Assessment of Selected Nutritional and Anti-Nutritional Analysis of Sweet Potato Tubers Collected From Tepi Market, Southwestern Ethiopia

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Data Article

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Abstract

Sweet potato is primarily used for nutrition and medicinal purposes. This study was done to determine proximate analysis and anti-nutritional factors of sweet potato tubers. The sample was randomly purchased from Tepi local market. Then it was analyzed for moisture content, ash content, crude fiber content, oxalate content and acid content. The result of the study showed that 87.6% moisture content, 7.5% ash content, 7.46 mg/100 gm oxalate content, 4.3% crude fiber content and 0.09 M acid content.

1. Background Of Study

Sweet potato (Ipomoea batatas), a dicotyledonous plant belongs to the family convolvulaceae (Ajani et al., 2016). Root crops were regarded as food mainly for the poor, and have played a very minor role in international trade. This misconception has lingered for so long because of the lack of appreciation of the number of people who depend on these root crops, and the number of lives that have been saved during famine or disasters by root crops. Root crops contain an appreciable amount of carbohydrate, vitamins and minerals and may have a competitive production advantage in terms of energy yield per hectare over cereals produced in ecologically difficult conditions (FAO, 1990).

Root crops are an important food source for one fifth of the total world population. With the escalating population, we may have to rely on root and tuber crops more. They are naturally energy rich and have been known to save lives during drought and famine. Taro, for example, has served as a staple in many countries in Asia, Africa, and the Pacific. Based on recorded global gross production data, taro is the fourteenth most consumed vegetable in the world (Lebot et al., 1991).

Root and tuber crops play multi-purpose roles in the global food system as a starch supplier, food security crop, source of cash income, raw material for feed and processed products, and as key components in small-scale agro-enterprise development. The relative importance of individual root crops varies both by region and country. For example yams are a major food crop in West Africa, the Caribbean, the south Pacific Islands, South-East Asia, India and some parts of Brazil. Cassava is particularly important in South America, west East, Central and South Africa and Oceania. Taro plays an important cultural role in the diet of the people of the pacific Islands, West Africa, Oceania and the West Indies (UNIFEM, 2002).

Sweet potato (Ipomoea batatas L.) is a dicotyledonous plant which belongs to the family of convolvulacea (Tewe et al., 2003). United Nation's Food and Agriculture Organization (FAO) (1990, 2011) reported that sweet potato (Ipomea batatas L.) is a very important crop in the developing world and a traditional, but less important crop in some parts of the developed world. According to (FAO, 2011), sweet potato is one of the seven crops in the world produce over 105 hundred million metric tonnes of edible food products in the world annually. Only potato and cassava, among the root and tuber crops, produce more. China alone produced 80 to 85% of the total sweet potato production in the world while the remaining countries in Asia have the next highest production and then, followed by Africa and Latin
America (Centro Internacional de la Papa, 2009). It is among the world’s most important and under-exploited food crops. With more than 133 million metric tonnes in annual production (Scott and Maldonado, 1999; Grant, 2003), sweet potato is the world’s seventh most important food crop after wheat, rice, maize, potato, barley and cassava (Tewe et al., 2003).

It grows under many ecological conditions, has a shorter growth period than most crops (Oke, 1990). Sweet potato is widely grown as a staple food in many parts of the tropical and subtropics, which include developing countries (Odebode, 2002). Its production is highly seasonal in most countries leading to marked variation in the quantity and quality of roots in markets and associated with price swings (Faostat, 2008; Centro Internacional de la Papa, 2009).

Sweet potato is a minor root crop in tropical Africa despite its industrial potentials as indicated by its growth in terms of production (Tewe et al., 2003). Among the root and tuber crops, it is the only one that had a positive per capita annual rate of increase in production in Sub-Saharan Africa (Hahn, 1984). Sweet potato roots are bulky and perishable unless cured. This limits the distance over which sweet potato can be transported economically. It will be established that in cases where countries are capable of generating surplus, it tends to be relatively localized but dispersed and this leads to a lack of market integration and limits market size (Katan and De Roos, 2004; FAO, 2011).

It has been a life saver for centuries in many tropical, sub-tropical and warmer temperate areas of the world, warding off famine in times of both climatic disaster and war. Sweet potato plays a major role as a famine reserve for many rural and urban households because of its tolerance to drought, short growth and high yield with limited inputs on relatively marginal soils (Tewe et al., 2003).

Despite the fact that sweet potato commonly categorized as a subsistence, “food security” or “famine relief” crop, its uses have diversified considerably in developing countries over the last four decades (Grant, 2003). Sweet potato consumption has been adjudged to decline as incomes rise - a change often linked with urbanization, partly because it is perceived as a “poor man's food” but mostly because of the lack of post-harvest processing or storage (Faostat, 2008; Centro Internacional de la Papa, 2009). The tubers can be steamed, roasted, boiled, baked, and fried. It has the potential of bridging food gap due to diversified processing and utilization technologies that have been produced but not yet fully exploited (Nungo et al., 2007).

Sweet potato is a very efficient food crop and produces more dry matter, protein and minerals per unit area in comparison to cereals (Woolfe, 1992). Research have reported that sweet potatoes being the staple food in the developed countries account for 130 kcal of energy per person per day against 41 kcal in the developing countries where it is still considered as vegetable. Apart from being a rich source of starch, sweet potatoes contain good quantity of secondary metabolites and small molecules which play an important role in a number of processes (Friedman, 1997). Many of the compounds present in sweet potato are important because of their beneficial effects on health, therefore, are highly desirable in the human diet and functions as a functional food (Katan and De Roos, 2004).
Also, it is a low input crop and it is used as a vegetable, dessert, source of starch and it is eaten as a substitute for yam due to its lower cost of production. Sweet potato is comparatively a nutritional heavy weight; rich in complex carbohydrates, vitamins C and E, and also contains good quantities of vitamins A and B, calcium and iron (Huang et al., 1999).

Processing root crops especially sweet potato into convenience foods will improve their being accepted by the urban population. This will lead to expand markets and thus encourage the increase production of root crops and also the use of processed foods based on local products to replace imported foodstuffs will also conserve foreign exchange (Olapade and Ogunade, 2014). There are wide ranges of snack items including potato chips, maize chips, puffed dough, cookies and crackers (Fazzolare et al., 1997). Sweet potato skin colors come in various shades of creamy white, yellow-orange, tan, reddish-purple and red. Sweet potato has also been used in the production of purees and these can be used as an ingredient in various products including baby food, casseroles, puddings, pies, cakes, bread, restructured fries, patties, soups and beverages (Truong et al., 1995).

1.2 Proximate composition

Sweet potato (Ipomoea batatas L.) has played an important role as energy and a phytochemical source in human nutrition and animal feeding. This tuberous root is a rich source of carbohydrates, dietary fiber, vitamin A (as β-carotene), vitamin B6, vitamin C (Anbuselvi and Balamurugan, 2014).

1.2.1 Nutritional Composition of Sweet Potato

Sweet potato are rich in dietary fiber and have high water content and also provide 359 kJ energy with low total lipid content, which is only about 0.05 g per 100 g. In addition, sweet potatoes also are high in minerals such as potassium, calcium, magnesium, sodium, phosphorus, and iron (USDA, 2009). Because of the various roles that sweet potatoes play around the world, the concept of nutritional quality and its contribution must transform to meet specific roles in human diet. For instance, staple type diets could require high vitamin C, iron, potassium, protein and as well as high fibre. Similarly, supplemental types of sweet potato must have many of the same characters as staple types in terms of nutritional components. However, as they will not be major food component, the level of components may be more flexible and good (Oke and Worknehm, 2013).

Sweet potato is a minor root crop in tropical Africa despite its industrial potentials as indicated by its growth in terms of production. Among the root and tuber crops, it is the only one that had a positive per capita annual rate of increase in production in Sub-Saharan Africa. Sweet potato has a high yield potential that may be realized within a relatively short growing season and adaptability to a wide ecological range of 0 to 2000 meters above sea level and 30° N to 30°S. It has been a life savior for centuries in many tropical, sub-tropical and warmer temperate areas of the world, warding off famine in times of both climatic disaster and war. Sweet potato is the world’s seventh most important food crop after wheat, rice, maize, potato, barley and cassava. It grows under many ecological conditions, has a shorter growth period than most crops and shows no marked seasonality (Olapade and Ogunade, 2014).
Sweet potato skin colors come in various shades of creamy white, yellow-orange, tan, reddish-purple and red. Sweet potato has also been used in the production of purees and these can be used as an ingredient in various products including baby food, casseroles, puddings, pies, cakes, bread, restructured fries, patties, soups and beverages (Truong et al., 1995; Walter et al., 2001).

Lack of industrial or village-level processing of the crop and low levels of commercialization are major constraints to increased production of sweet potatoes. The major avenue left for preservation of sweet potato is processing into secondary products. There are wide ranges of snack items including potato chips, maize chips, puffed dough, cookies and crackers. Processing root crops especially sweet potato into convenience foods will improve their being accepted by the urban population. This will lead to expanded markets and thus encourage the increased production of root crops and also the use of processed foods based on local products to replace imported foodstuffs will also conserve foreign exchange (Olapade and Ogunade, 2014).

1.2.2 Antinutritional Factors

Compounds, which act to reduce nutrient utilization and/or food intake, are often referred to as antinutritional factors. These toxic compounds may occur in all parts of the plant, but the seed is normally the most concentrated source. Food crops regularly eaten have many beneficial nutrients but there are traces of antinutritional components such as cyanoglucosides, oxalates, phytic acid, phenolics, protease inhibitors, heavy metal etc. These antinutritional factors when consumed in foods may have adverse effects on health through inhibition of protein digestion, growth, and Fe and Zn absorption (Omoruyi et al., 2007). Taro contains antinutritional factors such as: oxalates, tannins, phytates, trypsin inhibitors, amylase inhibitors and in some cultivars cyanide (FAO, 1990).

Boiling is effective method in reducing water soluble antinutrients. For example boiling of root crops such as taro and cassava could lead to significant reduction of oxalates and cyanide respectively. Boiling also found to decrease some amount of soluble phytate (Agbor et al., 1995). Both taro and yam in their raw forms are toxic. The toxin is however destroyed by processing techniques such as cooking, soaking, ensiling and drying (FAO, 1999). In Yeki woreda, sweet potato has been widely cultivated and consumed. About 15 hectares of the woredas farm land has been covered by this vegetable. From this sweet potato farm land of the woreda 250 tonnes of sweet potato has been produced annually. The varieties of sweet potato predominantly cultivated in the woreda are yellow and red colored (Yeki woreda agriculture office, 2017). The present study aimed to assess selected proximate composition and antinutritional factors content of sweet potato tuber.

2. Materials And Methods

2.1. Study area

Tepi, which is one of the woredas, town in the southern nations and nationalities and peoples regions of Ethiopia, is located at 611Km south west of Addis Ababa. It is situated at 7.2 degrees North latitude,
35.45 degree East longitude and 1097 meters elevation above sea level (https://www.Tepi town information.com).

2.2. Sample Collection and Preparation

Sweet potato tubers were randomly purchased and collected from Tepi market. The tubers were procured locally and cleaned under running tap water. The surface was dried. The clean sweet potato tuber was peeled by hand trim with stainless steel knife and held in water to prevent enzymatic darkening. Slices 2-3 mm thick was prepared from peel tubers, with grinder and it was dried by flowing air. It was ground into powder and sieved through a 0.5 mm sieve. The powder was transferred in polyethylene bag and it was stored until the next use.

2.3. Proximate Composition

2.3.1. Determination of Moisture Content

Accurately 5 grams of each of the sample was weighed into dried weighed crucible. The sample was mixed thoroughly and dried at 105°C for 24 hrs. The dried sample was put into desiccators for 30 min, allowed to cool and reweighed. The process was repeated until constant weight was obtained. The difference in weight was calculated as a percentage of the sample moisture content using method of (AOAC, 2000).

\[
\text{Percentage moisture content} = \frac{W_1 - W_2}{W_1} \times 100
\]

Where \( W_1 \) = weight (g) of sample before drying; \( W_2 \) = weight (g) of sample after drying

2.3.2. Determination of Ash Content

The porcelain crucibles was washed by dilute hydrochloric acid and washed with water respectively. Then it was dried at 120°C in an oven and ignited at 550°C in furnace for 3 hrs. Then the crucibles was removed from furnace and cooled in desiccators. The mass of the crucibles was measured as \( M_1 \). About 2 gram mass of samples powder was weighed in to the porcelain crucible and recorded as \( M_2 \). The samples were placed in a furnace at 550°C until free from carbon. The samples were removed from the furnace and placed in desiccators and allowed crucible to cool for 30 min prior to weighing. Finally the mass was weighed as \( M_3 \) and the total ash contents of the samples were calculated with the following formulae:-

\[
\text{Ash} \% = \frac{(M_2 - M_3)}{M_2 - M_1} \times 100
\]
Where, \( M_1 \) = mass of the dried crucible; \( M_2 \) = mass of the crucible and the sample; \( M_3 \) = mass of the crucible and the ash (AOAC, 2000).

2.3.3 Crude fiber determination

Crude fiber analysis was conducted using the method of AOAC (2000). 2 gram of sample was taken and added to 100 mL 1.25 % of \( \text{H}_2\text{SO}_4 \), next to this; it was boiled at 337°C for 30 minutes. After 30 minutes 20.0 mL of 28% of KOH and boiled for 30 minutes. After filtered it was dried in oven at 130°C for 2hrs and cooled at room temperatures and weighted as \( M_1 \). Then it was transferred to crucibles and placed in muffle furnace and ashed for 30 minutes at 600°C. Finally, it was cooled and weighted as \( M_2 \).

The crude fiber content was calculated as follow as:

\[
\text{Crude fibre (\%)} = \frac{\text{weight of sample before drying} - \text{weight of sample after drying}}{\text{weight of sample on dry base}} \times 100
\]

2.3.4 Oxalate determination

3 gram of sample was treated with 100 ml of water for five minutes. Then 10 ml of solution was mixed with 5ml 5% \( \text{CaCl}_2 \) and 5ml acetone together and it was cooled. Next the solution was centrifuged for 15 min at 300 rpm and the residue was transferred to flask with 5ml 10% \( \text{H}_2\text{SO}_4 \) and it was heated on water bath until dissolved. Then, it was immediately titrated with standard solution of the 0.1M of \( \text{KMnO}_4 \). Finally, the concentration was calculated.

\[
\text{Oxalates (mg/100g)} = \frac{\text{volume of } \text{KMnO}_4 \times \text{volume mass equivalent of } \text{KMnO}_4 \times \text{dilution factor} \times 10^5}{\text{molar equivalent of } \text{KMnO}_4 \text{ in redox (5)} \times \text{mass of sample}} \]

2.3.5. Estimation of acid content

10 gram of sample was mixed with 200 ml of water in beaker, heated for 30min and filtered out. 5ml of extract was taken in conical flask and 20ml of water was added and shaked to make homogeneous mixture. Finally, it was titrated against 0.02NaOH solution and the concentration of acid in extract was calculated by dilution formula and expressed in mg/kg. By dilution formula:

Concentration of standard \times \text{volume of standard} \times \text{concentration of acid} \times \text{volume of acid}

All results were expressed in mean ± standard deviation (SD).

3. Results And Discussion

3.1. Parameters analysis

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The moisture content of the current study was found to be 87.6%. This moisture content result is normal when compared with different international standards which are mostly ranging between 50-90%. The result obtained was higher than that obtained by (Abubakare et al., 2010) and (Ana cristiana et al., 2001) which was 54.8% and 64.1% respectively in Nigeria. This high moisture content of the sample under investigation may be because of the sweet potato sample collected was from Tepi market and this area is one the areas in Ethiopia known by getting high rain fall. Therefore, the sample from this green and high humid area is affected by this atmosphere and resulted in high moisture content.

The ash content of sweet potato collected from Tepi market was 7.5%. The result obtained agrees with the result referred by most international standards that is ranging between 2-15%. The result obtained was higher than that obtained by (Abubakare et al., 2010) and (Ana cristiana et al., 2001) which was 1.13% and 1.9% respectively in Nigeria. Besides it is comparable with the result obtained by (Ladino et al., 2009) that is 8.83% which conducted in Nigeria.

The crude fibre content result obtained for current study was 4.3%. The result obtained for the current study agrees with different international standards that are mostly less than 10%. This result was a little bit higher than the result obtained by (Abubakare et al., 2010) which is 0.84% conducted in Nigeria. But it is comparable with the result obtained by (Ladino et al., 2009) that is 5.88% conducted in the same country.

The oxalate content result obtained for oxalate content collected from Tepi market was 7.46mg/100gm. The WHO set the maximum permissible limit of oxalate content in sweet potato as 60mg/100gm. Hence the result obtained in this study is less than this value. On the other hand the result obtained is less than the result obtained in Ethiopia by Jiru and Urga that is 59.0mg/100gm. Besides the result obtained is than that obtained in Nigeria by (Ladino et al., 2009) that is 167.0mg/100gm.

The acid content in sweet potato collected from Tepi market was found to be 0.09 M and this is low acid content value. The result set by different international standards and different researchers showed that it is low in acid content. Therefore, this result agrees with such standards and researches conducted on sweet potato and hence the sample under investigation is safe related to its acid content.

4. Conclusion

The roots of sweet potato was collected and analyzed for proximate analysis such as moisture content, ash content, crude fiber content, acid content and oxalate. The result obtained for all parameters agree with different international standards and the results obtained by other researchers. In addition to this the oxalate content that has adverse effect on health was below the permissible limit set by world health organization.

List Of Abbreviations

FAO-Food and agricultural organization
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Declaration

“I hereby declare that the project submitted for the research conducted in Mizan-Tepi University in Chemistry department laboratory in Tepi of Ethiopia. It is my own original work and has not previously been submitted to any other institution of higher education. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references.”

Availability of data and materials

All data are available. This article is the original research that is to be published on this journal site for the first time. The work has been conducted by me and it is displayed on the manuscript.

Competing interests

On the other hand it is the first time of submitting this article to this site. Therefore, no conflict of interest on this publication process of it because of the name of researcher was displayed and the publication is going on based on the interest of researcher.

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Authors' contributions

Author contributed the comparison of the toxic heavy metals waste disposed to environment.

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