# Carotenoid retention in yellow – fleshed cassava during processing

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## Abstract

Cassava (*Manihot esculenta* Crantz) is a staple food for many people in the tropical and sub-tropical regions of the world. The tuber flesh colours of most of the edible varieties are cream or white which contains traces of carotene or devoid of any carotene. In the yellow- fleshed cassava the major carotenoid present in the tuber is β – carotene which is a precursor of vitamin A. In India, cassava tubers are consumed after boiling, baking or making it into dried chips. Hence the retention of carotenoids was studied in one local yellow- fleshed and three high carotene clones in four different processing methods. The results indicated that the highest retention of total carotenoids (79-84%) and β- carotene (83 -97%) was observed in oven drying followed by boiling *ie* 71–84 % of total carotenoids and 74 – 84 % of β – carotene. In the fried chips the retention of total carotenoids was 68 - 75 % and β – carotene was 45 – 75 % and the least retention of total carotenoids (22 -51 %) and β – carotene (37 -43 %) was recorded in the sun drying method. All the high carotene clones possessed low dry matter content. The tubers had poor cooking quality and are not suitable for consumption after boiling. However these clones are very good for making golden coloured, crispy fried chips. The high carotenoid retention in yellow- fleshed tubers in different processing methods indicates the possibility of significantly improving the nutritive value for making more acceptable products.

**Keywords:** Retention, carotenoids, yellow-fleshed cassava, processing.

## Introduction

Cassava (*Manihot esculenta* Crantz) tubers are mainly used for human consumption, animal feed and raw material for the industries. Tuber flesh colour and cooking quality are the important traits for human consumption. In most of the edible cassava, the tuber flesh colour is cream or white which contains traces of carotene or devoid of any carotene (Bradbury and Hollow,1988).The yellow-fleshed cassava contains higher amount of β-carotene (McDowell and Oduro,1983). The yellow pigmented cassava is under cultivation in a limited way in Colombia, Philippines, Jamaica and some African countries (Oduro,1981). Vitamin-A deficiency is a common dietary deficiency disease in many developing countries. In the yellow-fleshed cassava the major carotenoid pigment present is β- carotene. It has an important role as a principal pre-cursor of pro-vitamin-A which is involved in vision, cell differentiation, synthesis of glycoprotein, reproduction and overall growth and development of bones (Woolfe, 1982). In the CIAT funded project "Identification and promotion of cassava clones with higher nutritional quality", several local yellow-fleshed cassava clones with good culinary quality has been collected. The high carotene clones developed through gene pool development programme are maintained in the cassava germplasm. The tubers of all high carotene clones possess low dry matter and poor culinary quality (Moorthy *et al.*,1990). In India, cassava tubers are consumed after processing like boiling, baking or stored it by making it into chips. To alleviate vitamin-A deficiency through dietary intake it is necessary to get information regarding the stability of total carotenoids and β-carotene after different processing methods. Hence the objective of the present study is to find out the effect of different methods of processing on the retention of total carotenoids and β-carotene on the cassava tubers.

## Materials and methods

The material included to study the retention of carotenoids were one yellow-fleshed local cassava clone with good culinary quality Narayanakappa and three high carotene accessions with poor culinary quality from the cassava germplasm. About five cassava tubers were randomly selected from each clone peeled and cut it into small pieces and used for the different processing.

***Oven-drying***- 100g tuber sample were kept in a hot air oven at 50C and dried till a constant weight was obtained.

***Boiling***-100g tuber sample was cut into pieces and put it in boiling water and cooked for 10 minutes.

***Sun-drying***-100g tuber sample was cut it into small pieces and dried in direct sunlight till a constant weight was obtained.

***Frying***- 100g tuber sample was cut it into thin slices, blanched it in hot water for one minute, kept overnight in a hot air oven at $50^0$C for drying and fried in vegetable oil.

Carotenoids were extracted and separated based on the procedure described in AOAC (1995) using Alumina as adsorbent. The concentration of total carotenoids and β-carotene in the fresh as well as in the processed samples were calculated by determining OD at 450nm. β- carotene standard was prepared and used for the calculation of carotenes in the test sample.

## Results and discussion

The flesh colour of the tubers included in the study ranged from yellow to orange. In the fresh cassava sample the total carotenoids ranged from 3.10-10.54µg and β- carotene varied from 2.30-7.22µg. The local clone Narayanakappa has yellow-fleshed tubers with good culinary quality, however, the total carotenoid (3.10µg/g) and β-carotene (2.3µg/g) was low. The other three germplasm accessions had different intensities of orange-flesh colour. These clones were developed through the recurrent selection programme of Central Tuber Crops Research Institute ( Jos, *et al,*1990). Compared to the local clone, the orange-fleshed germplasm accessions had high total carotenoids (6.06-10.54µg/g) and β- carotene (3.77-7.22µg/g. The flesh colour of the tuber is correlated with the carotenoid content. Iglesias, *et al* (1997) and Chavez, *et al* (2007) also observed that the flesh colour in cassava is positively correlated with the carotenoids. Although there is close association of flesh colour and carotenoids, variability was also observed in the clones with similar colour which resulted variation in the total carotenoids and β- carotene content.

The nutritive value of yellow-fleshed cassava depends on the retention of carotenoids present after processing prior to its consumption. The retention of carotenoids varied in different processing methods. Highest retention of total carotenoids (79-84%) and β- carotene (83-95%) was observed in the oven-drying method. In the boiling method, the retention of total carotenoids was 71-84% and β- carotene was 74-84%. During boiling the flesh colour changes to dark yellow and orange and this may be due to the gelatinization of starch. Even though the retention of carotenoids was higher in the oven-drying method there was not much difference in both the processing methods. In the fried chips the retention of total carotenoids ranged from 68-75% and β-carotene varied from 45-75%. The least retention of total carotenoids (37-43%) and β-carotene (22-51%) was found in the sun-dried chips. Similar results were observed by Nascimento, *et al* (2008) *ie* highest retention of β –carotene was in the oven-drying (91%) followed by boiling (80%) and frying (54%). The studies on the retention of β-carotene in the cassava products (Oliviera,*et al*.,2008) indicated that boiling was the best method (72-96%) for the retention of carotenoids and lowest was in the fried chips (26-43%).Variation in the retention of carotenoids may be due to the difference in the enzymatic oxidation during processing. Retention of carotenoids in boiling is more important since majority of common people consume cassava tubers after boiling. In the present study highest retention of total carotenoids and β- carotene was found in the oven-drying method, but it is not a common method of processing for human consumption. The high carotenoid retention may be beneficial for the production of animal and poultry feed. The three high carotene accessions had poor culinary quality and all of them possess low dry matter (20-22%) since negative correlation exits between dry matter and carotene content as reported by Jos *et al* (1990) and Murthy *et al* (1990). It is very interesting to note that all the high carotene clones are very good for making golden coloured crispy fried chips. There was reasonably good retention of total carotenoids (45 – 75%) as well as β- carotene (68 – 75%) in the fried chips. Compared to other methods, sun drying resulted in the lowest retention of total carotenoids (37 – 43%) and β- carotene (22 – 51%). Similar results were reported by Chavez et al (2007). Sun drying is the most traditional, cheapest and acceptable means of food preservation. Since cassava tubers are easily perishable the common and quick method of storage is by making it into sun dried chips. The drastic reduction of carotenoids in the sun drying process may be due to the detrimental effect of the sun light on the stability of carotenoid pigment.

The high carotenoid retention in the different processing methods indicates the possibility of significantly improving the nutritive value by making more acceptable products to the consumers. Vitamin A deficiency is a preventable problem occurring due to the unbalanced diet of the people and it can be successfully overcome by the supplementation and fortification of different food especially from yellow- fleshed cassava.

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