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# Quality Evaluation of Fresh Selected Orange Fleshed Sweet Potatoes in Lake zone of Tanzania

Caresma Chuwa<sup>1</sup>, Abdulsudi Issa-Zacharia<sup>2,\*</sup>

<sup>1</sup>Tanzania Agricultural Research Institute (TARI) Ukiriguru, Mwanza, Tanzania

<sup>2</sup>Department of Food Science and Agro-processing, School of Engineering and Technology, Sokoine University of Agriculture, Chuo Kikuu, Morogoro, Tanzania

## Email address:

aissazac@gmail.com (Abdulsudi Issa-Zacharia)

\*Corresponding author

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**Abstract:** Vitamin A Deficiency (VAD) is a public health problem in developing countries in children below five years. Orange Fleshed Sweet Potatoes (OFSP) are rich in  $\beta$ -carotene a pre-cursor for vitamin A. Being a cheap and affordable source, can be utilized by incorporating in staple foods to combat VAD in developing countries. OFSP fresh roots (*Ejumla*, *Jewel* and *Carrot dar*) were collected from Ukerewe and Misungwi District, Mwanza region for quality evaluation. The findings of the study indicated that there was considerable variance in the nutrient content across the several types of OFSP that were tested. Among the varieties that were chosen for analysis, it was found that *Jewel* had the maximum quantity of  $\beta$ -carotene ( $113,565 \pm 1.45 \mu\text{g}/100 \text{ g}$ ), whilst *Carrot dar* had the lowest concentration ( $5,165 \pm 3.38 \mu\text{g}/100 \text{ g}$ ). In addition to  $\beta$ -carotene, the aforementioned varieties of OFSP exhibited a diverse array of nutrients, including protein (3.82% - 8.86%), fat (0.32% - 0.51%), fibre (1.83% - 3.15%), carbohydrate (87.05% - 92.60%), ash (0.86% - 1.09%), ascorbic acid (15.04 mg/100 g - 17.27 mg/100 g), and energy content (385.19 Kcal/100 g - 392.92 Kcal/100 g). Several minerals were discovered in the selected OFSP varieties. *Jewel* exhibits a high content of essential minerals such as calcium (44.30 mg/100g), iron (1.34 mg/100g), zinc (0.35 mg/100g), and potassium (317.12 mg/100g). Conversely, *Ejumla* is characterized by its notable sodium (112 mg/100g) and magnesium (2.73 mg/100g) content, making it a valuable source of these minerals. Based on the findings, it can be concluded that OFSP possesses a high concentration of essential nutrients that play a crucial role in addressing both macro and micro-nutrient deficiencies in developing countries. Hence, individuals should integrate Orange Fleshed Sweet Potatoes into their primary food sources as a means of enhancing the overall nutritional value.

**Keywords:**  $\beta$ -Carotene, Micro Nutrient Deficiency, Minerals, Orange-Fleshed Sweet Potato, Ascorbic Acid

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## 1. Introduction

Sweet potato (*Ipomoea batatas*) is a food crop that has been recognized as having an important role to play in improving household and national food security, health and livelihoods of poor families in sub-Saharan Africa [1]. From a dietary point of view and nutritional perspective, Orange Fleshed Sweet Potatoes (OFSP) ranked as number 1 among all vegetables [2]. One small root (100 g) of a medium-intensity OFSP variety can meet the daily vitamin A needs of a young child [3]. OFSP is appreciated due to the vitamin A contribution and role in VAD eradication in

developing countries [4, 5]. The many positive aspects related to agriculture, nutritional security and food security have resulted in intensified research on OFSP in the present decade to augment its production and consumption in different countries. The OFSP possesses the characteristic of an attractive sweet taste and eye-pleasing yellow to orange colour to children in comparison with white-fleshed sweet potato [6]; hence, OFSP has reported potential role in tackling calorific and VAD malnutrition problems of children in targeted communities. The World Health Organization (WHO) reported vitamin A deficiency (VAD) as a public health problem that affects more than 190 million preschool children and 19 million pregnant women Worldwide, the

majority being from Africa and Southeast Asia. The Tanzania National Multi-Sectoral Nutrition Action Plan [7] recognizes micro-nutrient deficiency as the greatest challenge facing Tanzania's population. Among the causes, Vitamin A deficiency is one of the main challenges. One out of three preschool children (6-59 months) in Tanzania has VAD, which increases the risk of blindness and limits their development potential. This level of Vitamin A deficiency is unacceptable and a big challenge towards achieving the government's goal of nutrition security. The use of supplements and fortified food are among the approaches used to address the problem. Vitamin A supplementation implemented by the government through six-monthly capsule distributions is one of the main methods used. The method is, however, costly and does not reach all children, especially in remote areas. A national demographic and health survey conducted in 2015-16 showed that only 40% of children aged 6-59 months received a vitamin A supplement in the six months before the survey. Several bio-fortified crops including Vitamin A-rich OFSP, cassava, maize, golden rice, and iron bio-fortified beans were identified as the most economical and cheapest ways to address malnutrition effects [8]. Several studies [9, 10] have reported a positive impact of OFSP on the reduction of vitamin A deficiency. For instance, integration of food-based agriculture and nutrition interventions at the community level, significantly reduced the burden of Vitamin A in Uganda up to 64% [10]. *Ejumla*, *Carrot Dar* and *Jewel* are among OFSP varieties released by the Tanzania Agricultural Research Institute (TARI). The varieties are high-yielding, tolerant to Sweet potato Viral Diseases (SPVD) and have high dry matter content. Therefore, these varieties need to be disseminated for utilization (value addition and product diversification) in a wider area in Tanzania. Therefore, the present study analyzed the nutritional content and sensory quality of the aforementioned OFSP fresh roots to provide information about composition, appearance, texture, flavour and acceptability by the consumers.

## 2. Materials and Methods

Three varieties of OFSP (*Ejumla*, *Jewel* and *Carrot dar*) were randomly collected from farmers within the study area (Misungwi and Ukerewe) Districts. The amount of 20 kg of fresh-form samples from each variety were collected, packed in labeled bags, transported and stored at room temperature in the Food Science and Agro-processing laboratory. All chemicals and reagents used in this study were of analytical grade and were procured from Sigma Aldrin Inc. Germany. All treatments and analyses were done using three replicates and results were reported on wet wet-weight basis. The present investigation was conducted in the Department of Food Science and Agro-processing, Sokoine University of Agriculture, Morogoro Tanzania for chemical and nutritional analysis.

### 2.1. Moisture

The moisture content (%), ash (%) and protein (%) were determined using the method recommended by AOAC [9]. Crude fibre (%) and Crude fat (%) were analyzed by AOAC [10]. Ranganna [14] procedure was employed in examining  $\beta$ -carotene (mg/100 g). Total carbohydrates (%) and total energy (Kcal/100 g) were calculated by the differential method according to the AOAC [15] method. Ascorbic acid was determined by the procedure given by AOAC [16]. Minerals (mg/100 g) were determined by AOAC [17].

The moisture content in different samples was evaluated as per the method by AOAC [9]. A known weight of sample in fresh (5-10 g) was taken in a pre-weighed flat-bottom metallic dish. The dish was placed in a hot air oven maintained at a temperature of 130-133°C for 2 h or until a constant weight was achieved. After drying, the dish was removed and allowed to cool in a desiccator containing fused calcium chloride. The dish containing the dried sample was weighed to know the weight of the dried sample. The per cent moisture content was calculated as follows:

$$\text{Moisture (\%)} = \frac{\text{weight of fresh sample (g)} - \text{weight of dried sample (g)}}{\text{weight of fresh sample (g)}} \times 100$$

### 2.2. Crude Protein

Protein content was determined by following the method given by AOAC [9] using a semi-automatic instrument i.e. KjelTRON (KDIGB 6M and KjelDISTEA). A moisture-free sample (0.3 g) was taken and added to digestion tubes containing a catalyst mixture containing potassium sulphate and copper sulphate (5:1). Six samples were taken at a time, out of which one was blank containing only the catalyst mixture. To each tube, 10 mL of concentrated sulphuric acid was added and samples were digested at 360-400°C in the digestion unit up to 2 h. After completion of the digestion process, the tubes were cooled down till there was the appearance of a clear bluish-green colour which is the indication of complete digestion. Then the sample tubes were fitted to the automatic distillation

unit where the aliquot was diluted and made alkaline by mixing with 40 per cent NaOH solution. Liberated ammonia was collected in a conical flask containing 25 mL of 4 per cent boric acid solution and 2-3 drops of  $W_1$ =Weight of empty Soxhlet flask  $W_2$ = Weight of Soxhlet flask containing fat methyl red and bromocresol green indicator. The distillate obtained was titrated against standard 0.02 N  $H_2SO_4$  till the endpoint (pinkish-red colour) appeared and the titre value was noted. Total protein content was calculated by multiplying per cent nitrogen by factor 6.25 to obtain the value of protein and 5.71 for soybean and soybean-based products.

$$\text{Nitrogen (\%)} = \frac{\text{Titre value (mL)} \times \text{Normality of acid}}{\text{weight of sample (g)} \times 1000} \times 100$$

$$\text{Protein (\%)} = \text{Nitrogen\%} \times 6.25$$

### 2.3. Crude Fat

AOAC [10] was anticipated for analysis of fat content using Automatic Soxhlet Apparatus (Soxtron). For analysis, the solid sample was ground into powder while the liquid sample was first dried in a hot air oven at 60°C followed by conversion into powder. Two g of sample (W) was weighed and transferred into the thimble which was placed in the thimble holder. After that, the thimble holder was adjusted in a pre-weighed collection vessel (W<sub>1</sub>) and fitted into the apparatus. The fat was extracted at 80°C for 45 min using 100 mL of petroleum ether (40-60°C). Once the extraction was completed, the excess solvent in the flask was recovered and the residual fat present in the collector vessel was dried at 80°C in a hot air oven for 1 h. The vessel was allowed to cool in a desiccator and weighed (W<sub>2</sub>). The results were expressed in per cent by using the formula as stated below:

$$\text{Fat (\%)} = \frac{W_2 - W_1}{w} \times 100$$

W=Weight of dried sample

W<sub>1</sub>=Weight of empty Soxhlet flask

W<sub>2</sub>= Weight of Soxhlet flask containing fat

### 2.4. Crude Fibre

The crude fibre was analysed using AOAC [10] method in the FibroTRON Automatic Fiber Analysis System (Tulin Equipments). One gram sample (W) was weighed and placed in a glass crucible which was fitted into the digestion block. To this, 1.25 per cent sulphuric acid (200 mL) was added and heated at 350°C for 30 min. The crucible was allowed to cool and the acid solution was drained off. The residue was washed thrice with hot distilled water. The same procedure was repeated using 200 mL of 1.25 per cent of sodium hydroxide. The crucible was removed and kept in a hot air

$$\beta\text{-carotene (mg/100g)} = \frac{\text{Concentration (mg)} \times \text{Final volume (mL)} \times \text{dilution (mL)}}{\text{Weight of sample (g)}} \times 100$$

### 2.7. Ascorbic Acid

AOAC [16] official method was followed for the determination of Ascorbic acid content. Three per cent meta-phosphoric acid solution was used for the preparation

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre value (mL)} \times \text{Dye factor} \times \text{volume made up (mL)}}{\text{Aliquot of extract taken for estimation (mL)} \times \text{Weight of the sample (g)}} \times 100$$

$$\text{*Dye factor} = \frac{0.5}{\text{Titre value of standard}}$$

### 2.8. Total Ash

Total ash was determined by AOAC [9]. Total ash content was determined gravimetrically by taking the known weight of samples in tarred silica crucibles. The dried samples after moisture determination were slowly heated over a hot plate until the bulk of organic matter was burnt. The crucibles were then placed in a muffle furnace for ashing at 550°C to

oven for drying at 100-105°C for 2 to 4 h. The material was cooled in a desiccator, weighed (W<sub>1</sub>) and subjected to ashing in a muffle furnace at 550-600°C for 4-6 h. After ashing the crucible was cooled in a desiccator and weighed (W<sub>2</sub>). The crude fibre was calculated and results were expressed in percent.

$$\text{Fibre} = \frac{W_1 - W_2}{w} \times 100$$

Where:

W= Weight of dried sample

W<sub>1</sub>= Weight of crucible and content before ashing

W<sub>2</sub> = Weight of crucible containing ash

### 2.5. Total Carbohydrate

Total carbohydrate was calculated by differential method by AOAC [15]

$$\text{Total carbohydrates (\%)} = 100 - [\text{Protein (\%)} + \text{Fat (\%)} + \text{Ash (\%)} + \text{Moisture (\%)}]$$

### 2.6. $\beta$ -carotene

$\beta$ -carotene was determined by Ranganna [14]. A known weight of the sample (2-5 g dried or 20- 25 g fresh) was dissolved in the solvent (acetone). The sample was ground till the whole colour was extracted and the residue became colourless. The extract was transferred into a separating funnel. A separated coloured portion was collected after adding petroleum ether and 5 per cent sodium sulphate solution. The final volume was made up to 25 mL. The optical density was recorded at 452 nm and the reading was compared with the standard curve. The concentration of  $\beta$ -carotene in the sample was calculated using a standard curve and the quantity was expressed in mg/100.

of sample and standard L-Ascorbic acid. The sample was titrated against 2, 6-dichlorophenol-indophenol dye till the light pink colour persisted for at least 15 sec. The Ascorbic acid content was calculated as per the formula given below:

obtain carbon-free white ash with constant weight. The Ash content of the sample was then calculated and expressed as per cent on a fresh weight basis.

$$\text{Ash (\%)} = \frac{\text{Weight of ash (g)}}{\text{Weight of fresh sample}}$$

### 2.9. Total Energy

Total energy was calculated by the differential method by AOAC [15].

$$\text{Total energy (Kcal)} = [(\text{Protein (g)} \times 4) + (\text{Fat (g)} \times 9) + (\text{carbohydrates (g)} \times 4)]$$

### 2.10. Mineral Analysis

The mineral content of fresh and processed samples was determined using [17]. Mineral contents including Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Zinc (Zn) and Iron (Fe) from OFSP samples were determined by using an Atomic Absorption/Flame Emission Spectrophotometer (AA 630-12). Absorbencies cations read at 422.7nm, 285.2nm, 589.0nm, 766.5nm, 213.9 nm and 5248.3nm for Calcium, Magnesium, Sodium, Potassium, Zinc and Iron, respectively. The mineral content (mg/100g) is calculated as below:

$$\text{Mineral content mg/100g} = \frac{\text{Rx100ml D.F}}{\text{S} \times 1000} \times 100$$

Where:

R = Reading in ppp

100 = Volume of sample made (ml)

D. F = Dilution factor

1000 = Conversion factor to mg/100g

S = Sample weight

### 2.11. Sensory Evaluation Procedures

Twenty-five panelists were randomly selected from Nyakasanga village in the study area to conduct a sensory evaluation as suggested by Sidel and Stone [18]. A 5- point Hedonic scale was used with 5- representing “like very much” while 1 “dislike very much” on attributes including colour, taste, texture, aroma and general acceptability. Cooked root samples were saved in disposable plates with three randomly coded digits. Panelists were provided with warm water for mouth rinsing after each test. For each coded sample, panelists were to evaluate colour, taste, texture, aroma and overall acceptability. Each panellist was required to test each sample at a time until all samples were finished. Each test attribute was filled in a sensory evaluation form that was provided to every panellist.

## 3. Results and Discussion

The results of chemical characteristics of OFSP fresh roots are presented in Tables 1 and 2.

### 3.1. Moisture Content

Table 1 compiled the nutritional components of OFSP roots in fresh forms. The mean moisture content was 68.05, 72.01 and 67.25 per cent for Ejumla, Jewel and Carrot dar, respectively. The moisture content range (67.25-72.01%) in the present study conforms with the study done by Rodrigues *et al* and Mustafa [19-21]. Furthermore, Wenkam [22] reported that fresh sweet potatoes had a moisture content of 77.8%. The variations in the moisture content among the sweet potato varieties can be due to the differences in the genetic composition and cultivation practices. In comparison

with other roots and tubers, the sweet potato has a high moisture content and, thus, has a low dry matter content. The normal dry matter content is around 30% but differs widely depending on aspects such as variety, geographic area, climate, amount of light, soil and cultivation practices [23].

### 3.2. Crude Protein

The mean protein contents ranged from 3.82-8.86%. This contains a higher amount compared to the study findings done by Khanam *et al*; Mustafa; Rorigues *et al*; Alam *et al*. [21, 20, 19, 24]. Protein content in the diets of the low-income population in developing countries like Tanzania is derived mostly from foods of animal origin. The typical total protein content of sweet potato is as low as 1.5% FW and as high as 5% (dry weight (DW)). However, it is superior to other roots and tubers, such as cassava and inferior to potatoes and cereals [23]. These tubers contain total protein from 1.0% to 2.5% (about 5% DW) [25]. Senanaake *et al*. [26] found it in the range between 1.2% and 3.3% on a DW basis. This indicated that the OFSP in our study, cultivated in Tanzania, had higher protein content. Some other studies also found lower protein content than our study [27, 28]. The different climatic condition, variety effects, soil composition type, fertility applied and climatic condition as reported by Woofe; Yashimoto *et al*. [29] and Leighton *et al*. [31].

### 3.3. Crude Fat

The mean crude fat in the present study ranged between 0.32 to 0.51%. This is similar to the findings by Rodrigues *et al*. [19] and Mustafa [20], higher than the range analyzed by Alam *et al*. [24] and lower than the range analyzed by Khanam *et al*. [21]. In root and tubers, sweet potato is well recognized for its low-fat content. Mu *et al*. [32] found 0.6% fat for sweet potatoes, while other studies, respectively, reported the fat content of sweet potatoes to be around 0.2% and 0.17%, [27-28]. Ishida *et al*. [33] also found the fat content of sweet potatoes ranges from 0.2% to 0.33% which is lower as compared to the present study. The different climatic condition, variety effects, soil composition type, fertility applied and climatic condition [29-31].

### 3.4. Crude Fibre

The mean crude fibre in the current investigation ranged from 1.83-3.15%. The present finding demonstrates a lower value compared to the range reported by Khanam *et al*. [21] and Mustafa [20] however, it is higher than the result examined by Rodrigues *et al*. [19]. According to a study conducted by Ishia *et al*. [33], the total fibre content of 18 different types of sweet potatoes in Hawaii varied between 2.01 and 3.87 g/100 g of fresh weight. FAO [27] reported 1.2%, and dietary fibre content of sweet potatoes was reported to be in the range between 2.28% and 11.7% [33]. These ranges are higher as compared with our study. This may be due to genetic and cultivars differences. However, Ingabire and Vasanthakalam [35] found 0.11% to 0.14% in the Rwandan varieties in their study. On the other hand,

based on dry weight, Oboh *et al.* [36] found that the crude fibre content of 49 sweet potato varieties ranged between 3.45% and 6.36%, and Senanayake *et al.* [26] found it in the range between 2.1% and 13.6% in Sri Lankan varieties. Dietary fibre has recently received much importance, as it is believed to reduce the incidences of colon cancer, diabetes, heart disease and certain digestive diseases [37].

### 3.5. Total Carbohydrates

The mean total carbohydrates analyzed in the present study (87.05-92.60%) are similar to the findings by Rodrigues *et al.* [19] and higher to the range by Khanam *et al.*; Mustafa; Alam *et al.* [21, 20, 24]. Wenkam [22] in his study stated that fresh sweet potato contained 27% of carbohydrates, and [27] reported 28% for fresh samples. Thus, we found higher carbohydrates compared to these studies, and the reason could be factors like varieties and stages of maturity of the roots.

### 3.6. $\beta$ -carotene

The mean  $\beta$ -carotene content in the present study ranges from 5,165 to 113,565  $\mu\text{g}/100\text{ g}$ . This amount is higher as compared to the range reported by Alam *et al.*; Ukpabi *et al.* [38, 39] who reported the amount of  $\beta$ -carotene from fresh OFSP roots ranging from 375.80 to 6710.50  $\mu\text{g}/100\text{g}$  and 3,868 to 6,636  $\mu\text{g}/100\text{g}$ , respectively. In addition, another study done by Institute of Medicine [40] reported that the content of  $\beta$ -carotene ranged from 300 to 1,300  $\mu\text{g}/100\text{g}$ . Conversely, Woofe [41] reported the amount of  $\beta$ -carotene in fresh OFSP was about 4,000 $\mu\text{g}/100\text{g}$  in fresh weight basis. The differences observed among these studies may be due to differences in climatic condition, variety effect, soil composition type and fertility applied as reported by Woofe [41] and Leighton *et al.* [31].

### 3.7. Ascorbic Acid

The average concentration of Ascorbic acid in fresh OFSP varied ranged between 15.04-17.27 mg/100g, as indicated in Table 1. Furthermore, a statistically significant difference ( $p \leq 0.05$ ) was seen among the different kinds of OFSP in terms of their Ascorbic acid content. The results of the present investigation contrast markedly with those of a previous study conducted in South Africa [40]. This study claimed that the concentration of Ascorbic acid in raw OFSP root was found to be 22.7mg/100g, which is notably higher than the levels seen in the current study. The mean range of Ascorbic acid in the present study is higher as compared to the range (4.85-5.73 mg/100g) reported by Alam *et al.* [38]. This may be due to different climatic condition, variety effects, soil composition

type, fertility applied and climatic condition as reported by Woofe; Yashimoto *et al.*; Leighton *et al.* [29-31].

### 3.8. Total Ash

The ash content of OFSP fresh roots in the current study revealed the amount of 1.09, 1.07 and 0.86% for Ejumla, Jewel and Carrot dar, respectively (Table 1). In a study conducted by Alam *et al.* [24], the ash content of orange-fleshed sweet potatoes (OFSP) was found to range from 1.17% to 1.31%, which was seen to be higher than the ash level recorded in the current study. According to Goodboy [42] findings, the ash concentration in fresh sweet potato was determined to be 1.7%. Similarly, Ingabire and Vasanthakalam [35] conducted a study and reported that the ash percentage in fresh sweet potato tubers ranged from 0.40% to 0.44%. Based on the observed quantities, it was determined that the sweet potato cultivars had a lower overall ash level. Several factors may contribute to this reduced total ash content. One possible factor could be the use of fertilizer. Application of fertilizer together with sufficient irrigation can influence the nutrient content of OFSP, especially the mineral content [25]. Besides fertilizer, the ash content of sweet potato varieties can also be influenced by other aspects, like soil, climatic conditions, etc. [44].

### 3.9. Total Energy

The total energy in the current study ranged from 385.19 to 389.92 Kca/100 g.

### 3.10. Minerals

The fresh roots of OFSP are considered to be a valuable mineral source. This study examined a limited number of minerals, as indicated in Table 1. However, it is important to note that numerous other minerals were not included in the analysis, including copper, selenium, phosphorous, and others. As compared to other varieties, Jewel exhibits a notable abundance of essential minerals, including calcium (44.30mg/100g), iron (1.34mg/100g), zinc (0.35mg/100g), and potassium (317.12mg/100g). On the other hand, Ejumla is characterized by its significant content of sodium (112mg/100g) and magnesium (2.73mg/100g), rendering it a valuable source of these particular minerals. The present discovery exhibits a greater magnitude in comparison to the findings reported by Institute of Medicine [40] and Sanoussi *et al.* [45] in some minerals like iron, and zinc. Calcium, and sodium although the present study discovered low content of magnesium and potassium as compared to the study by Sanoussi *et al.* [45].

Table 1. Nutritional characteristics of fresh OFSP roots varieties.

Parameters	OFSP Fresh roots		
	Ejumla	Jewel	Carrot dar
Moisture (%)	68.05 $\pm$ 0.31 <sup>b</sup>	72.01 $\pm$ 0.25 <sup>a</sup>	67.25 $\pm$ 0.34 <sup>b</sup>
Crude protein (%)	8.86 $\pm$ 0.01 <sup>a</sup>	8.24 $\pm$ 0.08 <sup>b</sup>	3.82 $\pm$ 0.39 <sup>c</sup>
Crude fat (%)	0.32 $\pm$ 0.02 <sup>b</sup>	0.51 $\pm$ 0.07 <sup>a</sup>	0.39 $\pm$ 0.09 <sup>b</sup>

Parameters	OFSP Fresh roots		
	Ejumla	Jewel	Carrot dar
Crude fibre (%)	1.83 ± 0.12 <sup>c</sup>	3.15 ± 0.19 <sup>a</sup>	2.34 ± 0.17 <sup>b</sup>
Total carbohydrates (%)	87.90 ± 1.96 <sup>b</sup>	87.05 ± 2.12 <sup>c</sup>	92.60 ± 1.16 <sup>a</sup>
β-carotene (μ/100 g)	6,165 ± 0.05 <sup>b</sup>	113,565 ± 1.45 <sup>a</sup>	5,165 ± 3.38 <sup>c</sup>
Ascorbic acid (mg/100 g)	15.04 ± 0.04 <sup>c</sup>	17.27 ± 0.02 <sup>a</sup>	15.39 ± 0.06 <sup>b</sup>
Ash (%)	1.09 ± 0.01 <sup>a</sup>	1.07 ± 0.05 <sup>a</sup>	0.86 ± 0.07 <sup>b</sup>
Total energy (Kcal/100 g)	389.92 ± 4.13 <sup>a</sup>	385.75 ± 3.72 <sup>b</sup>	385.19 ± 2.76 <sup>c</sup>
Minerals (mg/100 g)			
Ca	37.06 ± 1.21 <sup>b</sup>	44.32 ± 0.09 <sup>a</sup>	26.04 ± 2.43 <sup>c</sup>
Mg	2.73 ± 0.04 <sup>a</sup>	1.93 ± 0.07 <sup>c</sup>	2.32 ± 0.02 <sup>b</sup>
Na	112.03 ± 2.04 <sup>a</sup>	16.04 ± 1.53 <sup>c</sup>	75.09 ± 0.06 <sup>b</sup>
Fe	0.38 ± 0.001 <sup>c</sup>	1.34 ± 0.03 <sup>a</sup>	0.64 ± 0.07 <sup>b</sup>
Zn	0.28 ± 0.02 <sup>b</sup>	0.35 ± 0.01 <sup>a</sup>	0.32 ± 0.05 <sup>a</sup>
K	200.34 ± 1.45 <sup>c</sup>	317.12 ± 2.34 <sup>a</sup>	219.84 ± 1.79 <sup>b</sup>

Mean values followed by the same letters within the row do not differ significantly at  $p \leq 0.05$  according to the *Duncan Multiple Range Test (DMRT)*

### 3.11. Sensory Characteristics of Boiled OFSP Roots

According to the research conducted by Kader [46], it was discovered that several sensory properties, including appearance, taste, texture, stickiness, and softness, have a significant role in determining the acceptability of items that have undergone different processing methods. The results presented in Table 2 demonstrate the presence of three distinct types of orange-fleshed sweet potatoes (OFSP), namely *Ejumla*, *Jewel*, and *Carrot dar*. The *Ejumla* variety achieved the highest score of 4.00 in terms of general acceptability when compared to other types. Generally, the *Ejumla* variety was the most preferred by the majority of panelists in terms of colour, taste, texture and aroma. This may be because *Ejumla* had lower fibre content and high dry matter content which makes its root to be smoother than other varieties. This finding aligns with the research conducted by Leighton [47], which showed that many varieties of OFSP exhibited comparable properties. This study also identified variations in qualities such as

moisture content, adhesiveness, and texture across these types. Leighton [47] revealed that different OFSP varieties have similar characteristics but may differ in moist content, adhesive and texture and other attributes including general acceptability similar to what was observed in the current study. In line with study by Tomlins *et al.* [48], demonstrated that some types of OFSP exhibited varying levels of preference in terms of their attributes. In the current study, the *Jewel* variety was the least preferred by consumers. The observed phenomenon may be attributed to a low dry matter content and minimal starch content, leading to inadequate product thickness. Additionally, the larger fibre content of the product contributes to a rough texture, while the elevated water content diminishes its sweetness. This finding is supported also by the study done by Leighton [47] which revealed that different OFSP varieties have similar characteristics but may differ in moist content, adhesive, texture and other attributes including general acceptability.

**Table 2.** Sensory attributes of boiled OFSP varieties.

Varieties	Colour	Texture	Taste	Aroma	Overall acceptability
<i>Ejumla</i>	4.18 ± 0.12 <sup>a</sup>	3.87 ± 0.11 <sup>a</sup>	4.18 ± 0.17 <sup>a</sup>	3.91 ± 0.12 <sup>a</sup>	4.00 ± 0.72 <sup>a</sup>
<i>Jewel</i>	3.32 ± 0.18 <sup>b</sup>	3.35 ± 0.28 <sup>b</sup>	3.32 ± 0.22 <sup>b</sup>	3.18 ± 0.11 <sup>b</sup>	3.22 ± 0.19 <sup>b</sup>
<i>Carrot dar</i>	4.23 ± 0.16 <sup>a</sup>	3.97 ± 0.17 <sup>a</sup>	4.23 ± 0.14 <sup>a</sup>	3.58 ± 0.27 <sup>a</sup>	3.83 ± 0.08 <sup>ab</sup>
CD <sub>0.05</sub>	0.22	0.17	0.33	0.45	0.38

Data represented in the table are the average pooled values (mean ± SD), the values with different superscript letters in the same column are significantly different ( $p < 0.05$ )

## 4. Conclusion

The OFSP varieties (*Ejumla*, *Carrot Dar*, and *Jewel*) have demonstrated a significant concentration of β-carotene in their raw state. Particularly, the *Jewel* variety exhibits a higher quantity of β-carotene content (113,565 μg/100g) on a fresh weight basis compared to the other varieties. Despite its increased β-carotene content, the *Jewel* type was the least favoured by consumers. On the contrary, the *Ejumla* variety demonstrated the highest score of 4.00 in

terms of overall acceptability in comparison to other sorts. In addition to β-carotene, other nutrients have been identified as abundant in fresh roots of orange-fleshed sweet potato (OFSP). These include ascorbic acid, protein, fat, fibre, ash, carbohydrates, and energy. Among the three kinds mentioned, *Jewel* is the most nutritionally dense in its fresh form compared to the others. While it is true that fresh roots of orange-fleshed sweet potato (OFSP) cultivars are highly nutritious, it is important to note that they are not suitable for consumption in their raw state. Additionally, it is suggested that the nutritional quality of basic foods be

enhanced by including OFSP roots in formulation of several dishes such as oatmeal, soup, and vegetables. This measure aims to address the issue of micronutrient deficiencies prevalent in poor nations.

## ORCID

Abdulsudi Issa-Zacharia: 0009-0001-1357-6944

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## Conflicts of Interest

No conflict of interest is identified among the authors

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