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Processing of Orange-fleshed Sweet Potato Extract and Effect of Storage Conditions on Some Physicochemical Properties of Orange Fleshed Sweet Potato-based Drink Extract

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Authors' contributions

This work was carried out in collaboration among all authors. Author RMO designed the study, carried out the laboratory work, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author JCA vetted the protocol and the first manuscript. Author JME took part in the laboratory work data entry for analysis. All authors read and approved the final manuscript.

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ABSTRACT

The present study aims to find out the suitable storage condition of Orange-Fleshed Sweet potato (OFSP) beverage that will effectively retain the nutrient. Availability of OFSP may not necessarily translate to the bioavailability of the vitamin if the vitamin source is not optimally processed and utilized. Information about the processing and utilization of conventional white and pinkish-fleshed sweet potato, There is a paucity of information on the appropriate processing methods of OFSP and possible storage condition of such beverage. The drinks were analyzed for Total soluble solid (TSS), pH and Viscosity on the zero-day before storage. The total soluble solids (Brix) of the drink was measured with a digital refractometer (DR-122 Code No: 44-905, London). Based on the results of this study OFSP drink may be utilized and best consumed when freshly produced if there

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is a need to store at ambient (27ºC) conditions, it should not exceed 48hrs. If OFSP drink is stored under refrigerated (4-8ºC) condition, it should not exceed 7days to retain its nutritive and sensory attributes.

Keywords: Sweet potato; viscosity; total soluble solid; refractometer.

1. INTRODUCTION

Vegetable juice or beverage is a drink made primarily from an extract of blended vegetables. It serves as a low-sugar alternative to fruit juice [1]. Orange-Fleshed Sweetpotato (OFSP) is a pro-vitamin A (β Carotene) bio-fortified root crop. It was developed to diversify the sources and intake of pro-vitamin A [2]. However, availability of OFSP may not necessarily translate to the bioavailability of the vitamin, if the vitamin source is not optimally processed and utilized. Information abounds on the processing and utilization of conventional white to pinkish-fleshed sweet potato, but there is the paucity of information on the appropriate processing methods of OFSP and possible storage condition of such beverage [3]. Drinking fresh vegetable juice allows one to consume more vegetables than one would normally be able to eat otherwise or ordinarily [1]. The use of OFSP extract may also have some health benefits due to the presence of an appreciable concentration of β-carotene in OFSP. The aim of this study was to find out the suitable storage condition of OFSP beverage that will effectively retain the nutrient.

2. MATERIALS AND METHODS

2.1 Sample Collection

The OFSP roots were obtained from sweet potato field of the National Root Crops Research Institute (NRCRI) Umudike.

2.2 Preliminary Experiments

Prior to the actual extract preparation, the water ratio in sweet potato was evaluated. Six (6) batches (100g each) of OFSP were extracted with varying (50, 100, 150, 200,250 and 300ml) volumes of water as shown in Fig. 1. The extracts obtained were evaluated for colour intensity as an index of total carotenoids content, extract yield and degree of liking in term of colour and taste. Data generated were subjected to statistical analysis to select optimal sweet potato: water ratio. The selected was used for the actual extract preparation to be used for further work such as formulation of OFSP beverage.

Determination of Percentage extract yield: The method described by Mugwiza and Qian [4] was used on the weight of the sample and the volume of water used. The volume of the extract obtained and water used was measured and the percentage yield of the beverage (% EY) was calculated using the following expression:

$$(\%\ EY) = W1\text{-}W2/W1 \times 100$$

where

W1 = extract obtained
W2 = Total weight of water used

Orange-Fleshed Sweeet potato (OFSP) beverage prepared per the method described by Omodamiro et al. [5,6] and guided by the recommendations of NIS [7] and Codex Alimentarious, (2000) was packaged and corked in a plastic bottle and then stored for Physico-chemical properties evaluations.

Beverage storage: Equal number of bottled and sealed freshly prepared OFSP beverage were kept under two storage conditions: ambient (27ºC ± 3ºC & Relative Humidity (RH) 70.5 ± 5%) for 72h and refrigerated (4ºC) conditions for 35 days. Drinks stored under shelf condition were evaluated 24 hourly for 3 days and weekly interval for those under refrigerated condition.

Physicochemical analyses: The drinks were analyzed for Total soluble solid (TSS), pH and Viscosity on the zero-day before storage. The total soluble solid (^{0}Brix) of the drink was measured with a digital refractometer (DR-122 Code No: 44-905, London). The pH of the beverages was determined with a pH meter (Jen Way 3015 pH meter, England).

Viscosity: The cold paste viscosity of beverage samples was measured with digital Viscometer (Surgifriend medicals, model NDJ-5S, England). The beverage (150 ml) was measured into a transparent container. Spindle number 1 was fixed to the viscometer and the speed was set at 60 rpm. Viscosity reading was taken after 30 seconds to avoid vortex effects and sedimentation of solids in the beverage sample.

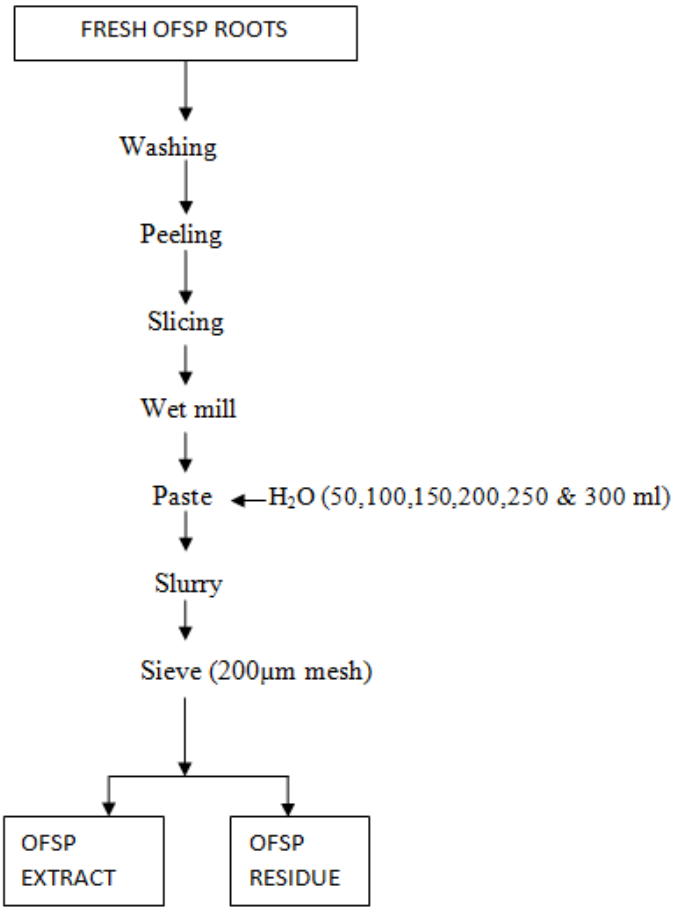

Fig. 1. Flow chart for the preliminary extraction of Orange-Fleshed Sweetpotato (OFSP) extract

The spindle was dipped into the beverage until the sensitive portion of the spindle was immersed in the sample then the reading was taken. Reading was in millipascal per second which is equivalent to the old unit in centipoise.

Titratable acidity: Standard method as described by Antony and Chandra [8] was used to measure titratable acidity. The sample (5 ml) was homogenized in distilled water (20 ml) and filtered through Whatman No.1 filter paper. Phenolphthalein (2drops) was added to 20ml of the filtrate as the indicator and titrated against 0.05 M NaOH to purple end. Titratable acidity was calculated and expressed as citric acid/100 g of juice using the formula:

TA = N NaOH x Volume NaOH x 0.09 x 100 juice sample

Total soluble solid-TSS, (^{o}Brix): The total soluble solid (^{o}Brix) of the beverages were evaluated with a digital refractometer (DR-122 Code No: 44-905, London) and the pH with a pH meter (Jen Way 3015 pH meter, England). Day zero analysis was carried out for each parameter before storage.

Statistical analysis: Data were subjected to analysis of variance using statistical analytical system (SAS) software, version 8, (2009). Means separation was done using Fischer LSD to determine significant differences.

3. RESULTS AND DISCUSSION

3.1 Effect of Volume of Extractant on OFSP Extract Yield and Dissolved Soluble Solid Content

Results of extract yields and the corresponding dissolved soluble solutes are shown in Table 1.

Table 1. Effect of volume of water on yield and total soluble solute

Volume (ml) of extractant (water)	Yield of extract (%)	Dissolved soluble (mg/l)
50	30.0^{d}±1.15	9.06^{a}±0.57
100	35.0^{d}±1.15	7.78^{b}±0.57
150	50.0^{c}±2.88	7.33^{c}±0.57
200	55.5^{bc}±0.57	6.73^{d}±0.57
250	58.0^{b}±1.15	5.53^{e}±0.57
300	65.0^{a}±0.58	4.73^{f}±0.57
p-value		

Values in the Table are meant ± standard deviations of 10 replicates. Means with different superscripts in the same column differ significantly (p< 0.05)

Table 2. Effect of volume of extractant (H_2O) on the taste and colour of OFSP extract

Volume (ml)	Colour	Taste
50	4.6^{a}±0.05	4.2^{a}±0.06
100	4.5^{a}±0.05	4.3^{a}±0.07
150	4.5^{a}±0.06	4.0^{a}±0.30
200	4.2^{a}±0.04	4.0^{a}0.30
250	3.3^{b}±0.08	3.4^{a}0.07
300	3.0^{b}±0.33	3.2^{a}±0.05

Values are means of 10 replicates at 5-Point scale. Means with different superscripts in the same column differ significantly (p< 0.05)

Table 3. Effect of ambient (27^0C) storage on the physicochemical properties of the OFSP drink

Storage time (days)	pH	Viscosity (mpa.s)	TSS (^{o}Brix)	Specific Gravity
0	6.50^{a}	88.40^{a}	7.60^{a}	1.06^{a}
1	6.46^{a}	86.40^{b}	7.60^{a}	1.06^{ab}
2	4.72^{b}	84.40^{c}	4.20^{b}	1.03^{bc}
3	3.36^{c}	82.70^{d}	2.20^{c}	1.01^{c}

Values are means of triplicate determinations. Means with different superscripts in the same column differ significantly (p< 0.05)

The yield differed significantly (p<0.05) with an increase in the volume of extractant (water).

Expectedly increase in the volume of extractant increased OFSP extract yield and decreased total soluble solid content of the extract. There was no significant difference between extract yield from 50 ml and 100 ml extractant, similarly yield from 150 ml and 200 ml extractant volume did not differ significantly (p>0.05) but the total soluble solid contents differed significantly due probably to dilution effects. This implies that 200 ml extractant could be used for the extraction to obtain more beverage volume though with relatively lower TSS.

Table 2 shows the Taste and colour mean scores of the preliminary extract as influenced by the volume of extractant. Extracts from 50 ml to 200ml extractant showed colour scores that ranged from 4.2 to 4.6 which did not differ statistically (p>0.05). Extracts from 250 and 300 ml extractant differed significantly (p>0.05) from others which imply that the volume of extractant at these levels may not be acceptable to consumers, due to low concentration of soluble solid content in the extract. Conversely, all the extracts showed comparable taste (p>0.05) score irrespective of the volume of extractant used. The 200ml volume of extractant was therefore chosen as the optimal volume of extractant.

3.2 Effects of Storage on the Physicochemical Properties of Stored OFSP Beverage

Results of the effect of storage on the physicochemical properties of the beverage stored under ambient (27ºC) condition are presented in Table 3. Significant differences (p<0.05) were observed in the physicochemical parameters of the freshly prepared OFSP beverages and those stored under ambient

Table 4. Physicochemical properties of OFSP beverage stored under refrigerated (4^0C) condition

Storage time (Day)	pH	Viscosity (mpa.s)	TSS (^{o}Brix)	Specific gravity
0	6.50^a	88.40^a	7.60^a	1.06^a
1	6.50^a	88.40^a	7.60^a	1.06^a
2	6.50^a	88.40^a	7.60^a	1.06^{ab}
3	6.50^a	88.30^a	7.60^a	1.06^{ab}
7	6.46^a	82.40^b	7.20^b	1.05^{abc}
14	5.13^b	80.35^c	6.80^c	1.04^{abc}
21	4.75^c	80.40^c	6.50^d	1.04^{bcd}
28	4.70^c	76.50^d	6.30^e	1.03^{cd}
35	3.56^d	76.10^e	5.60^f	1.02^d

Values are means of triplicate determinations. Means with different superscripts in the same column differ significantly ($p< 0.05$)

condition (27ºC) day 2 and 3. The pH reduced from 6.50 to 6.46 on day 1, 4.72 on day 2 and then 3.36 on day 3. The decrease in pH values was due to the increase in acidity of the beverage. Tariku et al. [9] reported similar observations.

The viscosity decreased from 88.40 to 86.40 in day 1, 84.40 on day 2 and then 82.70 (mpa.s) on day 3. The TSS reduced from 7.60 to 4.20 on day 2, and then 2.20 (^{0}Brix) on day 3. The specific gravity decreased from 1.06 to 1.06 on day 1; 1.03 on day 2 and then 1.01 on day 3. The increase in acidity could be attributed to possible fermentation of the drink, probably due to microbial activity which agreed with the reports of Imungi et al. [10] and El-Zoghbi et al. [11]. This explains the reason for the reduction in TSS 7.60 to 2.20^{o}Brix. The viscosity of the beverage was stable for two days then subsequently dropped by 5.7% on day 2 and finally to 82.7 mpa.s on day 3. The decrease in viscosity was probably due to the reduction in TSS which contributed to the body of the beverage.

Table 4 shows the effects of refrigeration (4-8^{o}C) storage on the physicochemical properties of the OFSP drink. Results showed that OFSP kept under refrigerated condition could store for up to 28 days before the pH decreased to 4.7, a value attained within 2 days of ambient storage. The TSS reduced from 7.60 to 5.60^{o}Brix; viscosity from 88.40 to 76.10 mpa.s and specific gravity from 1.063 to 1.020 for the refrigerated samples. High sugar concentration in the refrigerated samples could inhibit bacterial growth while the low pH in the shelf stored drinks probably due to fermentation could also be used to inhibit microbial growth. There was no appreciable change in the values for TSS content of the refrigerated drinks until day 35.

4. CONCLUSION

Based on the results of this study OFSP drink may be utilized and best consumed when freshly produced if there is a need to store at ambient (27ºC) conditions, it should not exceed 48hrs. If OFSP drink is stored under refrigerated (4-8ºC) condition, it should not exceed 7days to retain its nutritive and sensory attributes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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