The effect of processing on β-carotene levels in sorghum

J REDDY[A], C ERASMUS[A], L MLOTSHWA[A], J TAYLOR[B] AND NR DLAMINI[A]
[A]CSIR Biosciences, PO Box 395, Pretoria, 0001, South Africa
[B]Department of Food Science, University of Pretoria, Pretoria, 0002, South Africa
Email: jreddy@csir.co.za – www.csir.co.za

INTRODUCTION

Sorghum, a staple food in Africa, does not contain adequate amounts of provitamin A carotenoids to address the problem of vitamin A deficiency which affects up to 31 million people on the continent[1]. One attempt to solve this problem is through fortification with β-carotene, the primary compound in the carotenoid group due to its high provitamin A activity. Due to their high level of unsaturation (**Figure 1**), provitamin A carotenoids are unstable and are degraded by heat treatment and exposure to light and oxygen during processing and prolonged storage. Due to the importance of β-carotene in preventing diseases such as night blindness, the stability and retention of β-carotene have been tested in many foodstuffs that have been suggested for improving human nutrition.

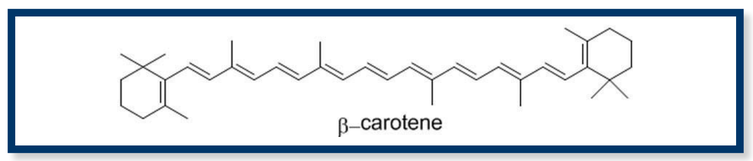

Figure 1: β-carotene structure

OBJECTIVE

To assess the retention of β-carotene in three traditionally prepared sorghum products made from milled sorghum flour, spiked with β-carotene. The guiding level of spiking was based on the level of β-carotene in golden rice, which is reported to be up to 35µg/g[2].

MATERIALS AND METHODS

Products selected for testing the effect of processing on β-carotene retention

- Two sorghum varieties, the SK5912 (a Nigerian yellow sorghum) and P898012 (a white high tannin sorghum) were milled and then spiked with β-carotene (**Figure 2**). The following three sorghum porridges were prepared:
  - Ugali (water medium)
  - Tô (alkaline cooked medium, using potassium hydroxide)
  - Ting (lactic acid fermented sorghum)
- The sorghum porridges were prepared under controlled heating and stirring conditions using the Rapid Visco Analyser.

The determination of β-carotene by HPLC:

- Cooked sorghum products were freeze-dried, and β-carotene was extracted using a micro-extraction procedure, with methanol and tetrahydrofuran as solvents.
- HPLC conditions:
  - Detector: Agilent HP 1100 HPLC system with diode array detector
  - Column: Waters YMC C_{30} column (250mm x 2.0mm, 5µm) with guard column (20mm x 2.0mm, 5µm)
  - β-carotene was monitored at 450nm using a gradient elution programme
  - Mobile Phase A: methanol: tertiary butyl methyl ether: water, 83:15:2; Mobile Phase B: methanol: tertiary butyl methyl ether: water, 8:90:2
  - Flow rate: 0.4mL/min
  - Injection volume: 20µL
  - Run time: 30 minutes
- Quantification was performed using an external standard calibration using analytical grade β-carotene.

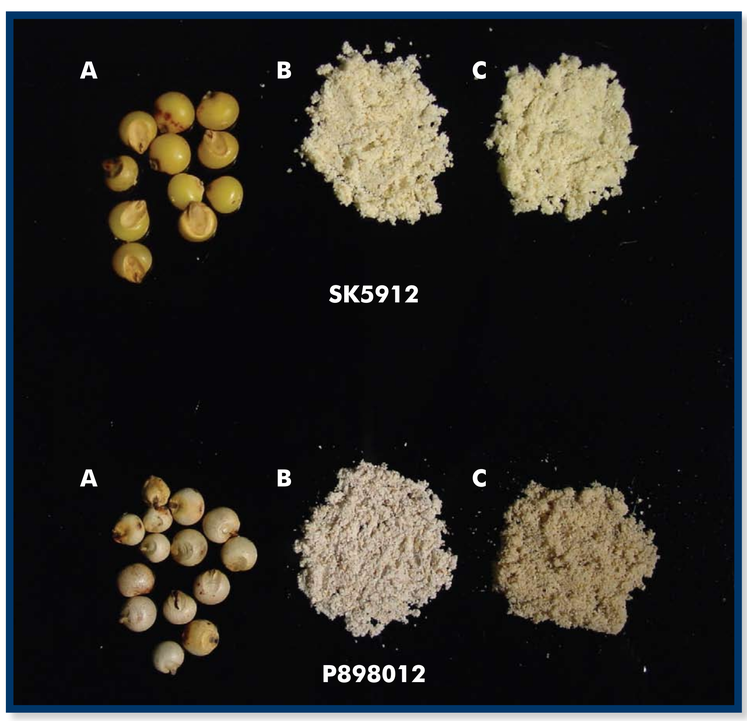

Figure 2: (A) intact sorghum seeds, (B) sorghum flour and (C) sorghum flour spiked with β-carotene

RESULTS AND DISCUSSION

Table 1 shows the effect of cooking on spiked sorghum samples for all three products made from the two sorghum varieties. The unspiked samples had initially low levels of β-carotene, and cooking did not show any significant changes in those levels.

Table 1: Levels of β-carotene (µg/g) in cooked spiked sorghum flour

Treatment	P898012		SK5912	
	Before cooking	After cooking	Before cooking	After cooking
Water (Ugali)	36.5	22.5 (3.59)	36.5	19.6 (0.80)
Alkali (Tô)	36.2	19.0 (3.42)	36.2	17.6 (1.06)
Fermented (Ting)	32.4	13.4 (1.67)	32.8	13.1 (2.04)

Figures in parentheses indicate standard deviations

In the spiked samples (**Table 1**), it was observed that cooking significantly reduced β-carotene levels. The retention of β-carotene in P898012 and SK5912 respectively were:

- Ugali: 62% and 54%
- Tô: 52% and 49%
- Ting: 41% and 40%

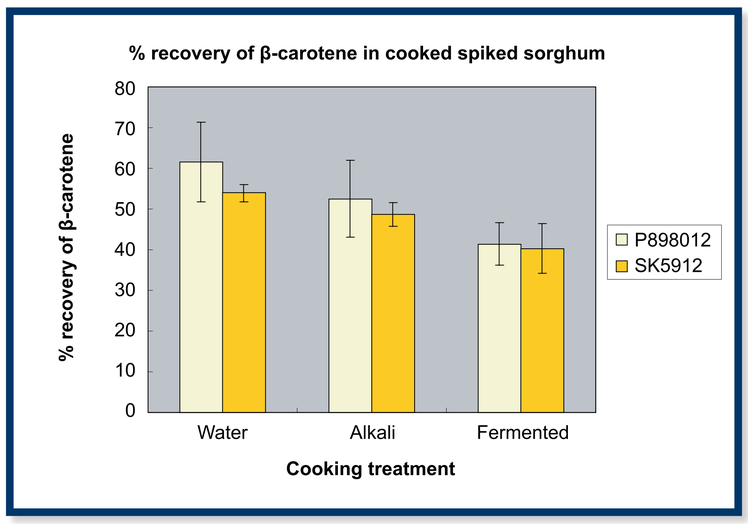

Figure 3: Retention of β-carotene in spiked products subjected to three cooking treatments

The recovery of β-carotene in the spiked samples of the two sorghum varieties is illustrated in **Figure 3**. The retention levels are similar to those reported in previous studies for other crops such as pumpkin[3] and also on encapsulated β-carotene[4]. The severe losses indicate that there is need for the stabilisation of β-carotene that could be present naturally, or added as part of the fortification process of cereals, thus minimising losses before the product reaches the consumer.

CONCLUSIONS

- β-carotene was found to be unstable in the spiked sorghum samples. This indicates that the common user conditions and processes such as milling and cooking may destroy some of the benefit of β-carotene that is added to sorghum products during fortification
- Research is required to determine the synergistic effect of antioxidants such as Vitamins E and C on the stability of β-carotene in sorghum products
- Furthermore, there is need to understand the effect of natural matrices on provitamin A degradation in these sorghum grain products and also to investigate processing methods that retain the highest levels of this nutrient.

REFERENCES

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Can fortification of sorghum with β-carotene address the problem of vitamin A deficiency in Africa? CSIR researchers have shown that food preparation methods may drastically affect the amounts available to the consumer.

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