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Full Length Research Paper

Evaluation of iodine content of some selected fruits and vegetables in Nigeria

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In the past few decades, there has been renewed interest on increase in intake of fruits and vegetables, owing to their numerous beneficial effects. The present study provides preliminary data on the ability of different fruits and vegetables grown and consumed in Ijebu North Local Government Area of Ogun State, Nigeria to concentrate iodine in their tissues, given the same environmental conditions. Chemical evaluation of iodine content of some selected fruits and vegetables, grown and consumed in the area was carried out. Out of the six fruits assessed, *Musa paradisca* has the highest level of iodine (258.83 ± 11.43 µg / 100 g edible portion), while the least value was observed in *Citrus paradis* (2.43 ± 0.01 µg / 100 g edible portion). No significant variation (P ≥ 0.05) was observed in the iodine content of *Citrus aurumthifolia* (27.38 ± 2.16 µg / 100 g edible portions) and *Musa sapientum* (19.79 ± 6.23 µg / 100 g edible portions). The iodine contents of *Carica papaya* and *Citrus paradis* were not significantly different (P ≥ 0.05) from each other. Out of the twenty (20) vegetables assessed, the highest iodine value was observed in *Amaranthus hubridus* (58.36 ± 1.88 µg / 100 g edible portion) and the least value was found in *Talinum triangulare* (0.49 ± 0.01 µg / 100 g edible portions). Our result indicates that few of the fruits and vegetables grown and consumed in the Local Government Area have the ability to concentrate enough iodine that can sufficiently meet the required daily allowance, thus, we advise that such fruits may need to be consumed along with some other dietary sources in order to meet the daily requirement for iodine. Furthermore, our result suggests that the ability of fruits and vegetables to concentrate iodine in their tissues varies from one to another.

Key words: Fruits, hypothyroidism, iodine, iodine-deficiency, vegetables.

INTRODUCTION

Iodine is an essential trace element of great importance in human nutrition. It is an integral part of the thyroid hormones (Dunn and Dunn, 2001; Horst et al., 2005). Recommended daily allowance of dietary iodine is 180 to 200 µg for adults, >100 µg for children and the daily intake during pregnancy should be at least 230 µg iodine (Delange, 2000). As iodine is essential for normal brain development (Venturi et al., 2000), it is particularly important that the foetus and young children have adequate intake (Delange et al., 1968).

Iodine deficiency disorders (IDD) is a broad based spectrum disorder affecting various stages of life with characteristic manifestations such as permanent brain damage, mental retardation in children, decrease child survival, reproductive failure, goiter and socio-economic stagnation (Meharigebre, 1994, Kontras et al, 1985). It is a nutritional as well as a geographical problem. The deficiency of iodine in the soil leads to its deficiency in animals consuming plant grown on such soil, thereby making individual in such area vulnerable to iodine

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Abbreviations: IDD, Iodine deficiency disorders; **RDA,** required daily allowance.

deficiency disorder (Matovinovic, 1983; Barbara, 1994; WHO, 2003). A World Health Organisation (WHO) report (Lamberg, 1985) indicated that about fifty four countries are still iodine deficient. There are however, no available data on the iodine status of people in Ijebu North Local Government Area of Nigeria.

Salt iodization has proven to be effective in the treatment and prevention of IDD (WHO/NUT, 1994; Babikin, 2005) but not without its attendant problem of recurrent cost, delivery network, storage ability (Feidt, 2001) and some health implications (Stephen and Hoption, 2001). The current campaign by WHO on salt/sodium (Nishida, 2010) in order to reduce cardiovascular disease and other problems due to sodium intake may consequently affect iodine intake from the salt. In twenty-nine countries, iodine intake as a result of salt iodization, was slightly high or even excessive and this may result in iodine-induce thyrodism (Lamberg, 1985). Prevention and treatment of certain diseases such as hypertension may require reduction of salt intake (Clark et al., 2002), thereby leading to decreasing iodine intake. Furthermore, salt intakes are generally low in the elderly and infants (Delange, 1993) and consequently, this may lead to hypothyroidism or iodine insufficiencies (FNBIM, 2001) in a situation where iodine source is solely from the salt. On the other hand, hyperthyroidism or thyrotoxicosis may occur in people consuming above tolerable upper intake level (Roti and Vegenakis, 1991) especially in adult whose consumption of iodized salt is average but consistently consumes food high in iodine such as seaweed product (Delange et al., 1999) and consumption of iodized salt in an area previously iodine deficient (Adebawo et al., 2006).

Intake of fruits and vegetables has been advocated within the last few decades because of its vitamins, minerals, antioxidants and other beneficial phytochemical constituents (Diosady and Fitzgerald, 1983). However, screening of many local fruits and vegetables for iodine content have not been carried out in order to know what level of iodine they store or concentrate in their tissues, given the same geographical condition. Generating such data would enable the use of fruits and vegetables carefully to the advantages of people that may have problem(s) with iodized salt.

Due to this, we set to investigate the iodine content of fruits and vegetables grown and consumed in Ijebu North Local government area of Ogun State, Nigeria. We believe that data generated here will enable physicians, nutritionists, food scientists and other health care workers to make wise decision in recommending appropriate dietary regimen for the people that live in this area.

MATERIALS AND METHODS

Sample collection

Fruits and vegetables used for the study were purchased from two major markets in Ijebu North Local Government Area of Ogun state, Nigeria. Eight samples were randomly purchased from each market. The weight of the samples varied from 0.5 to 1 kg. The samples were identified at the Herbarium of the Plant Science and Zoology Department, Olabisi Onabanjo University, Ago-Iwoye, Ogun state, Nigeria.

Sample preparation

The sixteen samples for each specimen (eight from each market) were pulled together, thoroughly mixed and divided into six parts. Edible portions were then prepared from the samples by removing stalk and stems from vegetables, peels and seeds from fruits thereby leaving only the eatable parts.

Sample analysis

Moisture content

30 g of sample were taken from each replicate (6 samples) into a 200 ml crucible, dried in oven at temperature of 105°C for 24 h and the moisture content was then determined. *Musa paradisca* and other fruits (fairly ripe) were finely sliced before oven drying for moisture analysis. Moisture content was calculated by subtracting the weight of dry sample from the wet sample and the difference was expressed as the moisture content.

Ash content determination

5 g of each dried sample was pulverized using mortar and pestle. 2 g of powered sample was taken and placed in ash crucible mixed with 5 g of Na_2CO_3, 5 ml of 0.5 M NaOH and 10 ml of ethanol. The sample was placed in the steam bath at 100°C for about 20 min and later transferred to carbolite furnace for about 50 min at temperature of 500°C.

Iodine content

The iodine content was analyzed by Elmslie Caldwell's method as modified by Diosdy and Fitzgerald (1983). The principle was based on the catalytic reduction of thiosulphate to tetraoxosulfate by the release of iodine. This method entails carbonation liberation of inorganic iodine and quantitative titration of liberated iodine.

Statistical analysis

The experimental design was completely randomized. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) 14. Significant difference between the data was determined at $P \leq 0.05$ using Duncan multiple range test.

RESULTS AND DISCUSSION

The result of iodine and moisture contents of fruits commonly consumed in Ijebu North Local Government Area is shown in Table 1. The result indicates that the iodine content of the vegetables significantly varied among each other. Highest iodine content was observed in *M. paradisca* (258.83 ± 11.43 µg / 100 g) which was significantly higher than the observed iodine value of 27.38 ± 1.39 µg / 100 g in *Citrus aurumthifolia*. The

Table 1. Iodine and moisture contents of fruits commonly consumed in Ijebu North Local Government Area.

Name of fruits		µgI/100 g weight	Moisture content (%)
Botanical	English/Local		
Musa paradisca	Plantain	258.83±11.43[a]	11.22±1.52[a]
Citrus aurumthifolia	Lime	27.38±1.39[b]	95.19±2.82[b]
Musa sapientium	Banana	9.79±1.27[c]	76.34±2.2[c]
Carica papaya	Pawpaw	7.30±1.28[c]	90.81±3.2[b]
Ananus cosmos	Pineapple	4.10±0.05[d]	92.26±1.23[b]
Citrus paradise	grape	2.43±0.01[e]	94.11±2.56[b]

Results presented are mean ± SEM (n = 5); values in the same column with the same superscript are not significantly different from each other (P > 0.05).

Table 2. Iodine and moisture contents of some selected vegetables with iodine concentration greater than 200µg/100g^{-1} edible portion.

Name of fruits		µgI/100 g weight	Moisture content (%)
Botanical	English/Local		
Amaranthus hubridus	Tete abalaye	58.36 ± 1.88[a]	71.11 ± 1.69[a]
Ocimum canum	Efirin wewe	40.20 ± 1.65[b]	76.42 ± 1.32[a]
Chordorins spp.	Ewedu	33.63 ± 1.82[c]	80.42 ± 4.69[b]
Veronia amydalina	Bitter leaf	24.82 ± 1.69[d]	81.00 ± 3.88[b]
Teleferia occidentalis	Ugwu	23.94 ± 1.88[d]	81.09 ± 4.32[b]

Results presented are mean ± SEM (n = 5); values in the same column with the same superscript are not significantly different from each other (P > 0.05).

observed iodine value of 9.79 ± 1.27 µg / 100g in *Musa sapientum,* though lower than that of *C. aurumthifolia*, was not significantly different from the observed iodine value of 7.34 ± 0.11 µg / 100 g in *Carica papaya*. The least iodine value was observed in *Citrus paradis* (2.43 ± 0.01 µg / 100 g) and this was significantly lower than that of *Ananus cosmos* (4.12 ± 0.65 µg / 100 g). *C. aurumthifolia* was observed to have the highest percentage moisture content (95.19%) followed by *C. paradis* (94.11%); *A. cosmos* (92.26%); *C. papaya* (90.81%); *M. sapientium*, (76.34%); while the least value was observed in *M. paradisca* (11.22%).

Table 2 shows the result of analysis of iodine and moisture content of some vegetables. The vegetables in this group contain more than 20 µg/100 g edible portion. The amounts of iodine concentrated by the vegetables analyzed in this group significantly differ (P ≤ 0.05) among each other except for the iodine concentration of 24.82 ± 1.96 µg / 100 g and 23.94 ± 1.88 µg / 100 g obtained for *Vernonia amydalina* and *Teleferia occidentals*, respectively, which were not significantly different (P ≥ 0.05) from each other but were significantly lower (P ≤ 0.05) than the values obtained for other vegetables in the group. The highest iodine content of 58.36 ± 1.15 µg / 100 g obtained in this group of vegetables was concentrated by *Amaranthus hubridus*. A percentage moisture content that was above 70% was recorded in all the vegetables in this group. The highest percentage moisture content was observed in *T. occidentals* (81.09), while the least value was observed in *A. hubridus,* (71.11%).

Table 3 shows the result of iodine and moisture contents of vegetables whose iodine concentration varies from 10 to 20 µg / 100 g. *Boerharia deflusa* was observed in the group which had the greatest capacity to concentrate iodine. The iodine content of 17.79 ± 1.84 µg / 100 g obtained for the vegetable was significantly higher (P ≤ 0.05) than those obtained for others. The iodine content of other vegetables in the group were however not different (P ≥ 0.05) from each other. The observed percentage moisture content for all the vegetables in the group was greater than 75%. The highest percentage moisture content of 86.31% was obtained in *Struchium sperganophora*, while the least value was observed in *A. clorostardy* (76.05%).

In Table 4, the result of iodine and moisture contents of vegetables with iodine concentration less than 10 µg / 100 g edible portion is shown. The highest iodine content was observed in *Ipomia batata*, *Celosia trigyna* and *Discorea avenmensis* leaves. The iodine content of these plants were not different from each other but were significantly higher than that observed in all other vegetables in the group. No significant difference (P ≥ 0.05) was observed in the iodine content of *Basella eaba* (3.17 ± 1.0 µg / 100 g), *Celosia* (3.65. 1.01 µg / 100 g), *Basella*

Table 3. Iodine and moisture contents of some selected vegetable with iodine content between 10 and 20 µgI/ 100 g^{-1} edible portion.

Name of fruits		µgI/100 g weight	Moisture content (%)
Botanical	Local		
Boerharia deflusa	Olowonjeja	17.79 ± 1.84^{a}	83.16 ± 3.98^{a}
Solanum gelo	Igbo	13.23 ± 1.85^{b}	86.16 ± 2.64^{a}
Amaranthus chlorostarrdy	Tete	12.84 ± 1.62^{b}	76.05 ± 1.23^{a}
Senecero biefrae	Boludo	12.20 ± 1.49^{b}	76.39 ± 3.12^{a}
Ocimum gratismim	Eferin	11.89 ± 1.90^{b}	81.03 ± 4.38^{a}
Struchium sperganophora	Ewuro odo	11.40 ± 1.80^{b}	86.31 ± 3.75^{a}

Results presented are mean ± SEM (n = 5); values in the same column with the same superscript are not significantly different from each other (P > 0.05).

Table 4. Iodine and moisture contents of some selected vegetables with iodine concentration less than 10 µg / 100 g edible portion.

Name of fruits		µgI/100g weight	Moisture content %
Botanical	English/ Local		
Ipomia batatas	Sweet potato leaf	9.88 ± 1.90^{a}	83.15 ± 2.30^{a}
Celosia trigyna	Ajefawola	9.25 ± 1.32^{a}	90.01 ± 3.32^{a}
Discorea avenmensis	Cocoyam	9.25 ± 1.42^{a}	90.01 ± 3.32^{a}
Celosia arginatae	Soko (red sp.)	5.41 ± 1.02^{b}	81.8 ± 2.92^{a}
Basella rubra	Amunututu (red sp.)	4.33 ± 1.01^{bc}	91.11 ± 4.59^{a}
Celosia specie	Soko (white sp.)	3.65 ± 1.01^{bc}	85.16 ± 3.11^{a}
Basella eaba	Amunututu (white sp.)	3.17 ± 1.07^{bc}	93.06 ± 3.94^{a}
Hibiscus esculentum	Okro	1.36 ± 0.24^{d}	90.11 ± 3.39^{a}
Talinum triangulare	Water leaf	0.49 ± 0.001^{e}	95.32 ± 3.51^{a}

Results presented are mean ± SEM (n = 5); values in the same column with the same superscript are not significantly different from each other (P > 0.05).

rubra (4.33 ± 1.01 µg / 100 g) and *Celosia argnatae* (5.41 ± 1.02 µg / 100 g). *Talinium triangulare* has the least iodine content (0.49 ± 0.01 µg / 100 g) among the vegetables in the group. The percentage moisture content obtained for all the vegetables in this group were above 80.0% and were not significantly different between the vegetables. The result generally indicates that the vegetables in this group have extremely low iodine content.

The observed iodine content of fruits and vegetables grown and consumed in Ijebu North Local Government Area as reported in this study indicates that, given the same geographical condition, ability of plant to fortify themselves with micro-nutrients, varies from one plant to the other. The result indicates that some fruits such as, *M. paradisca, A. hubridus* and *Ocimum canum* have high ability to concentrate iodine in their tissue, while *C. aurumthifolia, M. sapentun, T. triangulare* and *Hibiscus esculenta* have relatively low ability to concentrate iodine. Our findings here agree with the earlier report of Howarth (1999) indicating different abilities of plants to concentrate micro nutrients in their tissues. Consumption of 100 g of *M. paradisca* would supply 250 µg iodine, an amount greater than required daily allowance (RDA) (200 µg iodine) for adults. Intake of this fruit could therefore be a good source of iodine for those that cannot consume iodized salt, either for health (Clark et al., 2002) or other reasons (Stephen and Hoption, 2001; Raghunath and Belarady, 1997).

The result obtained for iodine content of vegetables as reported in this study indicates that absolute reliance on these vegetables for iodine source might not guarantee the RDA. This agrees with previous report indicating that vegetables are generally low in iodine content, except spinach (Howarath, 1999; Anderson et al., 2005). The relative high concentration of iodine observed in *A. hubridus* 58.36 ± 1.88 µg / 100 g compared with other vegetables analyzed indicates that its regular consumption would supply appreciable amount of iodine. Although, consumption of other vegetables in this group may not guarantee the RDA, however, combination of these vegetables with other cereals and legumes that are high in iodine levels would complement the iodine requirement of individuals. Furthermore, these groups of vegetables could be taken regularly by individuals who are susceptible to develop hyperthyroidism or thyrotoxicosis (FNBIM, 2001) or in an area where iodized salt is recently introduced (Delange et al., 1999).

Even though no relationship between iodine and moisture content had been previously reported, our result suggests that fruits and vegetables with low moisture content may have better capacity to concentrate iodine in their tissues.

Conclusion

The result obtained in this study will go a long way in helping individual living in Ijebu North Local Government Area to make reasonable decision on the types of fruits and vegetables to consume depending on the iodine requirement of the individual or the community at large. Since handling, storage and processing methods have been reported to influence the amount of iodine available in foods (Raghunath and Belarady, 1997), there is an ongoing study in our laboratory to determine the effect of different local processing methods on the iodine content of these fruits and vegetables in order to assess the amount of iodine that will be available after processing and thus, recommend the best processing methods for these fruits and vegetables. We also envisage that further investigation may identify the factors that enable these plants to concentrate iodine in their tissues and hence, such features may be transferred to staple crops that are low in iodine content.

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