INTRODUCTION

Plants are of many types and many of them have medicinal properties and potentials. They are a rich source of resources that are ingredients beneficial in synthesis and development of drugs. For
instance, laxatives, antibiotics, blood thinners, malaria drugs, Taxol, morphine etc. are all from plants (Hassan, 2013; Chukwuebuka & Chinenyew, 2015; Khare et al., 2021; Ngumah et al., 2022). Indeed, about 13 000 species of plants are into traditional or alternative medical therapy around the world in the last century. Nowadays, about 20000 plants or more are useful in medicine (Yudhara et al., 2016; Umar et al., 2022). Many plant materials, for example herbs are made into pills, capsules, tablets, and snuffs with a view to exert a number of actions and benefits on the human body. They are utilized to reduce pain, increase food flavor, treat headache, and prevent any diseases or ailments (Mohammed et al., 2019; Quds et al., 2021). Mostly, medicinal herbs support the activities of other compounds in the body or support official medicines or act as preventive medicinal agents (Mohammed et al., 2019). By and large, these properties are due to phytochemicals embedded naturally in the plants (Hassan, 2013; Kumar, 2015; Afuape et al., 2022).

Moreover, apart from medicinal value of herbs/ plants, a good array of nutrients such as micronutrients, macronutrients, and vitamins are present. Nevertheless, the useful properties of plants/ herbs regarding medicinal potential are ascribed to certain chemicals synthesized by the plants/ herbs for self-protection and biochemical functions. These chemicals are known with their ability to have medicinal or preventive potentials in many cases (Hassan, 2011; Yudharaj et al., 2016; Afuape et al., 2022; Tukur et al., 2023). These chemicals are called phytochemicals and some of them act as antinutrients more often.

Antinutrients (oxalate, phytate, etc.) consumption is a major risk that elicits malnutrition or deficiencies leading to effects such as scurvy, rickets, osteoporosis, goiter, xerophthalmia, etc. (Sree & Vijayalakshmi, 2018). However, the phytochemicals of great medicinal values in herbs when consumed by humans at excess amounts are likely to cause effects (Sree & Vijayalakshmi, 2018; Umar et al., 2023ab). Herbal snuffs are popular among Hausa people and are taken for medicinal or psychoactive purposes by many across the ages. Certainly, the effects (positive) exerted on humans by herbal snuffs are due to phytochemicals or other quasi constituents (Muhammad & Umar, 2015; Halden & Khaled, 2021; Arsene et al., 2022). Some of these constituents, when taken in excess elicit effects and act as antinutrients. Therewith, they inhibit proper uptake of nutrients by the body (Mohammed, 2019; Tukur et al., 2023). Thus, their levels in snuff needs to be monitored to safeguard public health. This study will help in providing a baseline information, as there is scarce information regarding constituents of herbal sniff in the state. The objective of this work was to measure levels of cyanide, nitrate, phytate, and oxalate, in herbal sniff in Sokoto, Nigeria.

**METHODS**

**Study Design**

The design of this research was a quantitative analysis of oxalate, cyanide, phytate, and nitrate compounds contained in several sniff herbs in Sokoto, Nigeria.
Settings
This research was conducted at Sokoto Market, Sokoto City, Sokoto State, Nigeria.

Research subject
The three different herbal snuffs namely, Hajiya Aisha, Hajiya Safiya, and Dr Lambo were purchased from Sokoto Market, Sokoto City, Sokoto State, Nigeria.

Instruments
Herbal snuffs are famous in Sokoto state, especially in the Sokoto city. Snuffs are made in powder and packaged in small plastic containers to be bought by consumers for solving health needs and elicitation of psychological feelings. They are used for various therapeutic means equally. Each herbal snuff pack is named after the manufacturer or uses or relations and the name is denoted in the container. Since the snuffs are from different companies/ manufacturers they may differ in effect and compositions, likewise their price and consumer preferences.

Data collection
After all the data were collected using checklists and paper, they were grouped according to the variables under investigation using a spreadsheet and the SPSS application, and both univariate and bivariate analyses were conducted.

Data Analysis
The determination of phytochemicals (particularly, the antinutrients including cyanide, oxalate, phytate, and nitrate) compositions in herbal snuffs was performed by the methods of Association of Analytical Chemists (AOAC) described in Hassan et al., (2011) and Umar & Sarkingobir et al., (2023).

Ethical Consideration
This research has received permission for implementation from the Shehu Shagari University of Education, Sokoto, Nigeria.

RESULTS AND DISCUSSION
The results for determination of antinutrients concentrations in snuff brands in Sokoto, Nigeria were shown in Tables 1-4.

Table 1. The Level of Nitrate Antinutrient Determined in Snuff Brands Collected from Sokoto, Nigeria.

<table>
<thead>
<tr>
<th>Type of snuff</th>
<th>Mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Lambo</td>
<td>19.21 ± 0.08</td>
</tr>
<tr>
<td>Hajiya Safiya</td>
<td>18.81 ± 0.9</td>
</tr>
<tr>
<td>Hajiya Aisha</td>
<td>21.82 ± 0.08</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation.

Excess nitrate is linked to birth defects and colorectal cancer (Wang et al., 2017). Table 1 shows the compositional amount of nitrate in 3 herbal snuff brands sold in Sokoto, Nigeria. The range of the nitrate concentration was 18.81 ± 0.9 mg/100g (found in Hajiya Safiya snuff brand) to 21.82 ± 0.08 mg/100g (found in Hajiya Aisha snuff brand). The values are above the level found in Garden cress...
The values are lower than the tolerance level of 220 mg/day for a 60kg person (Hassan et al., 2011).

**Table 2.** The Level of Phytate Antinutrient Determined in Snuff Brands Collected from Sokoto, Nigeria.

<table>
<thead>
<tr>
<th>Type of snuff</th>
<th>Mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Lambo</td>
<td>4.05 ± 0.04</td>
</tr>
<tr>
<td>Hajiya Safiya</td>
<td>5.94 ± 0.01</td>
</tr>
<tr>
<td>Haajiya Aisha</td>
<td>9.164 ± 0.001</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation.

Phytates are typical antinutrients produced in plants. However, human digestive system is unable to metabolize phytate and form complex with useful compounds such as Fe, Zn, Mg, and Ca in food materials and in turn render them unavailable (Halder & Khaled, 2021). On the other hand, phytate has an anticancer property, antioxidant purposes, reduces blood glucose, and helps in prevention of kidney stones (Chukwuebuka & Chinenye, 2015). The concentrations of phytate in three brands of herbal snuff in Sokoto, Nigeria were revealed in Table 2. The highest value (91.164 0.001 mg/100g) was recorded in Hajiya Aisha, and the lowest (4.05 0.04 mg/100g) was observed in Dr Lambo herbal brand. The values recorded (Table 2) are lower than the ones obtained in Garden cress, and also higher than the phytate recorded in *A. sessilis* from India (Sree & Vijayalakshmi, 2018); albeit higher values (than those in Table 2) were recorded in *Carica papaya, Curcubita maxima, and Allium cepa* from India (Halder & Khaled, 2021).

**Table 3.** The Concentration of Oxalate Antinutrient Assessed in Snuff Brands Collected from Sokoto, Nigeria.

<table>
<thead>
<tr>
<th>Type of snuff</th>
<th>Mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Lambo</td>
<td>0.0787 ± 0.059</td>
</tr>
<tr>
<td>Hajiya Safiya</td>
<td>0.0068 ± 0.0001</td>
</tr>
<tr>
<td>Haajiya Aisha</td>
<td>0.0055 ± 0.0001</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation.

Oxalate, a form of antinutrients found in some plant materials, when consumed by humans, it is able to make insoluble or soluble salts or esters (like calcium oxalate) that are harmful. For instance, when to the salts accumulate in the kidney, kidney stones are formed that in turn affect kidney functions (Halder & Khaled, 2021). Moreover, the oxalate compound can serve as chelating agent against harmful
metals such as lead and mercury (Chukwuebuka & Chinenye, 2015). The concentrations of oxalate observed in herbal snuffs were shown in Table 3. The highest level (0.0787 ± 0.059 mg/100g) was found in Dr lambo, and lowest (0.0055 ± 0.0001 mg/100g) observed in Hajiya Aisha snuff. The concentrations are much lower than 337.50 ± 56.25 found in Garden cress in Sokoto; and lower than 2-5g toxic levels for humans (Hassan et al., 2011). Similarly, the concentrations are lower than the levels found in A. sessilis in India (Sree & Vijayalakshmi, 2018).

Table 4. The Level of Cyanide Antinutrient Determined in Snuff Brands Collected from Sokoto, Nigeria.

<table>
<thead>
<tr>
<th>Type of snuff</th>
<th>Mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Lambo</td>
<td>25.68 ± 1.45</td>
</tr>
<tr>
<td>Hajiya Safiya</td>
<td>19.32 ± 1.04</td>
</tr>
<tr>
<td>Haajiya Aisha</td>
<td>23.86 ± 3.03</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation.

Cyanide acts in the body to prevent the bioavailability of the important micronutrient, the iodine. People consuming materials rich in cyanide are predisposed to iodine deficiency even when they consumed enough iodine. Low iodine affects growth and development especially in youngsters (Umar & Sarkingobir, 2023). Cyanide causes respiratory effect, itching, dermatitis, hindered oxygen transport chain and injured thyroid gland among others (Umar et al., 2023ab). The Table 4 shows the levels of cyanide in herbal snuff in Sokoto, the highest value (25.68 ± 1.45 mg/100g) was recorded in Dr Lambo snuff brand, and the lowest level of cyanide was recorded in Hajiya Safiya (19.32 ± 1.04 mg/100g). The values are lower than that of Garden cress from Sokoto and lower than 200mg/100mg fresh weight cyanide regarded as dangerous levels (Hassan et al., 2011). These values are lower than the concentrations observed in cannabis consumed in Sokoto, Nigeria (Umar & Sarkingobir, 2023); and lower than the values recorded in soil and tobacco from Sokoto (Sarkingobir et al., 2022; Umar et al., 2023ab).

LIMITATION

This study is limited to some antinutrients, other antinutrients and phytochemicals that affect biological systems were not part of the work.

CONCLUSION

Herbal stuffs are popularly used in Sokoto for therapeutic and other purposes by the citizens. Therefore, it is important to monitor the levels of metabolites embedded in plants that were used for the making of snuffs, because some of them like oxalate, cyanide, phytate, and nitrate when taken in excess amount can pose risk and act as antinutrients. The aim of this work was to discover the levels of oxalate, cyanide, phytate, and nitrate in herbal snuff in Sokoto, Nigeria. However, based on the findings revealed
by this work; it was denoted that, the oxalate, cyanide, phytate, and nitrate are lower than the levels that
could probably elicit risk to human consumers. More studies of toxicity possibility are required to
recommend or discredit the consumption of snuff to the public for better public health.

**AUTHOR CONTRIBUTION**

**Aminu Umar Imam:** Ensured the formulation of concept and design of the work and proofread the
document severally.

**Yusuf Sarkinobir:** Collected the data through analysis in the laboratory.

**Malami Dikko:** Ensured the writing of the manuscript and additional proofreading.

**Kasimu Abubakar Shagari:** Help in data collection.

**Bello Sulaiman:** Help in collection of data and data analysis.

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**CONFLICT OF INTEREST**

There is no conflict of interest in this work.

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