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Determination of Iron Content in Indigenous Vegetables in South West Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author OGD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JOO and RBA managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

This study was done to determine the level of iron in selected indigenous vegetables (grown in Ede, Osun State, Nigeria) using colorimetric method. The six indigenous and three common ones selected for the study are; *Basella alba* (*Amunututu*), *Ocimum gratissium* (*Efirin*), *Talinum fruticosum* (*Gbure*), *Amaranthus hybridus* (*Tete adayeba*), *Amaranthus hybridus* (*Tete olowojeja)*, *Corchorus olitorius* (*Ewedu*), *Telfairia occidentalis* (*Ugwu*), *Celosia argentea* (*Soko*) and finally *Amaranthus hybridus* (*Tete*). The vegetables were ashed and iron content of the vegetables was determined colorimetrically at 470 nm. The results showed that, amongst the indigenous vegetables the iron concentration ranged from 0.094 to 0.66 ppm with *Amaranthus hybridus* (*Tete adayeba*) and the *Basella alba* (Amunututu) recording the highest and lowest levels respectively. The common vegetables had iron levels ranging from 0.0304 to 0.703 ppm with *Amaranthus hybridus* (*Tete*) recording the lowest level and *Telfairia occidentalis* (*Ugwu*) recording the highest level respectively. The findings showed that the sampled indigenous vegetables are a good source of iron in diet.

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1. INTRODUCTION

Vegetables grow by cultivation and natural occurrence. Traditional vegetables are valuable sources of the nutrient with some having important medicinal properties [1]. Indigenous leafy vegetables are all plants, whose leaves, roots or fruits are acceptable and used as vegetables in the rural and urban population through traditions, custom and habit [2]. These vegetables are widely consumed, especially during the famine and natural disasters when cultivations of vegetables are not possible. Recently, indigenous vegetables have won some recognition through crop research at international regional and national institutions [3]. Leafy vegetables have been used through history to date [4]. According to Mwangi and Mumbai [5] most widespread and debilitating nutritional disorders, including birth defects, mental and physical weakened immune system blindness and even death have resulted from non - consumption of fruits and vegetable habits. Hunger and malnutrition threaten millions of people in sub - Saharan Africa, yet the value of African traditional vegetables is not fully appreciated. Increased consumption of African leafy vegetables (ALVs) can have a positive effect on nutrition, health and economic well-being of both rural and urban populations [6].

In developing countries, nearly 16 million people die every year from preventable causes, and sixty percent of these deaths are from hunger and malnutrition. Most poor people who battle hunger, battle with malnourishment, especially vitamins and mineral deficiencies which results in stunted growth, weakness and heightened susceptibility to illness.

In Africa, the number of indigenous vegetable species is far greater than the exotic ones. The consumption of green leafy vegetables, which have the highest nutritional value adds to the nutritional status of poor rural and urban households [7]. Also, increased consumption of African indigenous vegetables enhances crop diversity, alleviates poverty and promotes food security [8]. However, the statuses of the crops, as well as their conservation, need to be addressed to ensure sustainable use [4]. Iron (Fe) is the fourth most abundant element in the earth's crust and is an essential nutrient for plants [9]. Iron is an essential trace element, meaning a healthy diet must include this nutrient. An extremely important mineral for general well - being and energy, iron is the essential element within the haemoglobin molecule, which carries the oxygen in every red blood cell. It also functions in myoglobin, a molecule that supplies oxygen to the muscles. Iron is required for proper myelination of spinal cord and white matter of cerebellar folds in the brain and is a cofactor for several enzymes involved in neurotransmitter synthesis [10]. Iron ferrin, stored as ferritin or haemosiderin and it is lost in sloughed cells and by bleeding. Iron is required for making Hb and it is a preoxidant which is also needed for microorganisms for proliferation.

Iron can be found in high amounts in liver and meats. Vegetable sources include leafy greens, nuts and seeds. Iron is especially abundant in pumpkin and sunflower seeds, raisins and prunes and wheat germ.

This study sought to determine the iron content of each indigenous vegetable and common ones.

2. MATERIALS AND METHODS

2.1 Sample Collection and Authentication

The vegetable samples were obtained from three different locations in Ede. The authentication was carried out at Department of Botany, Obafemi Awolowo University Ile – Ife. The authenticated samples were *Basella alba* (Amunututu), *Ocimum gratissium* (Efirin), *Talinum fruticosum* (Gbure), *Amaranthus hybridus* (Tete adayeba), *Amaranthus hybridus* (Tete olowojeja), *Corchorus olitorius* (Ewedu), *Telfairia occidentalis* (Ugwu), *Celosia argentea* (Soko) and *Amaranthus hybridus* (Tete).

2.2 Methods

2.2.1 Preparation of stock solution

According to standard procedure as described by Narain & Ilango [11]. Three stock solutions were made ready before the experiment and were stored in five 500 ml neatly labelled standard flasks. Firstly, the 0.001 M $FeCl_3$ stock solution was prepared by adding approximately 0.162 g of $FeCl_3$ in 500 ml distilled water followed by the addition of 5 ml concentrated HCl. The contents were diluted to 1L and were mixed well before

being transferred to the standard flask. This solution was only used for calibration purposes and was discarded after that. The 1.5M NH_4SCN solution was prepared by adding approximately 36.375 g of NH_4SCN in 500 ml distilled water. The contents were mixed well before being transferred to the standard flask. This solution was the basis of the colourimetry involved in the analysis and was used till the end of the experiment.

The 2M HCl solution was prepared by adding 170 ml of concentrated HCl to 500 ml distilled water and diluting the solution to 1L with distilled water. The contents were mixed well before being transferred to the standard flask. This solution was used for dilution purposes and served as the blank in the colorimetric analysis.

2.2.2 Iron content determination

Thiocyanate colorimetry was carried out using a colorimeter. The colorimeter worked on the principle of the Beer-Lambert law and was operated in the visible range of the spectrum. The colorimetric reagent used for the analysis was ammonium thiocyanate, for which the λmax value obtained was 470 nm. The basic reaction when thiocyanate reacts with iron (III) is as follows:

Fe_3+ (aq) + 6SCN- (aq) ↔ $[Fe(SCN)_6]^{3-}$ (aq). The thiocyanate complex, $[Fe(SCN)_6]^{3-}$ had a deep red colour and its intensity was directly related to the concentration of the solution. The colorimetric analysis was used for its simplicity, convenience and availability in the institute.

2.2.3 Calibration curve

Seven standard solutions were prepared each having a molarity of $0.5x10^{-4}$M, $1x10^{-4}$M, $1.5x10^{-4}$M, $2x10^{-4}$M, $2.5x10^{-4}$M, $3x10^{-4}$M and $4x10^{-4}$M. The first solution was prepared by diluting 0.5 ml of 0.001M $FeCl_3$ solution with 9.5 ml of 2M HCl solution.

Similarly, the corresponding solutions are made by diluting 1 ml, 1.5 ml, 2 ml, 2.5 ml, 3 ml and 4 m of 0.001 M $FeCl_3$ solution to 10 ml by 2M HCl solution.

After this, 5 mL of 1.5 M NH_4SCN was added to each of the solution and mixed by swirling the test tubes. This step diluted the 10 ml solution to 15 ml causing the concentration to decrease by 2/3rd of its original molarity value. Thus, the values read by the colourimeter were for two-thirds of the actual concentration. After adding NH_4SCN, the absorbance was measured immediately because absorbance value can be affected as the colour of the solution fades within 15-20 minutes. 2M HCl was used as the blank. Using these solutions, the concentration vs absorbance curve was plotted.

2.2.4 Ashing of the samples

According to the ashing procedure as described by [11,12]. 1-15 g of the edible portion of the food samples was weighed. They were finely chopped and charred using a clay pot and hot plate for the purpose of ashing. The weighed samples were charred and heated in a muffle furnace at 200-240ºC for 3 hours. This step was carried out in a well-ventilated room. The samples were heated till a grayish ash was observed and then they were powdered using a mortar and pestle. After the samples were cooled, they were transferred to a small beaker of 100 ml capacity and the iron (III) in the ash was dissolved in 10 ml-30 ml of 2M HCl. The ash solution was stirred using a glass stirring rod for about 5 minutes and then filtered using what man filter paper.

2.2.5 Analysis of the samples

Five ml of the filtered sample was transferred to a test-tube and then 5 ml of 1.5M NH_4SCN was added. The mixture was stirred by swirling the test tube. The absorbance was measured without delay as the colour of the solution faded within 15-20 minutes. The solution concentration was halved by adding 5 ml of NH_4SCN. The 2M HCl solution served as the blank. The absorbance values were measured for all the 9 samples.

3. RESULTS AND DISCUSSION

Iron is important in the structure and function of red blood cell and deficiency leads to iron deficiency anemia, a common health problem in many developing tropical countries. African indigenous vegetable could be used in alleviating this problem as they have higher iron content that can meet daily iron content [13]. It is also an accepted that leafy vegetables are rich sources of micronutrients of which iron is of [14].

The iron content in a total of nine vegetables samples was analyzed using the thiocyanate colorimetric technique. The results showed a good quantity of iron in the Fluted Pumpkin (*Ugwu*) and African Spinach (*Efo tete*). The least

iron was available in the Malabar spinach (*Amunututu*). Iron deficiency individuals may improve their dietary iron intake, according to the Recommended Daily Intake (RDI) of iron, by following a diet containing iron-rich vegetables food sources like *Efo tete* and *Ugwu*. The iron concentration of these vegetables unravels a high concentration of iron [15]. WHO records the fact that children, women of reproductive age and pregnant women are most vulnerable to the micro-nutrient iron deficiency which subsequently leads to anemia [16]. Hence, they need food with high iron content, the RDI for pregnant women is 14.7 mg, while for children it ranges between 13.7 to 16.3 mg (https://ods.od.nih.gov). When these green leafy vegetables with enough iron content are eaten in dishes, there is no need for iron supplements. There is a risk of iron toxicity when iron supplements are over - dosed which may results in damage to liver an pancreas, and even sudden death in young children [17]. There is obvious under-utilization of indigenous vegetables [18], the world over, surprisingly Africa tops that list. There is the aggressive need to encourage use of such vegetables as they are easily cultivated within localities and access to them will prove no threat to the general populace.

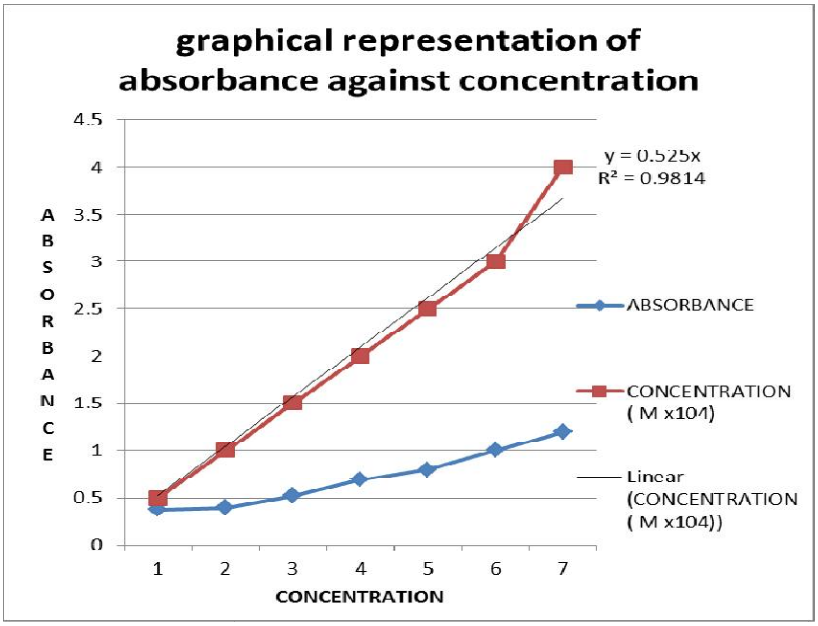

Fig. 1. Calibration curve used for the study

Table 1. Fe concentration in indigenous vegetables found in south west Nigeria

Vegetables	Concentration (ppm)
Amunututu (Malabar Spinach)	0.0945
Ewedu (Jute Mallow)	0.1575
Gbure (Water leaf)	0.1942
Efirin (Scent leaf)	0.3071
Tete olowojeja	0.3307
Tete adayeba	0.6667

Table 2. Showing the Fe concentration in common vegetables

Vegetables	Concentration (ppm)
Tete (African Spinach)	0.3045
Soko (Lagos spiinach/quail grass	0.252
Ugwu (Fluted punpkin)	0.7035

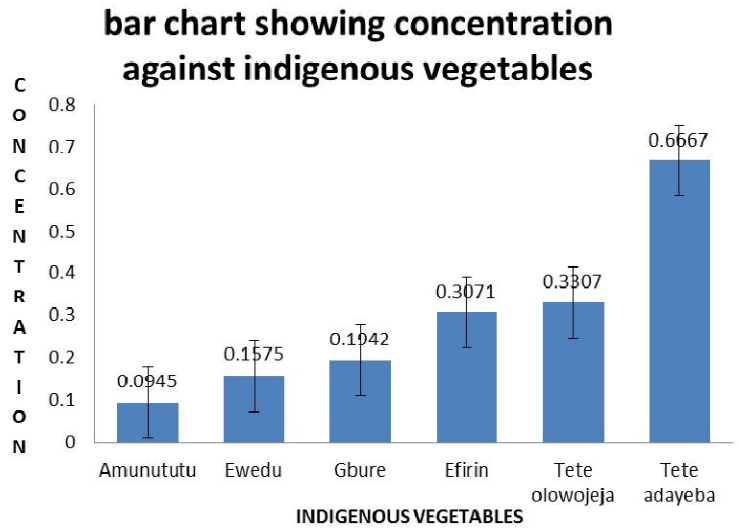

Fig. 2. Concentration of iron in indigenous vegetables

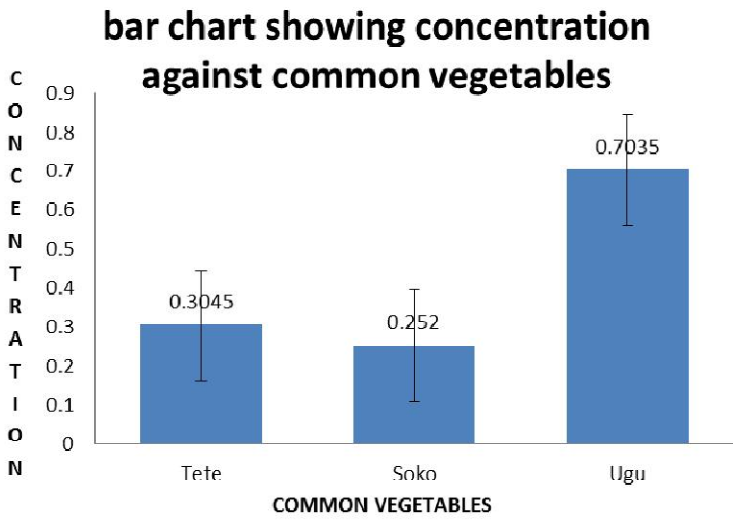

Fig. 3. Iron content in common vegetables

4. CONCLUSION

The present study revealed that the selected African indigenous vegetables are a good source of iron. Further studies on other nutrient should be done on the indigenous vegetables. This will help the consumers in obtaining information and promoting knowledge about high value of nutrients- rich indigenous vegetables could potentially address some health challenges. Increasing the production of indigenous vegetables and informing people how to prepare vegetables to gain maximum values will help ensure low cost nutrients reach vulnerable populations and enhance food and nutrition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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