred and fifty urine samples were randomly collected from each local government. These were collected from school children, women and Men in Obanliku and Calabar South Local Government Areas. It was collected in the morning between 7 and 9.am. Urine specimen bottles were used in the collection. The samples were sealed, properly labelled, preserved in iced coolers and transported to the University of Calabar Teaching Hospital (UCTH) for analysis.

### Determination of Iodine in Urine Using Atomic Spectroscopy

Atomic spectroscopy by PerkinElmer Shelton (C7 model 460) was used. A sample was aspirated into the furnace chambers, as light is emitted on the sample, it dissociates into ions, absorbs heat and moves to an unstable state. The absorbed heat sample is converted from aerosol to vapour to enable heat absorption. As the concentration of atoms in the light path increases the amount of light absorbed also increases. At this point, measurement is determined quantitatively. The urine sample is diluted 1:10 with 0.5% weighted by volume (w/v) Lanthanium diluent or distilled water. The diluted urine sample is then aspirated into the equipment at a wavelength of 303.9 nm and the concentration is recorded in mg/dl.

### Determination of Thiocyanate in Urine Using High-Performance Liquid Chromatographic Method and Picrate Kit-Methods

Samples were diluted with H20 1:10 dilution and the diluted samples were passed through a disposable Toyo pack comprising of ODS (Octadecyl Silane) and IC-SP (Ion chromatography Sulfopropyl type column). This equipment suppresses ion chromatography with conductivity detection. This was confirmed using the Picrate-Kit method as follows. The Picrate-Kit method determines the level of thiocyanate in the urine based on the quantitative oxidation of thiocyanate in acid permanganate at room temperature in a closed vial with the liberation of HCN, which reacted with a picrate paper for semi-quantitative analysis, the coloured picrate paper was used to match with a colour chart prepared using known amounts of KSCN. The results were obtained by elution of the coloured complex in water and measurement of the absorbance at 510nm. Over the range 0-10mg/dl, the equation gives a linear relationship: thiocyanate content (0.1mg/dl) = 78 x absorbance.

***Statistical Analysis***

Apart from the routine calculation of mean and standard deviation, other statistical methods, such as ANOVA (analysis of variance) was used to analyze the data.

***Urine Analysis of Thiocyanate and Iodine Among School Children and Adults in Calabar South****.*

In Calabar South, analysis of urine of males of age ranged 9 -12 years recorded 0.050 ± 0.0683 mg/dl (SCN) and 54.008 ± 4.0855 mg/dl (Iodine). The females of age ranged 9-12 years recorded 0.036 ± 0.0324 mg/dl of SCN and 52.588 ± 2.9651 mg/dl of Iodine (Table 1). In Calabar South, urine analysis of males between the age of 13-16 years recorded 0.063 ± 0.0858mg/dl (SCN) and 51.614 ± 3.8052 mg/dl (Iodine). The females within the age bracket of 13-16 years recorded 0.028 ± 0.0101 mg/dl of SCN and 53.122 ± 3.2526mg/dl of Iodine (Table 2). However, urine analysis of males of age 17-20 years recorded 0.067 ± 0.0878 mg/dl (SCN) and 51.483 ± 3.4012 mg/dl (Iodine). The females within the age of 17-20 years recorded 0.013 ± 0.0000 mg/dl of SCN and 59.630 ± 0.0000 mg/dl of Iodine (Table 1). The adult males and females of age ranged 21-25years recorded 0.174 ± 0.0552 mg/dl and 0.015 ± 0.0000 mg/dl of SCN respectively and 52.837 ± 4.7607mg/dl and 49.980 ± 0.0000 mg/dl of Iodine respectively (Table 1). The adult males and females between the age range of 26-30 years recorded 0.119 ± 0.0941mg/dl and 0.149 ± 0.1626 mg/dl of SCN respectively and 48.180 ± 2.0648 mg/dl and 52.350 ± 2.4325 mg/dl of Iodine respectively. In the same vein, urine analysis of males of age 31-35 years recorded 0.047 ± 0.0233mg/dl (SCN) and 53.950 ± 4.8243 mg/dl (Iodine). The females age range of 31-35 years recorded 0.192 ± 0.0000 mg/dl of SCN and 44.560 ± 0.0000 mg/dl of Iodine (Table 1).

The urine analysis of males aged 36-40 years recorded 0.036 ± 0.0138 mg/dl (SCN) and 57.257 ± 2.2964 mg/dl (Iodine). The females between the age range of 36-40 years recorded 0.035 ± 0.0000 mg/dl of SCN and 53.830 ± 0.0000 mg/dl of Iodine. The urine analysis of males between the age of 41- 45years recorded 0.062 ± 0.0000mg/dl (SCN) and 58.240 ± 0.0000 mg/dl (Iodine). The females within the age range of 41-45 years recorded 0.105 ± 0.0765 mg/dl of SCN and 51.063 ± 2.3451mg/dl of Iodine (Table 1). The urine analysis of males aged 46-50 years recorded 0.039 ± 0.0000 mg/dl (SCN) and 49.820 ± 0.0000 mg/dl. (Iodine). The females aged 46-50 years recorded 0.132 ± 0.1044 mg/dl of SCN and 51.353 ± 6.6107mg/dl of Iodine. In another development, urine analysis of males of age 51- 55 years recorded 0.069 ± 0.0000 mg/dl (SCN) and 53.430 ± 0.0000 mg/dl. (Iodine). The females between the age range of 51-55 years and recorded 0.016 ± 0.0000 mg/dl of SCN and 52.510 ± 0.0000 mg/dl of Iodine. Finally, urine analysis of males aged 56-60 years recorded 0.023 ± 0.0000 mg/dl (SCN) and 51.621 ± 0.0000 mg/dl. (Iodine). The females within the age range of 56-60 years recorded 0.090 ± 0.0354 mg/dl of SCN and 54.450 ± 1.6405 mg/dl of Iodine.

Table 1: Mean and standard deviation of thiocyanate (SCN) analysis and Iodine in Calabar South, calabar

**SEX**  **AGE-RANGE SCN Mean   ± SD** **IODINE Mean**   **± SD**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **(Mg/dl)** | | | | | **(Mg/dl)** | |
|  | |  | **School Children** | |  | |
| **Male** | | 9-12 | 0.050 ± 0.0683 | | 54.008 ± 4.0855 | |
| **Female** | | 9-12 | 0.036 ± 0.0324 | | 52.588 ± 2.9651 | |
| **Male** | | 13-16 | 0.063 ± 0.0858 | | 51.614 ± 3.8052 | |
| **Female** | | 13-16 | 0.028 ± 0.0101 | | 53.122 ± 3.2526 | |
| **Male** | 17-20 | | | 0.067 ± 0.0878 | 51.483 ± 3.4012 |
| **Female** | 17-20 | | | 0.013 ± 0.0000 | 59.630 ± 0.0000 |
|  |  | | | **Adults** |  |
| **Male** | 21-25 | | | 0.174 ± 0.0552 | 52.837 ± 4.7607 |
| **Female** | 21-25 | | | 0.015 ± 0.0000 | 49.980 ± 0.0000 |
| **Male** | 26-30 | | | 0.119 ± 0.0941 | 48.180 ± 2.0648 |
| **Female** | 26-30 | | | 0.149 ± 0.1626 | 52.350 ± 2.4325 |
| **Male** | 31-35 | | | 0.047 ± 0.0233 | 53.950 ± 4.8243 |
| **Female** | 31-35 | | | 0.192 ± 0.0000 | 44.560 ± 0.0000 |
| **Male** | 36-40 | | | 0.036 ± 0.0138 | 57.257 ± 2.2964 |
| **Female** | 36-40 | | | 0.035 ± 0.0000 | 53.830 ± 0.0000 |
| **Male** | 41-45 | | | 0.062 ± 0.0000 | 58.240 ± 0.0000 |
| **Female** | 41-45 | | | 0.105 ± 0.0765 | 51.063 ± 2.3451 |
| **Male** | 46-50 | | | 0.039 ± 0.0000 | 49.820 ± 0.0000 |
| **Female** | 46-50 | | | 0.132 ± 0.1044 | 51.353 ± 6.6107 |
| **Male** | 51-55 | | | 0.069 ± 0.0000 | 53.430 ± 0.0000 |
| **Female** | 51-55 | | | 0.016 ± 0.0000 | 52.510 ± 0.0000 |
| **Male** | 56-60 | | | 0.023 ± 0.0000 | 51.621 ± 0.0000 |
| **Female** | 56-60 | | | 0.090 ± 0.0354 | 54.450 ± 1.6405 |

SCN=Thiocyanate; SD= Standard Deviation

***Results: Thiocyanate and Iodine Concentrations in Obanliku and Calabar South.***

***Urine Analysis of Thiocyanate and Iodine Among School Children and Adults in Obanliku***

In Obanliku, urine analysis of males of age 9 -12 years recorded 0.1670 ± 0.0503mg/dl (SCN) and 42.43 ± 9.503 mg/dl (Iodine). The females of age ranged 9-12 years recorded 0.2017 ± 0.0405mg/dl of SCN and 37.04 ± 8.194 mg/dl of Iodine (Table 2). In the same vein, the analysis of urine of males of age ranged 13-16years recorded 0.1690 ± 0.2293mg/dl of SCN and 42.81 ± 9.614 of Iodine, while that of females recorded 0.2272 ± 0.1857 mg/dl of SCN and 26.97 ± 4.598mg/dl of Iodine. Females aged 13- 16 years recorded 0.2272 ± 0.1857mg/dl and 26.97 ± 4.598mg/dl of SCN and Iodine respectively. The males aged 17 – 20 years recorded 0.1525 ± 0.1485mg/dl of SCN and 49.70 ± 0.891mg/dl of Iodine. Females between the age range of 17 – 20 years recorded 0.1640 ± 0.1131mg/dl of SCN and 47.51 ± 0.700mg/dl of Iodine (Table 2). The male adults between 21-25 years recorded 0.1350 ± 0.0000 mg/dl of SCN and 47.63 ± 0.000 mg/dl of Iodine While the females of the same age ranged recorded 0.1724 ± 0.0655 mg/dl SCN and 43.58 ± 4.945 mg/dl (Table 2). The male adults between the age range of 26- 30 years recorded 0.1460 ± 0.0000 mg/dl of SCN and 33.53 ± 0.000 mg/dl of Iodine, while the females of age ranged 26–30 years recorded 0.1165 ± 0.0092 mg/dl SCN and 52.22 ± 5.699 mg/dl. However, males between the age range of 31-35 years recorded 0.1935 ± 0.0446 mg/dl SCN and 44.28 ± 6.859 mg/dl of Iodine. The females within the age bracket of 31-35 years recorded 0.2180 ± 0.0000 mg/dl SCN and 40.81 ± 0.000 mg/dl Iodine. The male adults between the age of 36-40 years recorded 0.1875 ± 0.0064 mg/dl of SCN and 52.34 ± 5.353 mg/dl of Iodine While the females of the same age ranged recorded 0.2280 ± 0.1174 mg/dl SCN and 37.46 ± 7.368 mg/dl (Table 2).

The males and females of age ranged 41 – 45 years recorded 0.2510 ± 0.0000mg/dl and 0.3810 ± 0.0000mg/dl of SCN respectively and 40.62 ± 0.000 mg/dl and 29.33 ± 0.000 mg/dl of Iodine respectively (Table 2). The males and females of age ranged 46-50 years recorded 0.1283 ± 0.0000 mg/dl and 0.4280 ± 0.0000 mg/dl of SCN respectively and 48.12 ± 0.000 mg/dl and 17.51 ± 1.202mg/dl of Iodine respectively. The males and females of age ranged 51-55 years recorded 0.1460 ± 0.0000 mg/dl and 0.4280 ± 0.0000mg/dl of SCN respectively and 42.67 ± 0.000 mg/dl and 16.10 ± 0.000 mg/dl of Iodine respectively. However, the males and females of age ranged 56-60 years recorded 0.1843 ± 0.0058mg/dl and 0.4870 ± 0.0000 mg/dl of SCN respectively and 47.39 ± 1.908 mg/dl and 12.07 ± 0.000 mg/dl of Iodine respectively (Table 2).

Table 2: mean standard deviation of analysis of Thiocyanate (SCN) and iodine in Obaliku

**SEX**  **AGE-RANGE SCN Mean   ± SD** **IODINE Mean**   **± SD**

|  |  |
| --- | --- |
| **(Mg/dl)** | **(Mg/dl)** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | | **School Children** |  |
| **Male** | 9-12 | | 0.1670 ± 0.0503 | 42.43 ± 9.503 |
| **Female** | 9-12 | | 0.2017 ± 0.0405 | 37.04 ± 8.194 |
| **Male** | 13-16 | | 0.1690 ± 0.2293 | 42.81 ± 9.614 |
| **Female** | 13-16 | | 0.2272 ± 0.1857 | 26.97 ± 4.598 |
| **Male** | 17-20 | | 0.1525 ± 0.1485 | 49.70 ± 0.891 |
| **Female** | 17-20 | | 0.1640 ± 0.1131 | 47.51 ± 0.700 |
|  |  | | **Adults** |  |
| **Male** | 21-25 | | 0.1350 ± 0.0000 | 47.63 ± 0.000 |
| **Female** | 21-25 | | 0.1724 ± 0.0655 | 43.58 ± 4.945 |
| **Male** | 26-30 | | 0.1460 ± 0.0000 | 33.53 ± 0.000 |
| **Female** | 26-30 | | 0.1165 ± 0.0092 | 52.22 ± 5.699 |
| **Male** | 31-35 | 0.1935 ± 0.0446 | | 44.28 ± 6.859 |
| **Female** | 31-35 | 0.2180 ± 0.0000 | | 40.81 ± 0.000 |
| **Male** | 36-40 | 0.1875 ± 0.0064 | | 52.34 ± 5.353 |
| **Female** | 36-40 | 0.2280 ± 0.1174 | | 37.46 ± 7.368 |
| **Male** | 41-45 | 0.2510 ± 0.0000 | | 40.62 ± 0.000 |
| **Female** | 41-45 | 0.3810 ± 0.0000 | | 29.33 ± 0.000 |
| **Male** | 46-50 | 0.1283 ± 0.0000 | | 48.12 ± 0.000 |
| **Female** | 46-50 | 0.3878 ± 0.0136 | | 17.51 ± 1.202 |
| **Male** | 51-55 | 0.1460 ± 0.0000 | | 42.67 ± 0.000 |
| **Female** | 51-55 | 0.4280 ± 0.0000 | | 16.10 ± 0.000 |
| **Male** | 56-60 | 0.1843 ± 0.0058 | | 47.39 ± 1.908 |
| **Female** | 56-60 | 0.4870 ± 0.0000 | | 12.07 ± 0.000 |

SCN=Thiocyanate; SD= Standard Deviation

***Urine Analysis of Thiocyanate and Iodine in Calabar South***

Analysis of urine samples collected from Calabar South shows that the sample contains highly reduced concentrations of thiocyanate (SCN) but increased iodine. This may be due to the location of Calabar South, which is Southern part of the state with enough iodine in soil, water, food and most importantly it could be because less cyanogenic food is consumed in Calabar south. Mowang *et al.,* (2017) studied the cyanide content of some cassava produce sold in Calabar Cross River State. In their research, the yellow garri concentration of cyanide across months recorded no significant differences (p > 0.05). The same in the white garri recorded no significant difference like- wise, the starch recorded no significant difference (p>0.05). But there was a significant difference (p < 0.05) in the concentration of cyanide in yellow garri, white garri and edible starch, across months. The cyanide concentration in white garri was higher than in yellow garri and edible starch. The cyanide concentration in these cassava products was in the order of edible starch <yellow garri <white garri. The results, however, were below WHO/FAO standards for cyanide in food. This is in agreement with the findings of Chandra *et al*., (2008) the role of thiocyanate ion in the homeostasis of the thyroid is a provocative issue where IDD persists in spite of adequate iodine intake and consumption of cyanogenic plant food is relatively high. Both iodine and thiocyanate enter the body/thyroid gland through food and water. Thiocyanate in relatively higher concentration regulates the uptake, efflux, organification of iodide, thyroid peroxidase activity and thyroid hormone biosynthesis. In addition, the retaining capacity of iodide in the thyroid gland and body also depends on thiocyanate concentration. In other words, the excretion of iodine is related to thiocyanate concentration.

In Nigeria, especially Cross River State Northern Senatorial District, the consumption of cyanogenic food (thiocyanate precursor) such as Garri, Chips, Fufu/Akpu, Tapioca and Cassava flour is relatively high and many regions are environmentally iodine deficient therefore, the people are the risk of iodine deficiency disorders (IDD). Studies have shown that cassava, a staple diet in most regions, has definite anti-thyroid action in humans and animals, resulting in endemic goiter and cretinism. This action is due to the endogenous release of thiocyanate (SCN) from linamarin, a cyanogenic glucoside contained in cassava. Even though cassava is consumed on a large scale within tropics, however goiter and cretinism are not found in all populations where the staple food is cassava. In the entire sample population of Calabar, iodine was very high. This could be the reason for lack of goitre among the people. This agrees with the findings of Delange *et al*., (1980) who stated that one possible explanation for cassava's lack of goitrogenic action in some populations might be that they have a high iodine intake. The development of goiter is critically related to the balance between dietary supplies of iodine and thiocyanate. Also, in Calabar South, the concentration of thiocyanate in girls of 9-20 years was a bid higher than boys of the same age range. This may be because iodine requirement for female children was higher than males, especially at the beginning of pubertal age. It may also be related to differences in sex hormones and pubertal growth patterns among boys and girls in higher age groups (Singh, 2010). However, ANOVA shows no significant difference (P > 0.05) between males and females of this age ranged in Calabar South. Still, there was a significant difference (P<0.05) between boys and girls of Calabar South and Obanliku.

There was an increase in thiocyanate with respect to age of females. There was no significant (P> 0.05) difference in the concentration of thiocyanate and iodine among males and females of aged 40 – 60 years in Calabar South. The concentrations of SCN in childbearing females were higher than that of teenagers. Though there was no increase in SCN among females in this region, but the highest concentration of thiocyanate was still recorded in 50-60 years of age. This agrees with the findings of Molla *et al*., (2014). Their study revealed that the prevalence of goiter was 98% higher among females than males in Northwest Ethiopia. However, the highest thiocyanates (SCN) with the lowest iodine in women's urines was recorded in age range 50-60 years. Malgorzata (2017) reported that thyroid diseases like hypothyroidism, nodular postmenopausal and cancer are especially frequent in postmenopausal and older women. The study reveals that a decrease in thiocyanate concentration in Calabar South leads to an increase in iodine concentration and vice versa. This decrease in thiocyanate ultimately enhances the synthesis of iodine in the body, resulting in less development of hypothyroidism (goiter) in the region. In their work, Oluwole & Oludiran (2013), normative concentrations of urine thiocyanate in cassava-eating communities in Nigeria. They opined that exposure to cyanide is a major public health problem where highly cyanogenic cassava foods are consumed. They estimated that thiocyanate (SCN), the biomarker of exposure to cyanide, is present in several foods and produced endogenously. Concentrations of urine thiocyanates were measured in endemic and non-endemic areas of ataxic polyneuropathy in Nigeria. Cassava food consumption in the endemic area was twice that of non- endemic regions. Exposure to cyanide is a major public health problem where highly cyanogenic cassava foods are consumed.

Analysis of some samples reveals that few men in Calabar south had increased thiocyanate and lower iodine concentration but not significant (P > 0.05) to females of the same region. This could be related to the habit of liking smoking, which increases SCN in body. These findings agrees with Buratti *et al*., (1997), while working on the validation of urinary thiocyanate as a biomarker of tobacco smoking, described thiocyanate ion (SCN) as a major detoxication product of cyanides which is converted to SCN by a thiosulphate sulphur transferase, mainly in hepatic mitochondrial and identified factors that cause man exposure to low-level cyanide as dietary intake of cyanogenic glucosides, tobacco smoking, drug administration and occupational exposure to organic intrigues. In their research, they determined the urinary SCN concentration through a commercial kit to analyse cyanide in water. The collected spot urine samples at 7:30h and 12:30h from 99 healthy male white collar office smokers (non-smokers n=72; smokers n=27). Comparison of SCN excretion values did not show any significant difference between the morning 24 µmol/l and was statistically different from that of smokers (92 µmol/l) (P < 0.001). In smokers’ median levels, SCN increased with the intensity of tobacco smoking and SCN individual excretion rose in relation to the number of cigarettes smoked daily.

In the group of investigated subjects, SCN excretion correlated with urinary cotinine, a well- known biomarker of tobacco consumption (Jain, 2016). When they applied this assay as a smoking habit screening test, with a cut-off value of SCN-38 µmol/l adopted to discriminate between non- smokers and smokers, the following smoker track down predictive values resulted in 93% negative for non-smokers and 96% positive for smokers. It also supports Eminedoki, *et al*., (1994), who studied thiocyanate levels of mainly dietary origin in serum and urine from a human population sample in Port Harcourt, Nigeria. They opined that thiocyanate levels were determined in serum and urine samples obtained from a human population sample of healthy non-smoking volunteers (aged between 14 and 30 years) of both sexes known to eat garri-based meals at least once daily. The samples collected before the test meals showed a wide variation, ranging between 39.20+/-1.95 to 160.95+/-9.78 to 294.01+/-14.70 µmol/l of urine. For each volunteer, the serum and urine thiocyanate were affected by the test meals. Average increases of 18 and 20% were observed for serum and urine thiocyanate following a garri-based meal. On average, a rice-based meal produced a 10% decrease in serum and urine thiocyanate. No significant effect of sex or age on the thiocyanate levels was observed. However, ANOVA shows no significant difference (P > 0.05) between males and females of this age range in Calabar South. Still, there was a significant difference (P<0.05) between boys and girls of Calabar South and Obanliku. There was an increase in thiocyanate concerning age of females. There was no significant (P > 0.05) difference in the concentration of thiocyanate and iodine among males and females of aged 40 – 60 years in Calabar South.

***Discussion****.*

***Urine Analysis of Thiocyanate and iodine in Obanliku***

Analysis of urine samples collected from Obanliku shows that the sample contains high concentrations of thiocyanate (SCN) and low iodine. This may be due to their staple food, cassava and its products, which contain cyanogenic glycoside. Cassava contains naturally occurring, but potentially toxic compounds called cyanogenic glycosides, which release hydrogen cyanide (HCN) as a result of enzymatic hydrolysis following maceration of the plant tissue (White, *et al*., 1998; Bahatia, 2012). This is in agreement with the findings of Uyoh *et al*., (2007), who reported that a food safety problem with cassava is it contains considerable quantities of cyanide, which occurs in the form of cyanogenic glycosides, primary linamarin and a small amount of lotaustralin. Mowang *et al.,* (2017) studied the cyanide content of some cassava produce sold in Calabar Cross River State. In their research, the yellow garri concentration of cyanide across months recorded no significant differences (P > 0.05). The same in the white garri recorded no significant difference likewise the starch recorded no significant difference (P > 0.05). But there was a significant difference (P < 0.05) in the concentration of cyanide in yellow garri, white garri and edible starch across months. The cyanide concentration in white garri was higher than in yellow garri and edible starch. The cyanide concentration in these cassava products was in the order of edible starch <yellow garri <white garri. Fao (1990) reported that chronic low-level cyanide exposure is associated with the development of goiter with tropical atomic neuropathy, a nerve- damaging disorder that renders a person unsteady and uncoordinated.

Severe cyanide poisoning, particularly during famines, is associated with outbreaks of a debilitating irreversible paralytic disorder called konzo and some cases death. In their work, Oluwole & Oludiran (2013), normative concentrations of urine thiocyanate in cassava eating communities in Nigeria. They opined that exposure to cyanide is a major public health problem where highly cyanogenic cassava foods are consumed. They estimated that thiocyanate (SCN) the biomarker of exposure to cyanide, is present in several foods and produced endogenously. Lakshmy *et al*., (1995) studies showed cassava, a staple diet in most regions, has definite anti-thyroid action in humans and animals, resulting in the development of endemic goiter and cretinism. Thiocyanate (SCN) is a complex anion that is a potent inhibitor of iodine transport. This result might also be due to Obanliku’s location at the northern region of the state belonging to the mountainous belt with poor soil and food iodine content. This is in agreement with the findings of Sabina *et al*., (2008) who studied the adequacy of Dietary Iodine in Two Local Government Areas of Cross River State in Nigeria in their study revealed that the Cross River State of Nigeria was in the goiter-endemic or goiter belt of Nigeria before the introduction of Universal Salt Iodization (USI) in 1996. The concentration of thiocyanate in girls of 9- 20 years was a bid higher than boys of the same age range. This may be because iodine requirement for female children was higher than males, especially at the beginning of pubertal age. This is related to the difference in sex hormones and pubertal growth patterns among boys and girls in higher age groups (Singh, 2010). However, ANOVA shows no significant difference (P > 0.05) between males and females of this age range in Obanliku, but there was a significant difference (P < 0.05) between Obanliku and Calabar South.

There was an increase in thiocyanate with respect to age of females. The concentrations of SCN in childbearing females were higher than that of teenagers. Though there was an increase in SCN among females in this region, but the highest concentration of thiocyanate was recorded in 50-60 years of age. This agrees with the findings of Molla *et al*., (2014). Their study revealed that prevalence of goiter was 98% higher among females compared to males in Northwest Ethiopia. However, the highest thiocyanates (SCN) with the lowest iodine in women's urines were recorded in age ranged 50 -60 years. Malgorzata (2017) reported that thyroid diseases like hypothyroidism, nodular postmenopausal and cancer are especially frequent in postmenopausal and elderly women. The study reveals that increasing thiocyanate concentration in Obanliku leads to a decrease in iodine concentration and vice versa. This increase in thiocyanate ultimately prevents the synthesis of iodine in the body, resulting in hypothyroidism (goiter). Thiocyanate (SCN) is a potent inhibitor of iodide transport. Even with adequate intake of iodine in food, goiter is still prevalent in the region. This may be due to high consumption of cyanogenic plants in food. Chandra *et al*., (2008) the role of thiocyanate ions in the homeostasis of the thyroid is a provocative issue where IDD persists in spite of adequate iodine intake and consumption of cyanogenic plant food is relatively high. Both iodine and thiocyanate enter the body/thyroid gland through food and water. Thiocyanate in relatively higher concentration regulates the uptake, efflux, organification of iodide, thyroid peroxidase activity and thyroid hormone biosynthesis. In addition, the retaining capacity of iodide in the thyroid gland and body also depends on thiocyanate concentration. In other words, the excretion of iodine is related to thiocyanate concentration. In Nigeria, especially Cross River State Northern Senatorial District, the consumption of cyanogenic food (thiocyanate precursor) such as Garri, Chips, Fufu/Akpu, Tapioca and Cassava flour is relatively high, and many regions are environmentally iodine deficient; therefore, the people are at the risk of iodine deficiency disorders (IDD). Nevertheless, ANOVA shows no significant difference (P > 0.05) between males and females of this age range in Obanliku, but there was a significant difference (P<0.05) between Obanliku and Calabar South.

***Summary***

Iodine is essential for thyroid hormone synthesis while thiocyanate prevents thyroid hormone synthesis. As a result, thyroid's physiological rather functional status is very much dependent on the balance between these ions because of their similar ionic volume and charges and competition at different steps in thyroid hormone-biosynthesis. Analysis of urine samples collected from Obanliku and Calabar South shows that Obanliku samples contain high concentrations of thiocyanate and low iodine, while samples from Calabar South contain high iodine concentrations and low thiocyanate. This is related to their feeding habits and locations. Obanliku’s location is in the state's northern region, which belongs to the mountainous belt with poor soil and food iodine content. Calabar South, the Southern part of the state, is close to the sea with enough iodine in soil, water, and food and, most importantly, consumes less cyanogenic food. The concentration of thiocyanate in girls of 9-20 years was a bid higher than boys of the same age range. This may be because iodine requirement for female children was higher than males, especially at the beginning of pubertal age. This is related to the difference in sex hormones and pubertal growth patterns among boys and girls in higher age groups (Singh, 2010). However, ANOVA shows no significant difference (P > 0.05) between males and females of this age range in Obanliku, but there was a significant difference (P<0.05) between Obanliku and Calabar South. There was an increase in thiocyanate concerning age of females. The concentrations of SCN in childbearing females were higher than that of teenagers.

Although there was an increase in SCN among females in this region, the highest concentration of thiocyanate was recorded in 50-60 years of age. The study reveals that increasing thiocyanate concentration in Obanliku leads to a decrease in iodine concentration and vice versa. This increase in thiocyanate ultimately prevents the synthesis of iodine in the body, resulting in hypothyroidism (goiter). Thiocyanate (SCN) is a potent inhibitor of iodide transport. Even with adequate intake of iodine in food still, goiter is prevalent in the region. In addition, the retaining capacity of iodide in the thyroid gland and body also depends on thiocyanate concentration. In other words, the excretion of iodine is related to thiocyanate concentration. In Nigeria especially Cross River State Northern Senatorial District, the consumption of cyanogenic food (thiocyanate precursor) such as Garri, Chips, Fufu/Akpu, Tapioca and Cassava flour is relatively high and many regions are environmentally iodine deficient therefore, the people are the risk of iodine deficiency disorders (IDD). Nevertheless, ANOVA shows no significant difference (P > 0.05) between males and females of this age ranged in Obanliku, but there was a significant difference (P<0.05) between Obanliku and Calabar South.

Analysis of urine samples collected from Calabar South shows that the sample contains highly reduced concentrations of thiocyanate (SCN) but increased iodine. However, ANOVA shows no significant difference (P > 0.05) between males and females of this age ranged in Calabar South. Still, there was a significant difference (P<0.05) between boys and girls of Calabar South and Obanliku. There was an increase in thiocyanate with respect to age of females. There was no significant (P > 0.05) difference in the concentration of thiocyanate and iodine among males and females aged 40 – 60 years in Calabar South. The concentrations of SCN in childbearing females were higher than that of teenagers. Though there was no increase in SCN among females in this region, the highest concentration of thiocyanate was still recorded in 50-60 years of age. The study reveals that a decrease in thiocyanate concentration in Calabar South leads to an increase in iodine concentration and vice versa. ANOVA shows no significant difference (P > 0.05) between males and females of this age range in Calabar South, but there was a significant difference (P < 0.05) between boys and girls of Calabar South and Obanliku. There was an increase in thiocyanate with respect to age of females. There was no significant (P > 0.05) difference in the concentration of thiocyanate and iodine among males and females aged 40 – 60 years in Calabar South. This decrease in thiocyanate ultimately enhances the synthesis of iodine in the body, resulting in less development of hypothyroidism (goiter) in Calabar South.

***Conclusion***

This research has shown that samples from Obanliku contain high concentrations of thiocyanate and low iodine, while samples from Calabar South contain high iodine concentrations and low thiocyanate. This is related to their feeding habits and locations. The concentration of thiocyanate in girls of 9-20 years was a bid higher than boys of the same age range. There was an increase in thiocyanate with respect to age, most especially in females. The highest concentration of thiocyanate was recorded in the 50-60 age range. As a result, interferes with thyroid gland morphology and function acting directly on the gland or indirectly by altering the regulatory mechanism of the thyroid gland. Thus, leading to ataxic polyneuropathy (goitre) because the uptake and utilization of iodine, by the thyroid gland is impaired by the pseudo halide thiocyanate (SCN-). This research has shown that thiocyanate is an Iodine Difficiency Disorders (IDD) precursor.

Iodine should be adequately consumed in food in the state's northern region to prevent ataxic polyneuropathy (goitre). The fermentation period of cassava should be increased beyond 48 hours to reduce cyanogenic glycoside. Cassava products should be regularly monitored and analyzed to avoid cyanide poisoning. Maximum removal of hydrogen cyanides from cassava should be encouraged. Non- governmental Organizations (NGOs) and individuals should mount aggressive campaigns to sensitize and educate the peasant farmers, cassava millers and traders on the risks involved in consuming high cyanide concentrations in foods. Most importantly cassava produce can be fortified with iodine. This will go a long way in reducing or eliminating ataxic polyneuropathy (goitre).

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