J. Natn Sci.Foundation Sri Lanka 2007 35(1): 53-55

SHORT COMMUNICATION

A study on post-harvest carotenogenesis of sweet potatoes under two different storage conditions

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Revised: 09 October 2006 ; Accepted: 16 March 2006

Abstract: In the context of prevention of vitamin A deficiency, the importance of orange-yellow fleshed sweet potato *(Ipomoea batatas* variety) has already been shown by many studies. In this study, the effect of storage on carotenogenesis was studied. The orange-yellow fleshed sweet potato variety, "Gannoruwa white" was stored under two different storage conditions namely (a) in the open air and (b) inside a Jute hessian (gunny) bag at ambient temperature for 12 days and carotenoid content was determined using HPLC on alternate days. Carotenogenesis occurred in both storage conditions with virtually no significant difference in β-carotene content between the two conditions after 12 days of storage. During open storage, the β-carotene content increased from 80.1 μg/100 g after day 1 of harvest to 172.5 μg/100 g at day 12 and in the Jute hessian bag storage, β-carotene content increased from 82.6 μg/100 g after day 1 of harvest to 188.0 μg/100 g at day 12. Both expressed on the basis of dry weight. An unidentified carotenoid was the second highest whose spectral data corresponded to the α–zeacarotene and high performance liquid chromatoghaphy (HPLC) retention time corresponded to lutein was showed the same trend of carotenogenesis as β-carotene. Carotenogenesis for 12 days increased β-carotene by 115% and 128% for the open air and the bag storage conditions, respectively.

Keywords: Ambient conditions, β-carotene, post-harvest carotenogenesis, sweet potato

INTRODUCTION

Micronutrient deficiency, particularly vitamin A deficiency is recognized as a public health problem in Sri Lanka[1] as a result of low content of pre-formed vitamin A and pro-vitamin A carotenoids in the diets of the affected populations. There is an increasing interest in incorporation of pro-vitamin A carotenoid containing food into diets to alleviate vitamin A deficiency. Further, in addition to the well known pro-vitamin A activity of carotenoids, they have been implicated in the reduced risk of developing degenerative diseases[2]. The availability of orange-yellow fleshed sweet potatoes (*Ipomoea batatas*) in Sri Lanka has increased in recent years following its successful propagation and promotion by Agricultural authorities. The selection of sweet potato to study carotenogenesis was also opportune as it has a tuber that can be stored for more than 10 days without spoilage under ambient conditions. This is important as rural communities, which are most affected by vitamin A deficiency, have limited facilities for refrigeration. The objective of the present study was to determine post-harvest carotenogenesis in sweet potato under ambient conditions stored in the open air, as well as in a Jute hessian (gunny) bag.

METHODS AND MATERIALS

Sweet potato (*Ipomoea batatas*) of the variety "Gannoruwa white" collected from the Horticultural Crop Research and Development Institute (HORDI) at Peradeniya was used in the study as it was available in large quantities grown under the same cultivation conditions. Tubers were harvested from the centre of each plot in morning (from 9 a.m. to 11a.m.). The plot sizes were approximately 1.5 x 4 m each. The plots were about 0.5 m apart. From the intact tubers a sample was selected at random but for using a device to select only tubers below ~ 4 cm diameter. Sample size was 20 kg. This sample was then randomly grouped into two batches of 10 kg each. One sample was stored in a room (under the shade) and open to the atmosphere. The other sample was stored in a Jute hessian (gunny) bag under similar atmospheric conditions. Storage was at ambient temperature (25-30 °C) and relative humidity varying from 70 to 90%. Storage period was 12 days. During open storage carotenoid

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content was determined at day 1, 2, 4, 7 and 12, whereas in the case of bag storage, analysis was done on day 1, 3, 5, 9 and 12 after harvest In each day, 2 kg lots were analysed individually, in duplicate The average weight of a tuber was 100 g and therefore, each 2 kg batch consisted of approximately 20 tubers Extraction was performed according to the procedure described by Rodriguez-Amaya[3] β-Apo-8' carotenal (*trans*) was employed as the internal standard

Carotenoids were separated in open column chromatography (OCC), column prepared with MgO celite (1 1 activated at 110 °C for 2)[3] Identification was based on scanning uv/visible spectrophotometry (Shimadzu model UV-1601), comparison of visible absorption spectra with the published spectral information (λ_{max} and spectral fine structure), high performance liquid chromatoghaphy (HPLC) retention time and order of elution in OCC[3] Identity was confirmed using authentic standards

Quantification was carried out by HPLC HPLC chromatographic conditions were similar to what has been described previously[4] Precautions were taken to minimize the losses of carotenoids during the analysis All experiments were conducted under dim light, samples were stored under nitrogen gas at -20 °C in amber bottles and experiments were completed within the shortest possible time Triplicate homogenized samples (5 g) were freeze dried to constant weight to determine moisture content

RESULTS AND DISCUSSION

In sweet potato the major carotenoid present was β-carotene The second height was an unidentified carotenoid, which by spectral data corresponded to the α-zeacarotene but HPLC retention time corresponded to lutein Relative changes accompanying in β-carotene content over 12 days storage in the open air and in the Jute hessian bag at ambient conditions are presented in Table 1 showing that enzymes responsible for the biosynthesis of carotenoids were apparently functioning normally under the storage conditions and carotenogenesis occurred during post-harvest storage β-carotene levels in the open and the bagged sample conditions on first day of harvest were 80 1 μg/100 g dry weight (DW) and 82 6 μg/100 g DW, respectively and these levels increased significantly with the storage, 2 2 and 2 3 fold for open and bagged samples respectively

Table 1: Changes in[a] carotene and unidentified carotenoid of sweet potatoes during the open and the Jute hessian bag storage under ambient conditions

Storage period (days)	â-Carotene[a]				Unidentified carotenoid[a]			
	Open		Bagged		Open		Bagged	
	Wet basis[b]	Dry basis[c]	Wet basis[b]	Dry basis[c]	Wet basis[b]	Dry basis[c]	Wet basis[b]	Dry basis[c]
1	22 2	80 1	22 8	82 6	8 3	29 9	7 51	27 2
2	36 7	119 2		-	11 6	35 6		-
3	-		32 2	115 4	-	-	10 1	36 2
4	43 1	136 8	-	-	15 4	48 8		-
5		-	41 6	147 0	-	-	11 7	41 3
6	-	-	-	-		-		-
7	48 7	148 0	-		21 3	64 7	-	-
8	-	-	-	-		-		
9		-	50 7	177 9	-	-	18 3	64 2
10	-	-	-	-		-		
11		-		-	-	-	-	-
12	59 5	172 5	54 9	188 0	25 2	73 0	23 7	81 2

[a] Values given ig/100 g

[b] Analysed by HPLC in duplicate

[c] Calculated from wet basis and moisture content

The normalcy of biosynthesis is further substantiated by the unidentified carotenoid, increasing by the same magnitude (2.4 and 3.0 fold for open and bagged samples, respectively). The possible effect of different maturity stages of tubers on β-carotene concentration was overcome as each lot analysed contained many tubers (~20 tubers) and the sample taken for the analysis was drawn after the edible part was chopped into very small pieces and then mixing thoroughly. The adequacy of sampling was reflected by the β-carotene content in the samples analysed on the first day of harvest (22.2 and 22.8 μg/100 g fresh weight for open and gunny bag storage respectively). In the study, factors that can affect carotenoid content in plant foods were minimized keeping the two different storage conditions as the only variable.

In addition to the post-harvest carotenogenesis, the degradation of the carotenoids also can occur during post-harvest storage, especially at elevated temperature and due to the enzymatic oxidation. But in the present study, concentrations of the β-carotene and the absence of enzymatic oxidation products of β-carotene showed that this did not happen. The study showed that in orange-yellow sweet potato carotenogenesis causes pro-vitamin A activity to rise more than two fold.

No comparison can be made with previous studies because the storage conditions of various studies were different to that of the present study, e.g. storage effect of raw spinach, carrots, green beans and broccoli were conducted under refrigerated conditions[5,6]. A study carried out on African mangoes stored at tropical ambient conditions showed the effect of post-harvest temperature on ripening of this fruit[7] but this is not relevant to sweet potatoes as the yam does not ripe. The only similar study was on pumpkin, stored under the same conditions (open storage) for three months showed 1263% increase of β-carotene but sampling procedure was not clear in that study[8].

CONCLUSION

Fresh, intact sweet potatoes could be stored in the open air or in a gunny bag for 12 days after harvest under ambient conditions with no signs of spoilage. Such storage can elevate pro-vitamin A carotenoid content (β-carotene) by more than two fold due to carotenogenesis. This information is of importance to rural Sri Lankans consuming sweet potato.

Acknowledgement

The authors thank IPICS SRI: 07 for a grant.

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