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EXTENT OF CYANIDE, NITRATE, AND FLAVONOIDS GOITROGENS IN SOILS AND TOBACCO PLANT IN SOKOTO, NIGERIA

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ABSTRACT

Nitrate, cyanide, and flavonoids are among the chemicals that threaten hormones and human body especially the thyroid gland and in turn affecting the body. Their presence in tobacco and cigarette shall be determine to inform the public. The objective of this work was to determine the extent of nitrate, cyanide, and flavonoids in soil and tobacco from Sokoto, Nigeria using standard methods. The results determined by this work indicated varied levels of goitrogens (cyanide, nitrate, and flavonoids) present in soils and tobacco leaves grown in three different points within Sokoto state, Nigeria (namely, Sokoto city, Gwadabawa, and Illela). 100.21±6.12 -705.10±4.60 ppm, 136± 6.10-170.30±3.36 ppm, 7.10±0.3-17.0±0.11ppm are range values of cyanide, nitrate, and flavonoids respectively obtained in soils in Sokoto state. Likewise, 90.0±2.16-500.0±1.3 ppm, 70.11±3.9-120.0±10.3 ppm, 6.2±0.5-25.11±0.05 ppm are the ranges of cyanide, nitrate, and flavonoids respectively determined in tobacco leaves in Sokoto state, Nigeria. There exist elevated levels of the goitrogens in soils and tobacco in Sokoto, therefore, risking the consumers and non-consumers to iodine deficiency.

Keywords: *Cyanide; Flavonoids; Goitrogens; Nitrate; Tobacco*

INTRODUCTION

Tobacco or its products are utilized widely worldwide for human consumption; therewith, about 5 trillion cigarettes obtained from tobacco are manufactured every year yielding 1, 000 cigarettes to every direct consumer living on earth (Nnorom et al., 2020). A tobacco or cigarette is bound to contain additives and impurities that are very harmful to biological system according to users or passive user statuses (Nnorom et al., 2020). Some of the components of tobacco or cigarette hail from the soil where the plant tobacco grows; whereas, some of them emanate from the processing or deliberate

incorporation during production (Yebpela et al., 2013). Many of these chemicals found in tobacco or its products are often toxic, carcinogenic, mutagenic, active, and indeed harmful to the biological system of humans or animals (Kaoje et al., 2021).

Goitrogens such as nitrate, cyanide, and flavonoids are some of the chemicals of concern that are reported from elsewhere to be present in tobacco or cigarette owing to their natural incorporation or uptake from the growing soils (Wang et al., 2017; Ward et al., 2018; Guven et al., 2019; Abu Bashar & Begam, 2020). However, the presence of these chemical goitrogens in tobacco remains a concern to the direct and indirect (passive) users of tobacco or cigarette (Oladejo et al., 2018).

Goitrogens indicates a group of substances that instigate an enlargement of thyroid gland to cause goiter by directly or indirectly impeding the regulation of the thyroid gland, and peripheral metabolism and clearance of the triiodothyronine (T3) or thyroxine (T4). Because of the sensitivity of the affected gland in manufacturing hormones that are responsible for protein synthesis, oxygen use, basal metabolic rate, and unavoidable functions. Thus, affecting thyroid gland is an eminent concern to public health (Oladejo et al., 2018; Abu Bashar & Begam, 2020).

In this vein, it is eminently important to ascertain the levels of goitrogens in soils where tobacco is grown, and in the tobacco; because past reports had reported iodine deficiency in the state, coupled with low iodine intake, and malnutrition of other essential elements that support iodine metabolism (Umar et al., 2021). Vividly, especially in women, girls, children, and youth that take in tobacco or cigarettes directly or indirectly, people taking low iodine diet, and people taking low goitrogens but for a longer period; people taking excess goitrogens, the significant effects on thyroid or its activities are bound to manifest (Bouga et al., 2015; Chandra et al., 2010; Abu Bashar & Begam, 2020). For instance, despite the beneficial effects of flavonoids presents in plants (tobacco included), they exert an antithyroidic and goitrogenic harm and cause an enlarged thyroid gland in animals (Chandra et al., 2010). People living in endemic iodine deficiency region, coupled with surplus intake of cyanide are bound to have iodine deficiency (Taga et al., 2008; Abu Bashar & Begam, 2020).

However, to the best of our knowledge, in Sokoto, there are scanty studies that were conducted on goiter and its common factors or iodine deficiency; Umar et al., (2021) in their studies of distributions of some goitrogens in different water sources in Sokoto found that iodine levels were lower than the recommended values in water. Likewise, goitrogens such as nitrate, chloride, magnesium etc were found in the water samples of the study. At national level, likewise, few studies were published related to goiter or goitrogens. Parable, surveys reported seasonal differences in levels of food intake and diverse deficiency manifestations and a consequent rise in levels of antinutrients that act as goitrogens and are taken in by humans. Therefore, there exists a relationship between the food intake and the goiter incidence in the country (Wilson, 1953). Oladejo etal (2018) aimed to fish-out the possible goitrogenic substances in common vegetables in the Southern part of the country. And in turn, nitrate, chloride, phosphate, cyanide, etc were determined and found to be within the accepted levels. In a study that determined levels of iodine and selected goitrogens (calcium, nitrate, cyanide, magnesium) in waterbodies in the southern part of Nigeria, it was shown that, the presence of factors that could affect the nutrition of the consumers by providing them with substances that could elicit iodine deficiency if caveat was not taken is of concern (Salawu et al., 2003). Thus, this kind of study will be unique in determining the levels of cyanide, nitrate, and flavonoids; the antinutrients and as well as goitrogenic substances in soils and ultimately tobacco plant (a commonly used drug in the state). The objective of this work is to determine the extent of nitrate, cyanide, and flavonoids in soil and tobacco from Sokoto, Nigeria.

MATERIALS AND METHODS

Study Area

This study was carried out in Sokoto state, Nigeria. The map of the area was revealed in **Figure 1.**

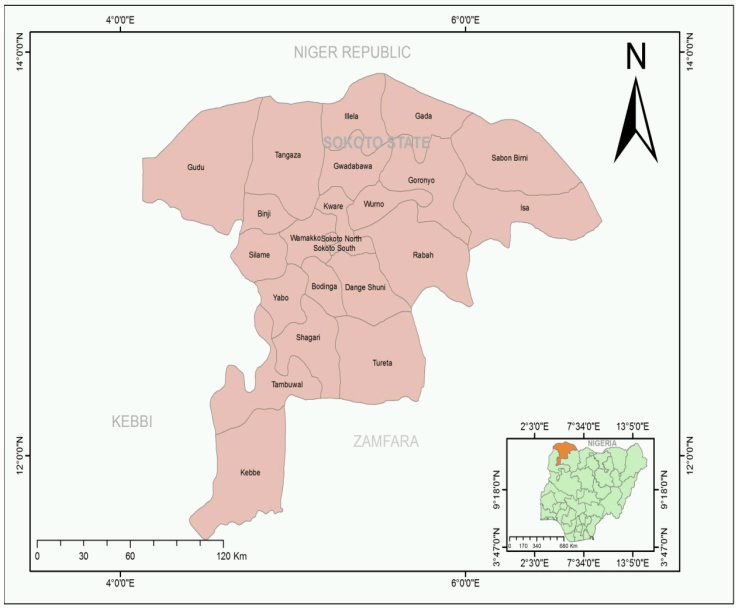

Figure 1. Map of the study location
Source: GIS Laboratory, Department of Geography Usmanu Danfodiyo University Sokoto (UDUS), 2022.

Determination of Nitrate

The determination of nitrate was carried out using colorimetric method with a spectrophotometer and commercial colorimetric kits according to protocols laid by the manufacturers (Mousavi etal., 2013). 0.1g of powder sample was added into 100ml conical flask. 10ml of distilled water was added and boiled for 30 minutes, filtered using filter paper (Mousavi et al., 2013). Determination of nitrate is presented in **Table 1.**

Table 1. Determination of Nitrate

Reagents	Test	Standard	Blank
Sample	0.2ml	-	-
Standard sodium Nitrate DH_2O	-	0.2ml	-
5% of salicyclic acid	-	-	0.2ml
	0.8ml	0.8ml	0.8ml
Mix and incubated for 20 minutes			
2NaOH			
Mixed and allowed to cool and measured the absorbance at 410nm			
	19ml	19ml	19ml

Calculation: Nitrate= Absorbance of Sample x Conc. of Standard/ Absorbance of Standard (Mousavi et al., 2013).
Source: Mousavi et al., 2013

Determination of Cyanide

The determination of cyanide was carried out using colorimetric method with a spectrophotometer and commercial colorimetric kits according to protocols laid by the manufacturers (Mousavi et al., 2013).

0.5g of powder sample was measured into 100ml of conical flask and 50ml of distilled water (DH_2O) was added and boiled for 30 minutes and filtered using filter paper. Determination of Cyanide is presented in **Table 2.**

Test for flavonoids

The flavonoids were determined as reported in the standard procedure mentioned in Shehu & Kurya (2019).

Table 2. Determination of Cyanide

Reagents	Test	Standard	Blank
Sample	1 ml	-	-
Standard KCN	-	1 ml	-
DH2O	-	-	1 ml
Alkaline picrate	4 ml	4 ml	4 ml

Mix and boil T 90º for 5minutes, Cool and measure the absorbance at 490nm.
Calculation: Cyanide =Absorbance of Sample x Conc of Standard/ Absorbance of standard (Mousavi et al., 2013).
Source: Mousavi et al., 2013

RESULTS AND DISCUSSION

This study aimed to determine nitrate, cyanide and flavonoid levels in soil and tobacco from Sokoto, Nigeria using standard methods. The results of research that has been carried out in data processing in this study are shown in **Table 3-5**.

Table 3. Extent of some goitrogens (cyanides, nitrate, and flavonoids) determined in soils and tobacco leaves in Sokoto, Nigeria

Goitrogen type	Soil (ppm)	Tobacco leave(ppm)
Cyanide	705.10±4.60	200.12±3.8
Nitrate	170.30±3.36	70.11±3.9
Flavonoids	10.11±0.12	25.11±0.05

Source: Researcher Analysis, 2022

Table 4. Extent of some goitrogens (cyanides, nitrate, and flavonoids) determined in soils and tobacco leaves in Gwadabawa Sokoto, Nigeria

Goitrogen type	Soil (ppm)	Tobacco leave(ppm)
Cyanide	612.20±4.10	500.0±1.3
Nitrate	152.30±12.10	120.0±10.3
Flavonoids	7.10±0.30	6.2±0.5

Source: Researcher Analysis, 2022

Table 5. Extent of some goitrogens (cyanides, nitrate, and flavonoids) determined in soils and tobacco leaves in Illela Sokoto, Nigeria

Goitrogen type	Soil (ppm)	Tobacco leave(ppm)
Cyanide	100.21±6.12	90.0±2.16
Nitrate	136.00±12.10	100.0±3.12
Flavonoids	17.00±0.11	20.0±1.3

Source: Researcher Analysis, 2022

The results determined by this work were indicated in **Tables 3-5** showing the varied levels of goitrogens (cyanide, nitrate, and flavonoids) present in soils and tobacco leaves grown in three different points within Sokoto state, Nigeria; namely, Sokoto city, Gwadabawa, and Illela. 100.21±6.12 - 705.10±4.60ppm, 136± 6.10-170.30±3.36ppm, and 7.10±0.3-17.0±0.11ppm are range values of cyanide, nitrate, and flavonoids respectively obtained in soils in Sokoto state. Likewise, 90.0±2.16-500.0±1.3ppm, 70.11±3.9-120.0±10.3ppm, and 6.2±0.5-25.11±0.05ppm are the ranges of cyanide, nitrate, and flavonoids respectively determined in tobacco leaves in Sokoto state, Nigeria. From this result it can be observed that, the soils had accumulated more goitrogens compared to the leaves of tobacco.

90.0±2.16-500.0±1.3 (ppm) levels of cyanide determined in tobacco leaves are of concern because it had exceeded the permissible limits of 1.0mg/L (of water), 40mol/L (enough level to spur signs of toxicity in humans) and are beyond the levels of cyanide found in cassava, and cocoyam in a Ghana study (Kwaansa-Ansah et al., 2017). Cyanide is a forefront harmful chemical on earth that is found in many instances that can cause bleeding, itching, dermatitis, cardiovascular problem, neurological effect, respiratory effect, inhibition of oxidative phosphorylation, inhibition of oxygen transport, and thyroid injury; and can be in contact with humans even through inhalation (Mahernia et al., 2015; Kwaansa-Ansah et al., 2017; Thomas & Jaiswal, 2021).

Soil is the vital part of the earth where plants are grown and ideally, it contains chemicals that are useful for plant growth (Iemaaniah et al., 2023). However, soil conditions and anthropogenic processes such as pollution have led to accumulation of chemicals such as nitrate, and cyanide. The accumulation of these substances

and relations to an unusual extent is an indication of pollution and the plants growing on that soil will definitely take in these substances despite their inherent methods of avoiding pollutants. Consequently, the plants will yield the substances into the course of food chain (Nedjimi, 2021; Umar et al., 2021; Iemaaniah et al., 2023). Nitrates (70.11±3.9-120.0±10.3ppm) found in the tobacco are due to soil pollution and in the plant are often converted to nitric oxide, N-nitroso. Indeed, nitrite compounds and pose health impacts in humans such as impairment of hemoglobin by making methemoglobin, hyperplasia of the zona glomerulosa in the gastric neoplasia, and adrenal cortex (Adebayo et al., 2018; Grout et al., 2023). Therefore, excess levels of nitrate in tobacco or any consumable be it food or drug are harmful. In this study the levels in the tobacco despite been within the 0-4000ppm /day are of concern because chronic exposure is deleterious (Adebayo et al., 2018). There are evidences linking nitrate with birth abnormalities, and colorectal cancer; that is why WHO sets a limit of 11.3mg/L of nitrate in drinking water, which is lower than what was determined in tobacco leaves in this study (Grout et al., 2023). Therewith, tobacco nitrosamines are readily formed during the storage of tobacco or cigarette smoking as a result of a combination that chemically involve the inherent tobacco alkaloids; and the end products are implicated in the formation of a diverse array of cancers (Wang et al., 2017). 6.2±0.5-25.11±0.05ppm is the range of the flavonoids in the tobacco leaves observed in Sokoto, Nigeria. Flavonoids in tobacco leaves are natural metabolites that might combine with many metals and enhance their bioavailability or reservation (Guven et al., 2019).

It is noteworthy, that the metabolites shown by tobacco are taken through the contaminated soil as shown by the study. Soil gets nitrates (through fertilizer and other harmful pollution sources), flavonoids (though organic matter addition as fertilizer, a usual practice in the area), and likewise, cyanide is incorporated into the soil via pollution as a result of anthropogenic processes (Shafiq et al., 2020; Paul et al., 2020ab; Yan et al., 2020; Sarkingobir et al., 2022; Sarkingobir et al., 2023). The higher levels of the pollutants in soil than in plant are due to a number of factors, such as the avoidance method undertaken by plants (to shun some

pollutants to certain levels), and reduced bioavailability (a situation whereby some pollutants cannot be absorbed by the plants because they had been chelated) (Shafiq et al., 2020; Yan et al., 2020). In another method, the plants utilized some strategies such as detoxification, chelation, vaporization, and the likes to reduce the levels of pollutants they had taken from soil. These might have contributed to reduction in goitrogens levels in tobacco examined (Shafiq et al., 2020; Yan et al., 2020). Certainly, it is a thing of concern to see higher levels of goitrogens in soils that are in turn taken by tobacco in Sokoto. Because the state is being challenged with the raising abuse of tobacco among the youth and females in various forms across the state (Miya et al., 2023). The state is also ravaged by malnutrition at certain levels, food insecurity in some instances, more prominently low iodine in soil, water, and iodine deficiency among some sections of the population (Hassan et al., 2018; Umar et al., 2021; Gada, & Ismaila, 2021). Another major concern about the elevated levels of nitrate, cyanide, and flavonoids found in from Sokoto tobacco is their ability to affect the thyroid gland and lead to goiter or related abnormalities. Chronic intake of cyanide which happen among smokers leads to hypothydrodism through disruption of uptake of potassium iodide by the sodium iodide symporter an action that is done by thiocyanate (a detoxification product of cyanide) (Chandra et al., 2010; Mwadzombo et al., 2019; Lopez-Moreno et al., 2022). Higher nitrate levels compete with the uptake of iodide and in turn affect thyroid functions and also cause risks of thyroid cancer (Ward et al., 2010). Likewise, the excess levels of flavonoids act negatively due to their capacity to cause goiter. Therefore, it is pertinent to advice the consumers of tobacco in the state especially, youth, and other vulnerable populations to shun tobacco to protect their thyroid gland and other body metabolic process for health (Rathore et al., 2012).

CONCLUSIONS

Soil is an important portion of the biosphere that has to be well for the wellness of organisms. However, recent advances have injected diverse chemicals into soils and cause pollution. Pollutants in soils are taken in by plants and shuttled into the food chain or food web. On the other hand, Sokoto state is

being challenged with issues such as malnutrition, burden of diseases, and drug abuse among vulnerable populations. Therefore, it is pertinent to assess the levels of goitrogens in soil and tobacco (a commonly consumed plant by many). This study in turn has revealed elevated levels of nitrate, cyanide, and flavonoids that when taken in over a longtime can easily spur iodine deficiency or goiter especially among the youth, females that take low iodine diet. Likewise, the levels of goitrogens found in some of these samples can harm people that take low iodine diet and surplus goitrogens. Even the non-users of tobacco can be affected by smoke of the tobacco involved.

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