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Full Length Research Article

Determination of Anti-nutrients and Toxic Substances of Selected Fresh Leafy Vegetables Obtained from Minna Town, Nigeria

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ABSTRACT: Determination of antinutrients and toxic substances in leafy vegetables is an imperative facet in nutritional studies as it establishes the baseline concentrations index for phytotoxins in the vegetables. Concentrations of cyanide, nitrate, soluble and total oxalates were quantitatively determined in the common leafy vegetables (*Amaranthus cruentus, Hibiscus sabdariffa, Corchorus olitorius*, *Telfairia occidentalis* and *Vernonia amygdalina*) consumed in Minna, Niger State, Nigeria, using colourimetric and titrimetric methods. The results show that the concentration of cyanide in the leafy vegetables is within the permissible level of 200 mg/kg fresh weight while the concentration of nitrate in *V. amygdalina* and *H. sabdariffa* is within the acceptable daily intake of 219.00 mg/day, those of *A. cruentus, C. olitorius* and *T. occidentalis* is enough to induce toxicity in man. The soluble and total oxalates content in the vegetables are higher than the permissible level except that the concentration of soluble oxalate in *H. sabdariffa* is within the acceptable level of 250 mg/100 g. The results suggest that while the concentrations of cyanide in the analysed vegetables and nitrate in *V. amygdalina* and *H. sabdariffa* are safe for consumption, the concentrations of soluble and total oxalates in the vegetables and nitrate in *A. cruentus, C. olitorius* and *T. occidentalis* may contribute to nutritional problems if ingested without proper processing.
Keywords: *Leafy vegetables, toxic substances, cyanide, nitrate, oxalates*

INRODUCTION

Leafy vegetables such as *Amaranthus cruentus* (amaranthus), *Hibiscus sabdariffa* (roselle), *Corchorus olitorius* (jute mallow), *Telfairia occidentalis* (fluted pumpkin) and *Vernonia amygdalina* (bitter leaf) are the major sources of phytonutrients such as vitamins and mineral elements require for normal metabolic activities of the body. Vegetables also contain dietary fibres for bowel movement (Lola, 2009; Musa and Ogbadoyi, 2012 a, b). Although, nutritional benefits abound in leafy vegetables, they bioaccumulate phytotoxins such as trypsin inhibitors, phytates, oxalates, nitrates, alkaloids, tannins and cyanogenic glycosides with attendant health problems at high concentrations (Macrae *et al*., 1997; Oboh, 2005; Antia *et al*., 2006; Weerakkody, 2006; Adeniji *et al*., 2007; Musa and Ogbadoyi, 2012 a, b). The antinutrients and toxic compounds in leafy vegetables sometimes make them inferior (Weerakkody, 2006). The non-nutrient constituents of vegetables (called phytotoxins) are of great concern because if present above the tolerable levels in our food, they can cause serious threat to health (Proph *et al*., 2006). For instance ingestion of high concentration of cyanogenic glycoside leads to respiratory poisoning and inhibition of ATP synthesis in electron transport chain (Ellenborn and Barcelonx, 1988; Musa *et al*., 2011; Musa, 2012; Musa and Ogbadoyi, 2012 c). Nitrate is one of the major culprits in cancer and metheamoglobinaemia (Macrae *et al*., 1997; Anjana *et al*., 2007) while oxalates and phytates chelate mineral elements and form complexes with proteins and thereby reduce their bioavailability and nutritive values. Combination of oxalate with calcium forms calcium oxalate which may be precipitated in the kidney to form kidney stone (Evans and Bandemer, 1967; Proph *et al*., 2006; Musa *et al*., 2011; Musa, 2012; Musa and Ogbadoyi, 2012 a, b, c). Generally people are advised to include a lot of leafy vegetables in their meals because of the nutrient contents in the vegetables. In most cases this advice undercut the presence of antinutrients and toxic substances in vegetables. Therefore, evaluating the concentrations of cyanide, nitrate and oxalates in the commonly consumed leafy vegetables in Minna, Nigeria, is very important in establishing the baseline levels and safety of the vegetables for human consumption with respect to the toxic substances.

MATERIALS AND METHODS

Sources of leafy vegetables

The fresh samples of *A. cruentus, H. sabdariffa, C. olitorius*, *T. occidentalis* and *V. amygdalina* were bought each in three sets at different time from Maikunkele,

Bosso and Chanchanga markets in Minna town, Nigeria.

Chemicals

All the chemicals used in this work were of analytical grade and were purchased from BDH and Sigma Chemical Companies, England.

Analytical procedure

The soluble and total oxalates concentrations in the fresh leaves of the vegetables were determined by titrimetric method of Oke (1966). Nitrate content in the test samples was determined by the colourimetric method of Sjoberg and Alanka (1994) while alkaline picrate method of Ikediobi *et al*. (1980) was used to analyse the cyanide content in the samples.

Statistical analysis

Analysis of variance (ANOVA) was used to determine the differences in the concentrations of the antinutrients and toxic substances in the fresh leaves of the vegetables using Minitab statistical package. P-values < 0.05 were accepted as significant while the DUNCAN's Multiple Range Test (DMRT) was used for comparison of mean.

RESULTS

Cyanide concentration

Analyses of cyanide concentration in the different fresh leafy vegetables shows that there is no significant difference (p>0.05) between *T. occidentalis*, *C. olitorius* and *V. amygdalina*, however, the concentration of cyanide in *V. amygdalina* is significantly ($p < 0.05$) higher than *C. olitorius*. Similarly, there was no significant difference in the cyanide concentration between *A. cruentus* and *H. sabdariffa*, however, the concentration of this compound each in these vegetables is significantly ($p < 0.05$) lower than in other vegetables analysed (Figure 1).

Nitrate concentration

The mean concentration of nitrate in the fresh leaves of *A. cruentus, H. sabdariffa, C. olitorius*, *T. occidentalis* and *V. amygdalina* is presented in Figure 2. Data analysis showed that concentrations of nitrate in *A. cruentus* was significantly ($p < 0.05$) higher than all the fresh leafy vegetables analysed. While the concentration nitrate in *H. sabdariffa* is significantly ($p < 0.05$) lower than in *C. olitorius* and *T. occidentalis,* there is no significant ($p > 0.05$) difference with *V. amygdalina*. Similary, *C. olitorius* and *T. occidentalis* have no significant ($p > 0.05$) difference.

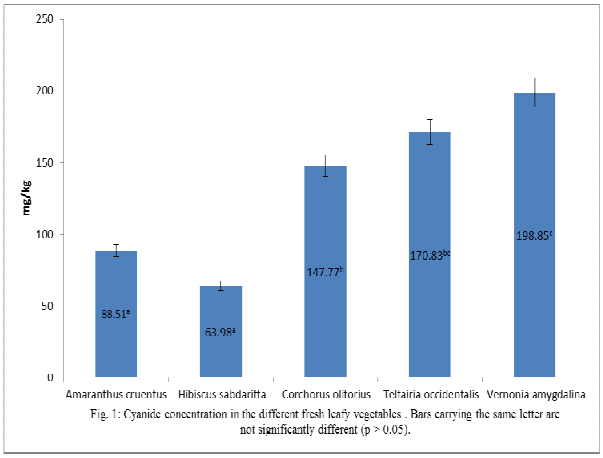

Fig. 1: Cyanide concentration in the different fresh leafy vegetables . Bars carrying the same letter are not significantly different ($p > 0.05$).

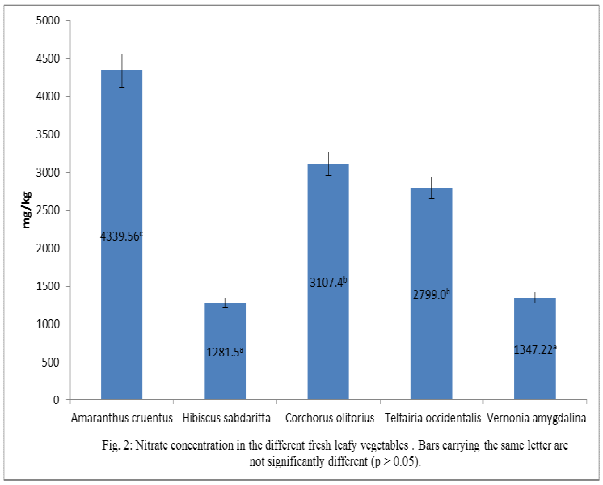

Fig. 2: Nitrate concentration in the different fresh leafy vegetables . Bars carrying the same letter are not significantly different ($p > 0.05$).

Soluble oxalate concentration

The soluble oxalate in the leaves of the selected leafy vegetables shows that the concentration is significantly ($p < 0.05$) lower in *H. sabdariffa* than in all the fresh leafy vegetable studied. Although the concentration of soluble oxalate in C. *olitorius* is not significantly ($p > 0.05$) different from *A. cruentus*, *T. occidentalis* and *V. Amygdalina,* the oxalate content in *A. cruentus* was significantly ($p < 0.05$) higher than *T. occidentalis* and *V. Amygdalina* (Figure 3).

Total oxalate concentration

Results from the determination of total oxalate in the different leafy vegetables showed that the concentration in *A. cruentus* was significantly ($p < 0.05$) higher than in all the leafy vegetables investigated. However, the concentration of total oxalate in *H. sabdariffa, C. olitorius*, *T. occidentalis* and *V. amygdalina* are not

significantly ($p > 0.05$) different from each other (Figure 4).

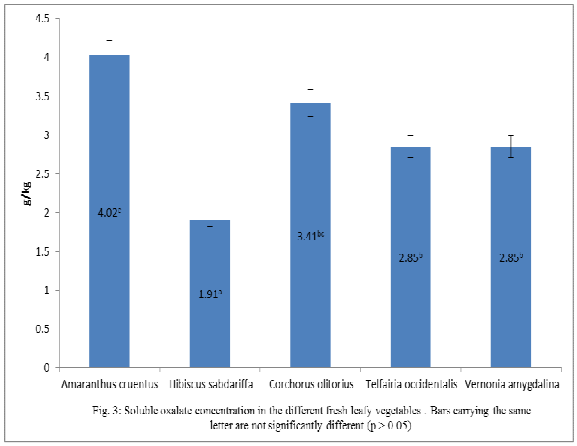

Fig. 3: Soluble oxalate concentration in the different fresh leafy vegetables . Bars carrying the same letter are not significantly different ($p > 0.05$)

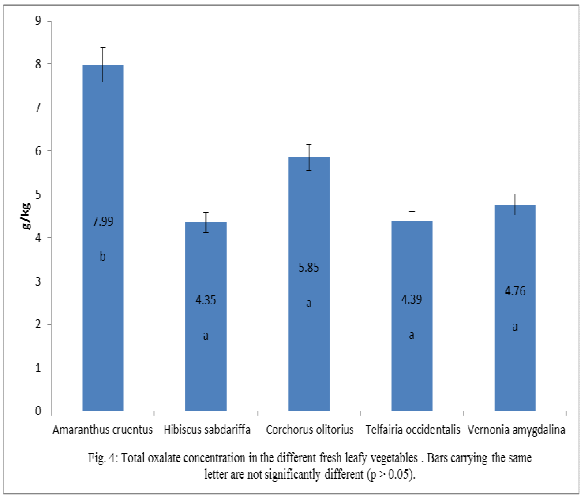

Fig. 4: Total oxalate concentration in the different fresh leafy vegetables . Bars carrying the same letter are not significantly different ($p > 0.05$).

DISCUSSION

The cyanide concentration in the fresh samples of the vegetables is *V.amygdalina* > *T.occidentalis* > *C.olitorius* > *H. sabdariffa* > *A.cruentus*. The concentration of the cyanide in the leafy vegetables is within the permissible level of 200 mg/kg fresh weight of vegetables or forages (Everist, 1981; Richard, 1991). The results thus suggest that the leaves of any of these vegetables are safe for consumption with respect to cyanide content.

Generally, vegetables with nitrate concentrations in the range of 1000 – 4000 mg/kg are classified as high nitrate containing vegetables (JECFA, 2003; Anjana *et al*., 2007). Consequently, the analysed leafy vegetables with nitrate concentrations of 1281.50 – 4335.21 mg/kg are high nitrate containing vegetables (Ogbadoyi *et al*. 2011; Musa and Ogbadoyi, 2012 b, c). The nitrate concentration in fresh leaves of these vegetables except *H. sabdariffa* and *V.amygdalina* are more than the acceptable daily intake (ADI) of 3.65 mg/kg for 60 kg body weight (219.00 mg/day) if 100 g samples are consumed per day (Anjana *et al*., 2007). Therefore regular consumption of raw leaves of *A.cruentus*, *C.olitorius*, and *T.occidentalis* may possibly over load the body with nitrates with attendant health problems of methaemoglobinaemia and cancers (Waclaw and Stefan, 2004; Anjana *et al*., 2007; Ogbadoyi *et al*, 2011; Musa and Ogbadoyi, 2013).

The higher concentration of soluble and total oxalates in fresh sample of *A.cruentus* than in any of the studied vegetables corroborate the work of other researchers (Abakr and Ragaa, 1996),. to the effect that *A.cruentus* is one of the major leafy vegetables with high oxalate content. The soluble and total oxalates content in the vegetables are higher than the permissible level except that the concentration of soluble oxalate in *H. sabdariffa* is within the acceptable level of 250 mg/100 g fresh sample (Oguchi *et al*., 1996). Regular consumption of fresh raw samples of the vegetables without proper processing could deliver toxic levels of these antinutrients into the body with attendant health problems of oxalate toxicosis (Ogbadoyi *et al*., 2006). This can lead to hypocalcaemia, kidney stone, electrolytes imbalance and reduction of bioavailability of minerals in the body (Okon and Akpanyung, 2005;Antia *et al*., 2006; Proph *et al*., 2006; Musa *et al*., 2011). This finding questions the safety of these vegetables for human consumption with respect to oxalates content.

The variations in the concentrations of antinutrients and toxic substances in the different fresh leafy vegetables is in line withprevious report (Aliyu and Morufu, 2006; Adeboye and Babajide, 2007), which also shows that the bioaccumulation of chemical substances in plant is greatly influenced by plant species / cultivars.

CONCLUSION

The cyanide levels in the analysed vegetables and nitrate in *V. amygdalina* and *H. sabdariffa* are safe for consumption. However, the concentrations of oxalates in the vegetables and nitrate in *A. cruentus, C. olitorius* and *T. occidentalis* may contribute to nutritional problems. This study therefore, suggests that while leafy vegetables are widely consumed because of their nutritional benefits, we should be mindful of the

presence of inherent antinutrients and toxic substances in them and their attendant health problems.

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