Retention and bioaccessibility of β-carotene in cassava (Manihot esculenta, Crantz) are affected by style of cooking

Sagar K. Thakkar¹ and Mark L. Failla¹,²

¹Interdisciplinary PhD Program in Nutrition, The Ohio State University and ²Department of Human Nutrition, The Ohio State University

INTRODUCTION

MATERIALS AND METHODS

1.3 PREPARATION OF CASSAVA

We previously demonstrated that the bioaccessibility of β-carotene (BC) in boiled cassava from various cultivars is highly correlated with BC content. However, cassava is also prepared by fermentation followed by either boiling (fufu) or roasting (gari). The potential impact of such processing on retention and bioaccessibility of BC was investigated. We first compared retention of BC in boiled cassava, gari, and fufu each prepared from the roots of three different cultivars. BC content in unprocessed cultivars was 6.4-µg/g wet weight and six isomers accounting for approximately one-third of total BC. Apparent retention of BC was approximately 90% for boiled cassava and fufu. In contrast, roasting fermented cassava at 195°C for 20 min to prepare gari decreased BC content by 90%. Retention was increased to 85-90% when roasting temperature was reduced to 165°C for 10 min. Processing also was associated with a decline in all-trans BC and concomitant increase in cis-BC isomers. The efficiency of micellarization of all trans and cis isomers of BC during simulated digestion was 25-30% for both boiled cassava and gari and independent of cultivar, but only 12-15% for fufu. These differences in retention and bioaccessibility of BC from cassava processed in traditional styles suggest that gari and fufu likely provide fewer retinol activity equivalents than an equivalent caloric intake of boiled cassava.

SPECIFIC AIM

The objective of the current study was to compare the retention and in vitro bioaccessibility of pro-vitamin A carotenoids in gari (fermented cassava granules) and fufu (fermented, cooked cassava paste) and boiled cassava for three cultivars that were selected for their relatively high BC content.

ABSTRACT

We previously demonstrated that the bioaccessibility of β-carotene (BC) in boiled cassava from various cultivars is highly correlated with BC content. However, cassava is also prepared by fermentation followed by either boiling (fufu) or roasting (gari). The potential impact of such processing on retention and bioaccessibility of BC was investigated. We first compared retention of BC in boiled cassava, gari, and fufu each prepared from the roots of three different cultivars. BC content in unprocessed cultivars was 6.4-µg/g wet weight and six isomers accounting for approximately one-third of total BC. Apparent retention of BC was approximately 90% for boiled cassava and fufu. In contrast, roasting fermented cassava at 195°C for 20 min to prepare gari decreased BC content by 90%. Retention was increased to 85-90% when roasting temperature was reduced to 165°C for 10 min. Processing also was associated with a decline in all-trans BC and concomitant increase in cis-BC isomers. The efficiency of micellarization of all trans and cis isomers of BC during simulated digestion was 25-30% for both boiled cassava and gari and independent of cultivar, but only 12-15% for fufu. These differences in retention and bioaccessibility of BC from cassava processed in traditional styles suggest that gari and fufu likely provide fewer retinol activity equivalents than an equivalent caloric intake of boiled cassava.

MATERIALS AND METHODS

1.1 CASSAVA VARIETIES

Varieties of cassava were planted at the beginning of the rainy season in 2006 and grown under rain-fed conditions in a randomized complete block design with two replications at the research farm of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Fertilizer and herbicides were not applied during growth, and hand weeding was done as needed. Roots used for this study were from three cultivars previously determined to contain relatively high amounts of total BC (b). Roots were harvested in summer 2007, washed, peeled, dipped in liquid nitrogen, and wrapped in aluminum foil before shipping on dry ice to The Ohio State University, Columbus, OH.

1.2 CALORIE CONTENT OF COOKED CASSAVA

Cooked varieties of cassava (cultivar TMS 01/3173) were dried to constant mass at 105 °C. Pellets of 0.5 g dried mass were prepared for combustion in an oxygen bomb caloriometer (model 1281, Parr Instrument Company, Moline, IL). Energy content in skim milk and yeast (P/N 3041) were determined to contain 4.9 and 4.8 kcal/g dry weight, respectively.

1.3 PREPARATION OF CASSAVA

Preparation of gari requires fermentation of grated cassava for three days in dark, followed by dehydrating and roasting to produce granules.

Fufu is prepared by five day fermentation of chopped cassava in water followed by mixing, slow cooling and boiling.

1.4 IN VITRO DIGESTION (5)

β-carotene content was homogenized in 0.5 ml of CFA (Clench medium) (1:1) for 1 hr. 6.6 ml of buffer was added as an excess standard prior to homogenization. The homogenized extract was then filtered through a 0.2 mm black funnel filter paper. Extraction of the pulp was repeated until residue and filtrate were colorless. Filtrates were pooled and transferred to a 500 ml separatory funnel with Teflon stop-cock. The organic layer was separated from water with the help of gravity. The wet weight of the organic layer was determined, and the filtrate was evaporated to dryness. The efficiency of micellarization of BC during simulated digestion was 25-30% for both boiled cassava and gari and independent of cultivar, but only 12-15% for fufu. These differences in retention and bioaccessibility of BC from cassava processed in traditional styles suggest that gari and fufu likely provide fewer retinol activity equivalents than an equivalent caloric intake of boiled cassava.

SUMMARY

Contrary to proposed theory, BC is relatively stable during fermentation of cassava.

Roasting during preparation of gari was associated with major loss of all-trans BC and concomitant increase of 13-cis BC.

Despite greater retention of BC during preparation of fufu as compared to gari, bioaccessibility of BC during simulated digestion was markedly reduced.

As RAE of cis-isomers of BC is 50% that of all-trans BC, isomeric profiles in cultivars must be screened to select those with greatest pro-vitamin A activity.

CONCLUSION

Processing cassava not only has impact on stability of BC but also its bioaccessibility.

REFERENCES