REDUCING VITAMIN A DEFICIENCY THROUGH INTRODUCTION OF ORANGE SWEETPOTATOES IN WESTERN KENYA*.

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Abstract

This study was designed to agronomically introduce orange-fleshed sweetpotatoes to a sample of 20 women's groups from two divisions of Western Kenya, educate members about Vitamin A, train half the groups in sweetpotato processing and utilisation, and evaluate changes in Vitamin A consumption patterns among children using the HKI food frequency method. Pre-intervention baseline assessment from 15 communities in which the women's groups were located showed that Vitamin A consumption was quite low-average HKI score of 4.0, well below the cut off of 6.0. Results suggested that orange-fleshed sweetpotatoes would be the cheapest source of dietary Vitamin A that could be produced year-round by the households, the best source of calories among all the available major plant source of Vitamin A, and that frequent feeding of orange-fleshed sweetpotatoes could ensure the recommended daily allowance of Vitamin A. While orange sweetpotatoes were introduced to the entire sample of women's groups, training activities to encourage a variety of ways to prepare and process the sweetpotatoes, including weaning feeds, were only done among 10 women's groups. Post-intervention HKI scores from the women's groups, earnings from sales of orange-fleshed sweetpotatoes and other income variables were compared to the 10 other groups with no food processing training activities, and significantly indicated an improved average score and good knowledge on food sources of Vitamin A among the intervention groups. Our results suggest that introduction, training in processing and marketing of orange-fleshed sweetpotatoes combined with nutrition education activities could contribute in alleviation of Vitamin A deficiency within the communities of Western Kenya.

Introduction

Vitamin A deficiency is a serious nutritional problem among many developing countries and is widely spread in Kenya and extremely low serum retinol levels are found in the arid and semi-arid northeast, along the coast and throughout densely populated western Kenya (Government of Kenya and UNICEF, 1995).

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Since the early 1990s, the main strategy for combating vitamin A deficiency in public health programs has been to distribute capsules containing massive doses (Kennedy and Oniango, 1993). Those programs are costly and dependent on capsule donations from UNICEF in Kenya. However, a similar effect could be achieved by an equivalent consumption of β–carotene-and vitamin A-rich foodstuffs, as the safest and most appropriate long-term approach to controlling vitamin A deficiency (Rahmathullah et al., 1990). Foods such as dairy and meet products containing pre-formed vitamin A are often too expensive for the majority of people in Western Kenya. Therefore, plant food which produce concentrated pro-vitamin A carotenoids can make a tremendous contribution to improved human health. The challenge is to increase their availability, utilisation and consumer acceptance.

Sweetpotato (*Ipomoea batatas*) has a broad genetic base with tremendous variability in biochemical composition (Woolfe, 1992). In addition to their high starch content, sweetpotato roots are one of the major food sources of carotenoids along with apricot, carrot, and peach (Henkel, 1996; Woolfe, 1992). The colour intensity of the flesh roots differs from one cultivar to another, and varies from white to deep orange. The intensity of the orange colour of flesh roots is correlated with carotenoid content (Ameny and Wilson, 1997). Carotenoids are yellow-red colored plant pigments belonging to the family of fat-soluble terpenoids. In the human body, some carotenoids are enzymatically broken down to retinol (Vitamin A) (Simon, 1997). Amongst the carotenoids with vitamin A potency, β–carotene has the greatest activity (Almeida et al., 1988).

Sweetpotato has been receiving increasing attention from agriculturists and ecologists interested in developing world's sustainable production systems because it can grow on soils of limited fertility, is relatively drought tolerant, provides good ground cover, and is usually cultivated without fertilizer or pesticide (Ewell, 1990). In Africa, it is an important source of calories and consumed by all age-groups but is particularly liked by young children, the group most vulnerable to the vitamin A deficiency. It is generally considered to be a "woman's crop". Most varieties currently consumed have white or pale yellow flesh color which contain very little amount of β–carotene (Takahata et al.,1993; Ameny and Wilson, 1997) while carotenoids of orange-fleshed sweetpotato storage roots are highly Vitamin A active and almost exclusively β–carotene (Purcell, 1962; Purcell and Walter, 1968; Simonne et al., 1993; and Takahata et al., 1993). Consumption of orange-fleshed sweetpotato roots and foods based on them could provide a significant proportion of the required dietary vitamin A intake.

Objective of the study

The main goal of the study was to determine whether β–carotene rich sweetpotato cultivars can provide a year-round, sustainable source of vitamin A in the diets of the communities where significant low levels of Vitamin A consumption among children under five years of age have been identified.

The specific objectives were:

1. To introduce and evaluate the β–carotene-rich sweetpotato cultivars among women's groups in the South Nyanza region;

2. To educate communities on the role of vitamin A in the diet for both children and adults through working directly with women's groups, mobilizing public health workers, and utilizing the mass media;

3. To collaborate closely with women's groups in developing sweetpotato-based infant weaning foods without significant loss of β–carotene content, in producing and marketing of processed sweetpotato products as income-generating activities;

4. To increase the capacity for the women's groups to monitor and evaluate their own progress concerning varietal suitability and processed product feasibility.

Methodology

The conceptual framework of the study is shown in Figure 1. An intervention strategy which comprised of introducing the high β–carotene sweetpotato to women groups, nutrition education to ensure that women had a role in defining the intervention for sustainability of the activities, sweetpotato processing for optimizing pro-vitamin A carotenoids retention, and mass distribution of the high β–carotene sweetpotato cultivars have been undertaken.

Results and discussion

Performance of new sweetpotato cultivars. Table 1 shows the main characteristics of four newly introduced cultivars from on-farm trials in Ndhiwa in 1995. Simama consistently had the highest total yields of fresh storage roots. In almost all cases Pumpkin and Japanese had above average yields. Kakamega 4 had an average but stable yield and performed better than the local check. On average the local checks had the lowest yields. The mean performance of clones across all sites in Ndhiwa and Rongo for each season had a similar trend for storage root yields.

The general evaluation of cultivars by both farmers and researchers rated Simama as the highest, and there was a good agreement between farmers and researchers on assessment results of cultivars. Farmers gave the local checks a low score compared to the newly introduced cultivars, which might be an indication of the value farmers attached to new sweetpotato varieties. There was a low level of damage by diseases and pests at most sites, but the difference was not significant among cultivars.

Considering the performance across seasons and sites, the varieties Simama, Pumpkin, Japanese, and Kakamega 4 were found to be agronomically suitable for production in Rongo and Ndhiwa. Farmers stated that they based their evaluation on high yield, good foliage cover and resistance to weevil damage. Farmers indicated that this might present good potential by these varieties for prolonged piecemeal harvesting, which is commonly practiced in the area.

Acceptability. Taste tests conducted with the women's groups also indicated that Simama, Pumpkin, Kakamega 4 and Japanese were acceptable to local consumers. Overall mean scores were higher in Rongo than those in Ndhiwa. In Rongo, the taste of Simama and Pumpkin was preferred over that of Kakamega 4 and Japanese. In contrast, in Ndhiwa, the taste of Kakamega 4 and Simama was preferred over Pumpkin and Japanese. At both locations Simama was preferred to Japanese. Kakamega 4 ranked highest in terms of cooked appearance with Pumpkin and Simama having consistently high appearance ratings as well. Mean acceptability of local check clones for taste and appearance was high at both sites.

Chemical characteristics of newly introduced cultivars. Dry matter, total carotenoid and β–carotene content determination showed that Simama, Kakamega 4 had dry matter content above 27%. This concurs with the eating preferences of the community who prefer high dry

matter sweetpotato varieties. Pumpkin and Japanese had relatively low dry matter contents resulting in a mushy texture, less preferred by East African adult consumers but very much liked by children. The two, however, had the highest ß-carotene contents, close to that of carrots sold on Nairobi markets (result not shown). Kakamega 4 had adequate levels of ß-carotene (>100 µg retinol equivalent/ 100 g of fresh root) to be considered a good source of vitamin A. The level of ß-carotene was low to very low for Simama and the local check cultivars evaluated. The flesh color of the high ß-carotene varieties was orange while the ß-carotene content was low to very low in yellow- and white-fleshed varieties. These results concur with findings reported by Takahata et al. (1993). The yellow- and white-fleshed local checks which were evaluated had very low levels of ß-carotene.

Processed sweetpotato products. Figure 2 shows the total carotenoid contents of the products changes when sweetpotato roots from the cultivar Pumpkin are used as one of the ingredients in chapatis, mandazis, and buns. Roots were used as either boiled and mashed, fresh grated, or flour. Incorporation of orange-fleshed sweetpotato roots increased significantly the total carotenoid contents and improve the coloration of the products.

Results from the surveys

Vitamin A deficiency is a major problem in Ndhiwa division. None of the 15 communities surveyed exceeded the 6.0 cut-off point for community level Vitamin A deficiency using the Total Weighted Index, whose overall mean was only 4.0 days per week. The mean for frequency of consumption of animal sources was only 3.0 for the entire sample.

Given that none of the surveyed communities passed the threshold value of HKI food frequency method, it is reasonable to conclude that vitamin A deficiency is a problem of public health importance in Ndhiwa. While a diversity of plant and animal sources of vitamin A are available, cheaper plant sources which can easily be grown within the homestead are not being fully exploited and most animal sources must be purchased and are frequently beyond the means of poorer households. Strategy of nutrition and health education in combination with the introduction and promotion of orange-fleshed sweetpotato varieties was required. There were three sources of vitamin A which most households could produce year-round: sweetpotatoes, dark green leaves, and papaya. However, note should be taken that recent work indicated that the pro-vitamin A in some leafy vegetables may have low availability (de Pee et al., 1995), and hence, are less desirable as sources of vitamin A than sweetpotatoes, which are known for their high bioavailability (Tsou, 1994).

A two-tiered approach was adopted. Intensive intervention with selected number of women's groups in both Ndhiwa and Rongo has been the principal mean for testing educational materials, new sweetpotato cultivars, and exploring the potential for income-generating activities. Twenty women's groups received sweetpotato cultivars to test in group-managed trials. Groups were most closely matched based on their mean HKI scores and mean distance to the nearest market. Intervention groups received nutritional education messages and worked with village-based extension agents to decide how best to use their new sweetpotatoes.

Figure 3 shows HKI scores of the pre- and post-intervention activities. Pre-intervention results indicated that the scores were similar among intervention and control groups in both Rongo and Ndhiwa. However, Ndhiwa had low HKI scores of 4.8 for the intervention women's groups and 4.6 for the control groups; and Rongo had higher scores of 8.9 and 8.0 for intervention and control women's groups respectively. These results indicated that the practice of consuming vitamin A foods was similar for intervention and control groups and that communities in Rongo had a high level of vitamin A consumption.

Post-intervention data indicated a similar pattern but with a better positive change among the intervention groups both in Ndhiwa and Rongo.
In Rongo, a -0.5 was observed among the intervention groups but still they were above the cut-off point of 6.0. This negative change was probably due to an unusual long drought experienced in Rongo during the post-intervention survey. There was a big change of -3.7 in the control groups indicating that the intervention groups were able to cushion the drought effects probably through the intervention tools applied.
In Ndhiwa, post-intervention survey indicated an increase of HKI scores by 1.6 among intervention groups while a drop of 2.2 HKI score was observed for the control group (Figure 3). Knowledge related to the poor sources of Vitamin A had tremendously increased in groups receiving project intervention package.

Conclusion

- Orange-fleshed sweetpotato cultivars were successfully accepted by the communities of Rongo and Ndhiwa through the women's groups and their increased consumption in either fresh or processed form can be an important factor in reducing dietary deficiency of Vitamin A;
- To efficiently combat vitamin A deficiency through the use of orange-fleshed sweetpotato, provision of sweetpotato planting material should be accompanied by processing, utilization and marketing of the crop, and improvement of the knowledge on Vitamin A for the women's groups.

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Table 1. Performance of newly introduced sweetpotato cultivars in Ndhiwa division

Cultivar	Origin	Flesh color	Yield (T/Ha)	Dry Matter (T/Ha)	β–carotene (g/Ha)	Overall Acceptabili
Simama (Kemb 10)	Kenya	Yellow	11.70	3.90	12.90	3.70
Kakamega 4 (SPK 004)	Kenya	Orange	8.60	2.50	183.00	3.80
Pumpkin (CIP 420027)	Peru	Orange	9.30	1.80	381.10	3.20
Japanese (CIP 420009)	Peru	Orange	8.70	2.20	535.40	3.20
Local check	Kenya	Yellow	4.50	1.60	3.60	3.80

*Hedonic scale was 1-5 where 1 was very bad and 5 very good.

Figure 1. Conceptual Framework

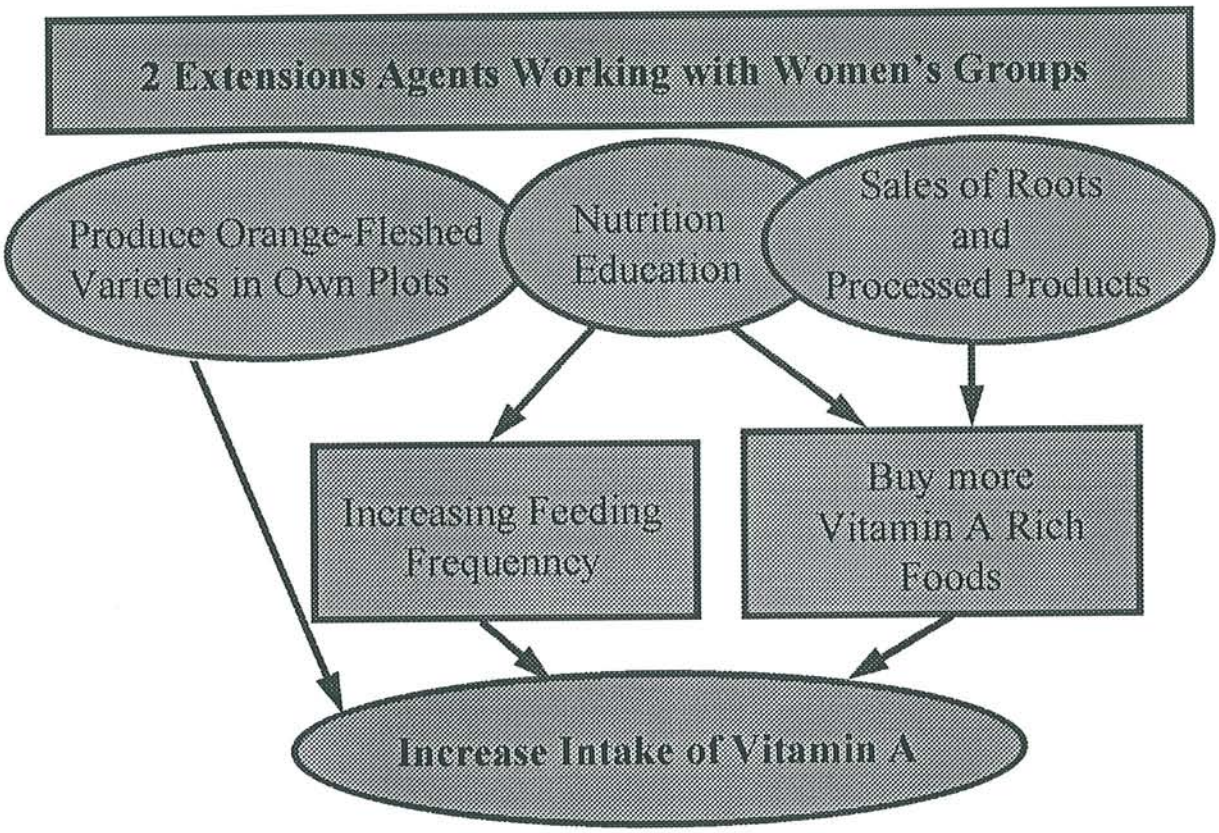
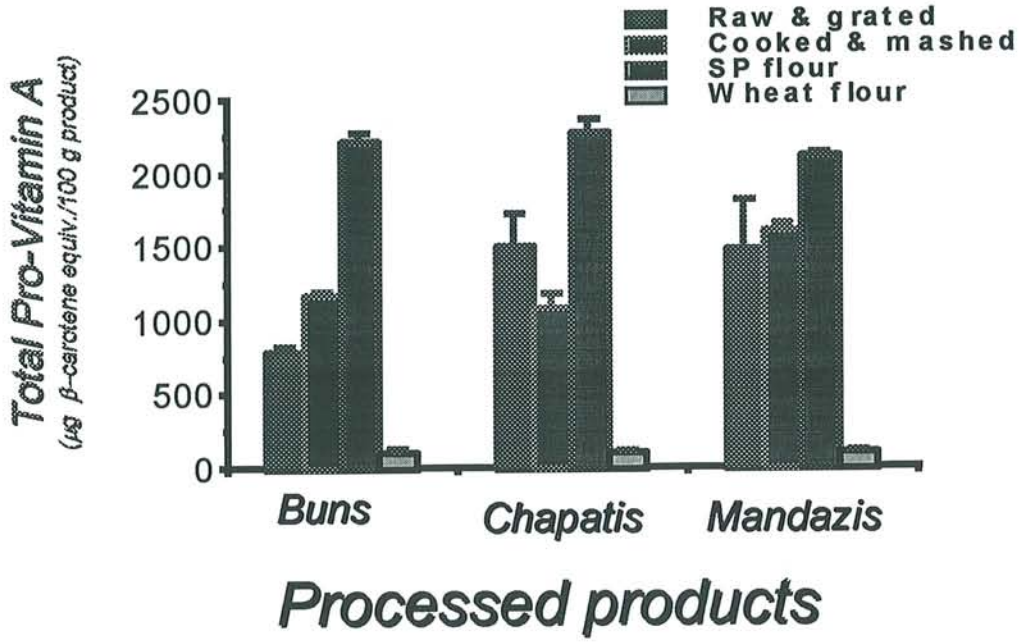


Figure 2. *Improvement of Pro-Vitamin A in Foods by incorporation of sweetpotato, Pumpkin Cultivar (CIP420027)*



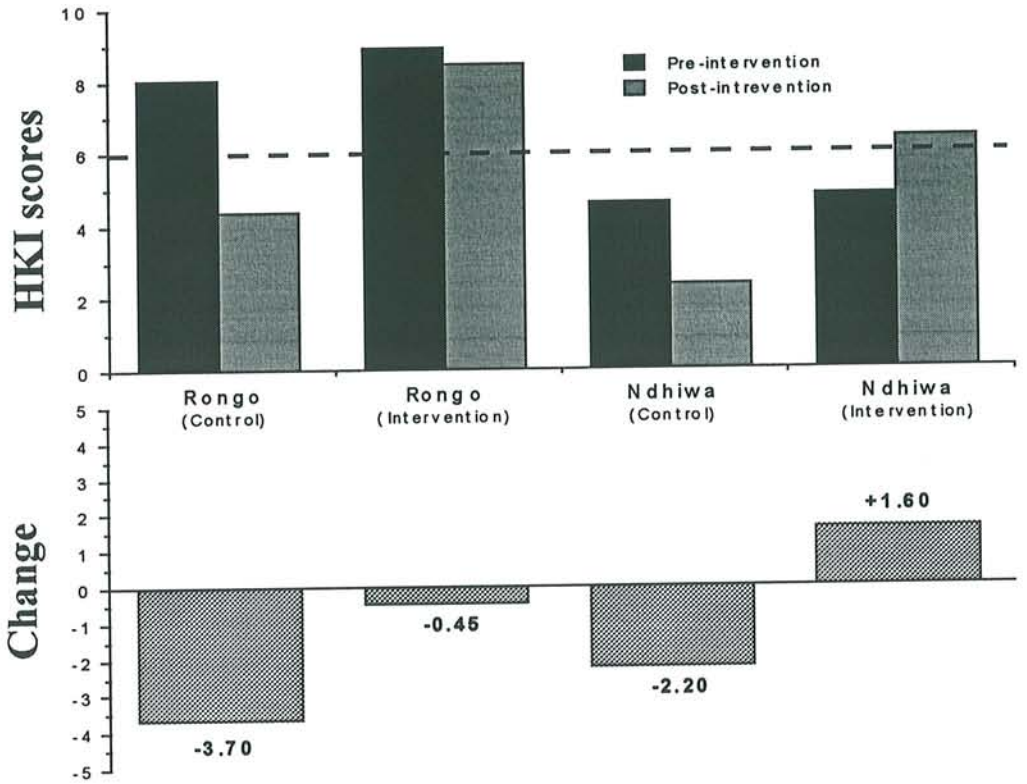


Figure 3. Pre- and post- intervention HKI scores (Use of orange-fleshed sweetpotatoes by women's groups in combating against Vitamin A deficiency).