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Carotenoid Stability and Quantity of Different Sweet Potato Flesh Colour over Postharvest Storage Time

[1]S.M. Hussein, [1, 2]I. Jaswir, [1, 2]P. Jamal, and[2, 3]R. Othman

[1]Department of Biotechnology Engineering, Faculty of Engineering, International Islamic University Malaysia, P.O. Box 10, Kuala Lumpur 50728, Malaysia.
[2]International Institute for Halal Research and Training (INHART),Faculty of Engineering Buildings, International Islamic University Malaysia, P.O. Box 10, Kuala Lumpur 50728, Malaysia.
[3]Herbarium Unit, Department of Landscape Architecture, Kulliyyah of Architecture and Environmental Design, International Islamic University Malaysia, P.O. Box 10, Kuala Lumpur 50728, Malaysia.

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ABSTRACT

Sweetpotato*(Impomeabatatas)* or locally known as '*keledek'*in Malaysia, is one of the popularcrops grown by small farmers for the fresh market. Sweet potato is a rich crop with carbohydrates, carotenoidsand pro-Vitamin A.Carotenoids are antioxidants with pharmaceutical potential and have attracted the interest ofresearchers from diverse fields including, biochemistry, biology, food science and technology, medicine, pharmacy, and nutrition for more than a century.Malaysian climate is suitable for sweet potato growingandthere are 10 popular sweet potato variety recommended to grown in Malaysia. This study was conducted to identify which type of Malaysian sweet potato ttuber is the best in its content of carotenoids. Moreover, this study was carried out to evaluate and compared the total carotenoid content (tot. carot. cont.) and their stability in themost popular, available and cheapest variety of Malaysian sweet potato tuber over different postharvest storage time of four types of fresh flesh of sweet potato (SP) from KL, Malaysian local markets. Totalcarotenoid content were identified by spectrophotometric method for the powder of freeze dried of flesh for; orange, yellow, purple and white sweet potatofresh samples. The results of this study showed that the orange sweet potato flour showed the highest value in total carotenoid content for the whole four weeks of storage comparing to the other types of sweet potato followed by yellow, purple and white sweet potato for four weeks storage. Total carotenoid content ranged from 111.18 µg/g dry weight (DW)in white sweet potatoWSP to 382.217 µg/gdry weight (DW)in orange sweet potato (OSP) in the first week of storage, while the fourth week of storage shows that total carotenoid content ranged from 42.903 µg/g DW in white sweet potato WSP to 233.182 µg/g DWin orange sweet potato OSP.This study showed that the local varieties of sweet potatoes differ among themselves with respect to the content of carotenoids in tubers before and after storage. The postharvest storage time was influenced by the quantity and stability of those four types of fresh flesh of sweet potatoes nutritional values.

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INTRODUCTION

Sweet potatoes grow well in tropical, subtropical, and temperate areas. Sweet potatoes originated in the New World and were introduced into Spain, India, and the Philippines by Spanish explorers in the 15th and 16th centuries. Their distribution is now worldwide. In parts of Africa, Asia, and the Pacific, sweet potatoes are an important staple crop [1, 2]. Sweet potato is an emergency crop in Asia, and it is usually associated with hard times; wars, typhoons, other natural disasters, and economic disruptions. Sweet potato is a crop of the smallest and poorest farmers [3].

Sweet potato is one of the most important tuber crops for fresh consumption in Malaysia. It is traditionally grown for the fresh root market with a very small percentage being processed into traditional snacks such as kerepek (sweet potato crackers) or cakarayam (fried sweet potato)[4]. The storage roots can also be commercially processed and used in the manufacturing of various food and non-food products. These include flour, starch, health food, baby food and animal feed [5].

Corresponding Author: Irwandi Jaswir, Department of Biotechnology Engineering, Faculty of Engineering, International Islamic University Malaysia, P.O. Box 10, Kuala Lumpur 50728, Malaysia.
Tel: 603-6196 4549; Fax: 603 6196 4442; Email: irwandi@iium.edu.my

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Sweet potato (*Ipomoea batatas*) is a perennial tuber. Flowers can be white or purple, and leaves can be green or purple. Flesh can be white, cream, yellow, orange, or purple [1, 2], with orange, white, and cream the most commonly grown and eaten. Both the leaves and, more commonly, the tuberous roots are eaten [1, 2].

Sweet potatoes can be grown from seeds, but they mainly are propagated from root cuttings, a simple technique useful for subsistence farming. They grow well in hot, humid climates but need a rather long growing season of approximately 90 to 150 frost-free days [2]. Sweet potatoes normally flower insummer and bear fruit in late summer and fall, thus providing a source of carotenoids and vitamin A (VA) in the fall and winter. Sweet potatoes are a nutritious food and protein, but rich in carbohydrate. Tubers and leaves are good sources of antioxidants [6], fibre, zinc, potassium, sodium, manganese, calcium, magnesium, iron, and vitamin C [7].

Recent studies associating consumption of foods rich in carotenoids with a decreased incidence of certain cancers in humans, and the possible role of carotenoids in immunity, fertility, and early prophylaxis of cardiovascular diseases in livestock have generated interest in these compounds [8]. Carotenoids are primarily of plant origin and β-carotene, with few exceptions, predominates. β-carotene serves as an important nutritional component in foods, as a major precursor of vitamin A, and it provides pleasant yellow-orange colours to foods [9].

Sweet potato has been receiving increasing attention from agriculturalists and ecologists interested in developing sustainable food production systems in the tropics, in part because it can grow on soils with limited fertility, is relatively drought tolerant, provides good ground cover, and is usually cultivated without fertilizer or pesticide. Also, it has remarkable pro-vitamin A quantities [1]. In parts of West, Central, and East Africa, sweet potato is an important staple food source of calories and is consumed by all age-groups, but is particularly liked by children, who also are at most risk of vitamin A deficiency [10]. Widely consumed varieties, however, are white or pale yellow in flesh color and contain very little β-carotene [11].

Orange-fleshed sweet potatoes (OFSP) are also very good sources of VA [6, 10, 12]. Because of their nutritional qualities, sweet potatoes were selected as one of the foods tested for long-term space travel [13]. Because of their high carotenoid content and good yields, OFSP have also been used in several small-scale studies to increase VA status [14]. Orange-fleshed sweet potato storage roots high in carotenoids and pro-vitamin. Consumption of orange-fleshed sweet potatoroots and sweet potato-based processed foods would provide sustainable, cost-effective, and necessary vitamin A. Therefore, the use of orange-fleshed sweet potatoes as a food source of pro-vitamin A merits further attention.

MATERIALS AND METHODS

Sample Preparation:

Sweet potato (SP)sampleswere bought from Gombak, local market (OTK), KL in Malaysia. Samples were cut to reduce the size and were freeze-dried for 72 hr, after which the samples were ground into fine powder and kept at -20°C until further analysis.

Sample extraction:

The extraction procedure essentially follows the methods described by [15], with some modification. 0.1 g of each powderedsample was rehydrated with distilled water and extracted in acetone: methanol mixture (7:3) containing calcium carbonate (0.1 w/v). The samples were mixed well and left overnight in darkness at room temperature. The following day, each sample was vortexed and centrifuged for 5 minutes at 10000 g and supernatant was collected. The extraction procedure for every sample was repeated until the supernatant or the tissue is colourless, but at this time, without additional calcium carbonate. The pooled supernatant were centrifuged to remove fine particles and then stored at -20 ºC in the dark prior to analysis. In brief, the carotenoids were extracted by adding in hexane and distilled water to the pooled supernatant. The mixture was then allowed to separate under centrifugal force and the upper hexane layer was collected. The procedure (without addition of distilled water) was done until the hexane layer seemed colourless. The combined hexane extracts would be dried completely under a gentle stream of oxygen-free nitrogen. Vials/tubes would then be capped and sealed to prevent oxidation and immediately stored at -20 ºC until subsequent analysis.

Determination of total Carotenoid content:

The dried carotenoid was re-suspended in 150 µl of ethyl acetate for determination of tot. carot.. 50 µl of the re-dissolved sample was then diluted with 950 µl chloroform for spectrophotometric analysis. The steps of extraction and re-suspension,were repeated at least three times for each sample.Tot.carot.concentration was determined by spectrophotometric method as described by [15]. The dried extracts were subjected to re-suspension in ethyl acetate and then diluted in chloroform for determination of tot. carot.. The carotenoid-containing solutions were measured at three wavelengths: 480 nm, 648nm, and 666nm. The Wellborn Equation [16], in chloroform was applied to obtain the total carotenoid content as described below:

$C_a = 10.91A666 - 1.2A648$ (1)

$C_b = 16.36A648 – 4.57A666$ (2)

$C_{x+c} = (1000A480 – 1.42C_a – 46.09C_b)/202$ µg/ml (3)

Wheres; C_a= concentration of carotenoid *a*; C_b= concentration of carotenoid *b;* and $_{Cx+c}$ = total carotenoid concentration.

Statistical analysis:

Mean and standard deviations, were computed using Microsoft Excel software.

RESULTS AND DISCUSSION

In this study, it is the first time that Malaysian sweet potato's carotenoids to be extracted, quantified and successfully the effect of storage was investigated. So, the results from this study for those four local varieties of Malaysian sweet potatoes samples, would providenew information of the carotenoids content that can be found in variety species of carotenoids in the most popular, available and cheapest variety of Malaysian sweet potato over storage period time.

Fig. 1 shows the total carotenoid content(tot. carot. content) measured by (µg/g) DW in four types of sweet potato; orange, yellow, purple and white sweet potato.Fig 1 and Table 1 shows that the highest tot. carot. wasobserved in the orange sweet potato OSP sample, at 382.217(µg/g) DWfollowed by the yellow sweet potato YSP sample with value of 122.962 (µg/g)DW,and the lowest tot.carot.was shown in the white sweet potato WSP sample, at 111.18(µg/g)DW.Comparing to this study and according to [17], the values of total carotenoid content in orange sweet potato was 294.5 and 250.3µg/g DWinformUganda and UK, respectively, this findings indicate thatcarotenoid content level differsdepending on the extraction method, the drying method and environmental factors.Also, that mentioned study found that orange-fleshed sweet potato (OFSP) could make a major contribution to tackling vitamin A deficiency in affected countries where sweet potato is commonly consumed. There is a potential to make a variety of products from OFSP, and drying is a viable option for OFSP processing.

Moreover, both purple and white sweet potato samples had almost the same total carotenoidscontent, 116.275(µg/g)DWand 111.18(µg/g)DW, respectively as shown in Fig. 1 and Table 1.

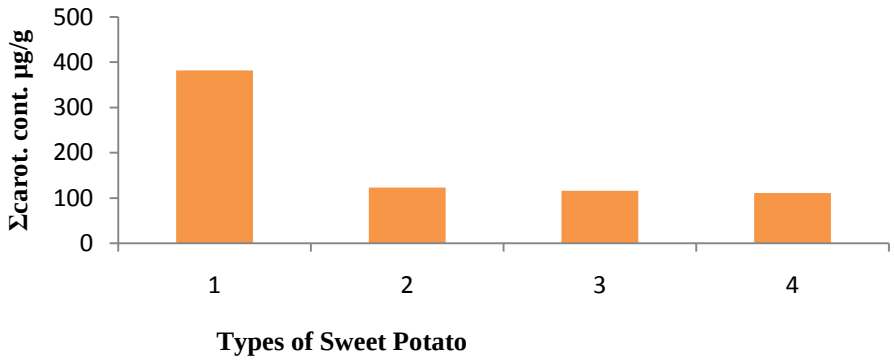

Fig. 1: Total content of carotenoids (µg/g)/ DW in; 1: orange, 2: yellow, 3: purple and 4: white sweet potato.

Table1 shows the total carotenoid content(µg/g DW) in four types of Malaysian sweet potato SP; orange, yellow, purple and white SP for four weeks storage. Decreasing the amount carotenoids during storage can be explained due tocarotenoid degradation. This finding is emphasized by the findings of [17] study, he found that sweet potato variety had a significant impact on total carotenoid loss during storage time.The highest tot.carot. in the first week was shown in the OSP sample, at (382.22± 2.18µg/g DW) and it is obviously continued to be the top during the 4 weeks storage time comparing to yellow, purple and white SP.Meanwhile, the lowest tot.carot. was shown with the value of (111.18±0.71 µg/g DW) in white SP and was continued to be the less during the 4 weeks storage time comparing to orange, purple and white SP.In the same time, both yellow and purpleSP samples had tot. carot.,**(**122.96±1.54 µg/g DW) and(116.28±1.80µg/g DW), respectively as shown in Table 1. In addition, in this current study, the lowest tot. carot. was shown in the whiteSP (WSP) sample, at range of (111.18±0.71- 42.90±0.63) µg/g DW, for the whole four weeks of storage [12] also detected the total carotanoid content in different colures of sweet potato and found that the highest carotenoid content was consistently exists in orange sweet potato, with low to very carotenoids in yellow and white sweet potato. [17] found in his study that sweet potato variety had a significant impact on total carotenoid loss during storage time. At the same time results obtained from these storage experience shows that yellow sweet potatoYSP in the second, third and the fourth week of storage has almost maintained the value of tot. carot. at the rate

between(91.27±2.01-87.63±0.31-81.96±4.50)µg/g, respectively.It is essential to understand the losses of carotenoids occurring in the drying of orange-fleshed sweet potato (OFSP) in order to achieve products with adequate nutritional quality [12, 18].

Table 1: Total carotenoids content (µg/g) in; orange, yellow and white sweet potatofor dour weeks storage.

SAMPLE	1st WEEK	2nd WEEK	3ed WEEK	4th WEEK
Orange	382.22± 2.18	308.81± 3.08	262.16± 1.34	233.18± 0.97
Yellow	122.96±1.54	91.27±2.01	87.63±0.31	81.96±4.50
Purple	116.28±1.80	84.53±4.11	71.36±0.06	58.54±1.45
White	111.18±0.71	82.33±5.53	51.32±0.98	42.90±0.63

The experiments were done in triplicate (n=3).

Conclusions:

This study showed that the Malaysian orange sweet potato was the best in its content of carotenoids, comparing to other types of Malaysian sweet potato tubers. Moreover, the study of the stability and quantity of carotenoids in different sweet potato flesh colour over postharvest storage time showed that the highest total carotenoid content was in orange sweet potato flesh sample followed by the yellow and the lowest was in the white sweet potato flesh sample. All samples were observed decline in total carotenoid content after 4 weeks of storage. It can be conclude that postharvest storage time will influence the quantity and stability of sweet potatoes nutritional values.Therefore, and due to its cheapness and availability throughout the year, Malaysiansweet potato consideredto bea potential source of carotenoids which have the ability to fight Vitamin A deficiency, reduce the incidence of certain types of cancer in humans, and the role that could carotenoids play in the immune system and fertility, it is highly recommended to use the sweet potato inthe pharmaceutical industry.

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