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Research Application Summary

Variability in carotenoid content among introduced yellow-fleshed cassava clones

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Abstract

Cassava is important in semi-arid Kenya. However, the crop is low in micronutrients including beta-carotene. A total of 129 high beta-carotene cassava clones from the International Institute of Tropical Agriculture (IITA) were established in Kenya. Root samples were collected for carotenoid quantification by high performance liquid chromatography and spectrophotometry methods. Root yield of the clones ranged from 26.5-85 tons/ha. Mean root cyanogenic potential was 3.84. Carotenoid content ranged from 23-2232 µg/100g. The clones were ranked on basis of carotenoid content, root yield, cyanogenic potential and availability of planting material. The top ten clones in the rank were selected for incorporation in the carotenoid content trait in local varieties.

Key words: beta-carotene, cassava, Kenya

Résumé

Dans la partie semi-aride du Kenya, la culture du manioc est d’une importance capitale. Cependant, la récolte est faible en micronutrients y compris le bêta-carotène. Un total de 129 clones de manioc avec haut bêta-carotène de l’institut international de l’agriculture tropicale (IITA) ont été établis au Kenya. Des échantillons de racine ont été rassemblés pour la quantification de carotenoïde par des méthodes de chromatographie liquide et de spectrophotométrie de haute performance. Le rendement de racine des clones s’est étalé de 26.5 à 85 tonnes/ha. Le potentiel cyanogénique moyen de racine était 3.84. Le contenu de carotenoïde s’est étendu de 23 à 2232 µg/100g. Les clones ont été rangés sur base de la teneur en carotenoïde, du rendement de racine, du potentiel cyanogénique et de la disponibilité de la matière végétale. Les dix principaux clones dans la classification ont été choisis pour l’incorporation du trait de contenu de carotenoïde dans des variétés locales.

Mots clés: Carotène -bêta, manioc, Kenya

Background

A large proportion of the population in developing countries is affected by micronutrient malnutrition. The main limiting micronutrient is vitamin A. The micronutrient malnutrition is reported to be higher among populations that depend on root crops as their main staple hence low dietary diversity. Cassava can be biofortified for vitamin A content. It is an important crop in Kenya for ensuring food security and is a source of income especially in the semi arid regions which occupy 80% of the country. Though cassava roots are rich in calories, they are highly deficient in proteins, fat, and some of the minerals and vitamins. All the cassava varieties grown in Kenya are white fleshed thus are deficient in carotenoids. The local germplasm can be biofortified for improved nutrient content.

The crop is vegetatively propagated and will retain the enhanced trait across generations.This will help reduce cases of malnutrition reported particularly among children and mothers. High beta-carotene clones from the International Institute of Tropical Agriculture (IITA) were established at KARI-Thika in Kenya. They were harvested nine months after planting and their beta-carotene content quantified. The clones were then ranked based on their beta crotene content, root yield, cyanogenic potential and dry matter content. The best clones were hybridised with local gernplasm to incoporate the beta-carotene trait.

Literature Summary

Vitamin A defieciency is a serious global nutritional problem that particularly affects pre-school children. In Kenya, it is estimated that 23500 annual child deaths are linked to micronutrient malnutrion and 70% of the children under six have subclinical vitamin A deficiency (UNICEF, 2005).

Cassava is an ideal candidate for biofortification. This is because there exists genetic variation that can be utilized in improving the micronutrient value of cassava (Maziya-Dixon *et al.*, 2000). Cassava clones with high levels of provitamin A carotenoids, iron, and zinc have been developed by IITA and International Centre for Tropical Agriculture (CIAT) (Chavèz *et al.*, 2005). The beta-carotene content of cassava can be improved through cycles of recurrent selection. Root colouration can be white, cream, yellow, orange or pinkish depending on the beta- carotene content. The intensity of the root colour has been shown to be highly correlated with carotene content making it feasible to use visual selection for colour intensity in improvement of carotene content (Iglesias *et al.,* 1997). Indeed, 98% of the variability in carotene content can be explained by the variability in root colour. The micronutrient content is dependent on genetic variation and the environment (Howeler and Cadavid, 1983; Ssemakula and Dixon, 2007). Inspite of the progress so far made, there is need to screen local elite clones before they can be used for biofortification in local cassava breeding programmes (Maziya-Dixon *et al*., 2000). High carotene content should be combined with farmer-preferred traits in order to have cassava that matches production and quality of popular cultivars in the different regions, but with the added benefit of high carotene content.

Study Description

A total of 129 high beta-carotene cassava clones from IITA were established at Kenya Agricultural Research Institute (KARI)-Thika in 2009. The clones were established in single-row plots of five plants per plot. Necessary agronomic practices for the crop were carried out whenever necessary. During the vegetative growth period the clones were rated monthly for their reaction to pests and diseases using a scale of 1-5 where, 1 = no symptoms to 5 = very severe symptoms.

Harvesting was carried out on all the plants within a plot in November 2009. Root yield was obtained from all the plants harvested whereas samples were taken for determination of cyanogenic potential, dry matter content, root colour chart rating and carotenoid content of the harvested clones. Dry matter was determined based on the specific gravity method (Kawano *et al*., 1987). The picric acid test was adopted for determination of the cyanogenic potential with a score rating of 1-9. Colour rating of the root parenchyma of the clones was obtained using a colour chart provided by the International Potato Centre (CIP). Carotenoid content was determined using absorption spectrophotometry and HPLC methods.

Research Application

The root yield ranged from 8-85 tons/ha while the cyanogenic potential ranged from 2-7 with an average of 3.6. The average dry matter content was 23%. The total carotenoid content for the top ten clones was as shown in Table 1.

Only preliminary work has so far been done. However, the study provides a basis for improvement of the beta-carotene trait in local germplasm. Ten clones with high beta carotene content have so far been identified. These best ten parents were crossed with ten local parents in a North Carolina II mating design. The resultant genotypes will be evaluated across sites

Table 1. Total carotenoid content of the top ten ranked clones evaluated at Thika, Kenya.

Clone	Total carotenoid content	
	Spectrophotometry	HPLC
05/1814	2322.2	2231.5
07/0634	2163.9	2053.4
01/1635	2095.7	2114.8
07/0962	1980.0	1652.1
05/1646	1903.7	1582.3
06/1539	1869.0	1789.1
98/2132	1842.4	1748.2
07/0835	1772.7	1671.4
05/0125	1727.2	1662.3
06/0620	1713.6	1642.7
Mean	937.3	841.9
SE	59.2	55.6

as the beta carotene trait is reported to have high G x E interactions (Ssemakula and Dixon, 2007).

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