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Nutritional Status of Orange-Fleshed Sweet Potatoes in Alleviating Vitamin A Malnutrition through a Food-Based Approach

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Abstract

Sweet potato (*Ipomoea batatas* L. Lam), the second most important root tuber and the seventh most important food crop of the world, although categorized as "poor man's food" or "famine crop", has tremendous potential to contribute to a food based approach to promote food security, to alleviate poverty and to supplement as an alternative staple food for the resource poor farmers, because of its diverse range of positive attributes like high yield with limited inputs, short duration, high nutritional value and tolerance to various production stresses. Orange-fleshed sweet potato is now emerging as an important member of the tropical tuber crops having great possibility for being adopted as regular diet of the consumer food chain to tackle the problem of vitamin A deficiency. Apart from cheap source of energy, the tubers are rich in starch, sugars, minerals and vitamin A in the form of β-carotene. Thus, the poor people having only limited access to the expensive vitamin A rich animal foods like fish oil, egg, milk and butter, can meet the daily requirement of vitamin A along with some other essential nutrients through increased consumption of these tubers. Being rich in β-carotene, a precursor of vitamin A, orange-fleshed sweet potatoes are now considered as an important biofortified crop in many developing countries in alleviating Vitamin A malnutrition. The focus of this paper is on identification of potential cultivars of orange-fleshed sweet potato having high β-carotene and higher percentage of its retention after cooking. The cultivars with high β-carotene had consistently orange flesh and those with low to very low in β-carotene content had light orange or yellow-fleshed tubers. Results of this study suggest that increased consumption of orange-fleshed sweet potato in either fresh or cooked form can contribute considerably in alleviating dietary deficiency of Vitamin A and thereby combating night blindness, a major public health concern in rural areas.

Keywords: Sweet potato; Orange-flesh; Vitamin A; Malnutrition; Alleviation

Introduction

Deficiency in vitamin A is one of the most prevalent problems in developing countries and the most common cause of childhood blindness in the world. Its severe deficiency has very high fatality rates but even a little deficiency is also associated with the increase in preschooler mortality. Thus, vitamin A malnutrition is a major public health concern of the developing countries and is responsible for millions of deaths annually among the young children. The nutritionists in several developing countries compelled the evidence of lack of adequate essential vitamins and minerals in the diet of many children and adults [1]. In India, about 40,000 children are affected every year by blindness mainly due to the deficiency of vitamin A and nearly half of the world's micronutrient deficient people may be found in this country. Various international efforts are being made since long back for alleviating vitamin A deficiency and thereby combating night blindness. Among three different approaches, namely supplementation programme through distribution of vitamin capsules; fortification of common foods with micronutrients and the improvement of dietary quality through diversification of foods, the third one is an important food based approach in achieving and maintaining adequate intake of micronutrient-rich foods in the context of an adequate total diet [2]. Food based approaches requiring an inter-sectoral perspective like providing agricultural and educational inputs with an awareness of cultural, socio-economic, market and health conditions may prove to be the most sustainable of the various interventions. Introduction of new crops and home gardening have also been proved to be the most important components of food based approach in improving both dietary quality and quantity. The focus of this paper is on the potential of orange-fleshed sweet potato in a food based intervention in increasing vitamin A intake in poverty stricken small and marginal farming community.

Sweet potato (*Ipomoea batatas* **L. Lam**), an important root crop of Asia is now grown all over the world spreading throughout the tropical and subtropical countries. Asia as a whole accounts for about 78% of the world area under this crop and about 92% of the world production. India is one of the leading producers of this crop along with China, America, Brazil, Peru, Mexico and Thailand. China is the largest producer and consumer of sweet potato in the world accounting about 67% of global area and about 86% of the global production. India accounts for about 68% of the total production of South Asia followed by 27% in Bangladesh and about 5% in Sri Lanka. In India, Sweet potato is cultivated mainly in Orissa, Uttar Pradesh, West Bengal, Bihar, Karnataka, Tamil Nadu and Kerala. Sweet potato tubers are rich in starch, sugars, minerals and vitamins. Being rich in β-carotene, the orange- fleshed sweet potato is gaining importance as the cheapest source of antioxidant having several physiological attributes like anti-oxidation, anti-cancer and protection against liver injury and is most suiting as biofortified crop to combat malnutrition in small and marginal farming community. Orange fleshed sweet potato has considerable potential to contribute to a food based approach to tackle the problem of vitamin A deficiency, a major public health concern of the poorer sections. Thus, there is a great possibility of this subsistence crop for being adopted as regular diet of the consumer food chain to supplement as an alternative staple food source for the resource poor farmers in

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the era of extensive population growth and nutrition crisis. However, a large number of consumers are not aware of the nutritive value of some high yielding orange-fleshed sweet potato cultivars. Moreover, the biochemical constituent of orange-fleshed sweet potato varies among the genotypes. Therefore, assessment of biochemical composition of different genotypes is essential for selecting the cultivars having high counts of β-carotene. Considering all these aspects, the relevance study of orange-fleshed sweet potato in alleviating vitamin A deficiency and complementary to this study, assessment of nutritional quality of the tubers of different genotypes of orange-fleshed sweet potato were made for selecting the promising cultivars having optimum yield and quality.

Materials and Methods

Fifteen potential exotic and indigenous cultivars of orange-fleshed sweet potato were grown at the horticultural research station of Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia,West Bengal during winter planting seasons of 2006 and 2007 in a randomized block design with three replications. The tuber yield (t/ha) of all the cultivars harvested at 120 days after planting (DAP) were recorded. After washing, peeling and shredding, fresh tubers of each cultivars were dried at 70°C for about 48 hours till the tubers gained constant weight to determine the dry matter content (%). Starch (%) total sugar (%), vitamin C (mg/100 g) and β-carotene (mg/100 g) content of the tubers were estimated following the standard procedures as described in A.O.A.C. [3]. For estimating true form of vitamin A content, a new conversion unit Retinol Activity Equivalent (RAE) was calculated following the formula established by Institute of Medicine, Food and Nutrition Board [4]. All the data were statistically analyzed following the method as described by Panse and Sukhatme [5]. For determining the changes in β-carotene content in cooked tubers among the cultivars, the amount of β-carotene retained in the orange-fleshed sweet potatoes after cooking was calculated as follows:

True retention (%) = (carotenoid content per g of cooked food x g of food after cooking)/(carotenoid content per g of raw food × g of food before cooking) × 100.

Potential impacts of orange-fleshed sweet potato in alleviating vitamin A deficiency and its relevance in India through nutrition education, monitoring of Vitamin A status and production of vitamin A rich foods have also been reported for improving orange-fleshed sweet potato through participatory breeding and its dissemination to farmers' field to increase consumption and availability of vitamin A among the people in poverty stricken areas.

Genotypes	Total tuber yield (t/ha)	Dry matter (%)	Starch (%)	Total sugar (%)
S-61	18.33	23.42	9.26	2.41
S-594	21.66	25.51	10.84	2.39
S-1156	15.00	26.13	17.38	2.48
S-1281	13.33	26.52	15.37	2.54
SV-98	24.16	24.46	9.71	2.42
362-7	20.23	25.67	9.93	2.79
IGSP-15	19.99	24.73	10.13	2.49
CIP SWA-2	21.66	24.27	9.54	2.61
187017-1	6.67	25.34	14.17	2.24
440038	23.58	22.53	8.98	2.67
440127	26.66	23.42	9.19	2.56
420027	9.99	24.78	13.92	2.28
ST-14	22.16	24.16	8.23	2.69
Kamala Sundari	27.48	22.47	7.68	2.63
90/101	26.87	21.23	8.82	2.47
C.D. at 5%	2.51	1.46	2.14	0.14

Table 1: Performance of orange fleshed sweet potato genotypes harvested at 120 DAP during 2006-07.

Genotypes	Ascorbic acid (mg/100g)	β-Carotene content (mg/100g)	Retinol Activity Equivalent (RAE)	Retention of β-carotene in cooked tubers (%)
S-61	14.37	4380	365.0	87.76
S-594	12.87	5840	486.6	82.28
S-1156	13.75	4730	394.1	76.69
S-1281	14.57	5420	451.6	81.46
SV-98	26.82	4860	405.0	78.65
362-7	15.78	6970	580.8	84.08
IGSP-15	13.92	2890	240.8	79.82
CIP SWA-2	15.76	6570	547.5	81.29
187017-1	17.31	3120	260.6	78.32
440038	13.97	5470	455.8	76.56
440127	15.29	2580	215.0	79.63
420027	14.12	2710	225.8	77.77
ST-14	18.66	9740	811.6	87.22
Kamala Sundari	21.54	6430	535.8	81.56
90/101	19.93	4060	338.3	80.44
C.D. at 5%	0.72	-	-	2.18

Table 2: Nutritional composition of orange-fleshed sweet potato genotypes.

Results and Discussion

Significant variations in yield, dry matter, starch and total sugar content of the tubers were observed among the genotypes of orange-fleshed sweet potato (Table 1). Higher tuber yields were recorded with Kamala Sundari (27.48 t/ha), 90/101 (26.87 t/ha), 440127 (26.66 t/ha), SV-98 (24.16 t/ha), ST-14 (22.16 t/ha) and CIPSWA-2 (21.66 t/ha). Vitamin C and β-carotene content of the tubers also varied significantly among the genotypes (Table 2). The highest dry matter and starch content of 26.52% and 17.38% were observed in S-1281 and S-1156 respectively. The highest and lowest total sugar content of the tubers were recorded in 362-7 (2.79%) and 187017-1 (2.24%) respectively. The tubers of SV-98, Kamala Sundari, 90/101 and ST-14 recorded higher values of vitamin C content ranging from 18.66 to 26.82 mg/100 g. The β-carotene content of the tubers varied from 2.58 to 9.74 mg/100 g among the cultivars and higher values were recorded in ST-14, 362-7, Kamala Sundari, CIP SWA-2, 440038 and S-1281. Marked variation in chemical constituents of the tubers of different genotypes of sweet potato was also observed by Chattopadhyay et al. [6]. True retention percent of β-carotene in cooked tubers varied among the cultivars ranging from 76.56 to 87.76 percent. Although some degradation occurred during cooking, the β-carotene content of the cooked tubers in 362-7, S-61, Kamala Sundari, ST–14, S-594 and CIPSWA-2 was still substantial.

Thus, consumption of some of the orange-fleshed sweet potato cultivars like ST-14, 372-7, Kamala Sundari, CIPSWA-2 and 440038 with high retinol equivalents can make a significant contribution in alleviating vitamin A malnutrition and combating night blindness which is a major public health problem in poverty stricken small and marginal farming community (Figure 1).

Food Based Strategies for Improving Vitamin A Status

Despite the considerable efforts and investments put into tablet, capsule and injection based approaches, the significant progress on supplementation programs to reduce the magnitude of vitamin A deficiency in developing countries had not occurred over the past

Figure 1: Different cultivars of Orange Fleshed Sweet Potato.

few decades. The low dietary intake of vitamin A is the major cause of vitamin A deficiency in developing countries [7].

Although, some animal foods like fish oil, liver, egg and butter, rich in vitamin A in its true form, the retinol are used directly and easily by the human body, the poor people cannot afford these expensive foods. Considerable efforts are, therefore, to be made to promote vitamin A intake through increased consumption of cheap plant foods and vegetables which although do not contain vitamin A as such but do contain its precursor, the β-carotene that can be converted to vitamin A by the human body. Supplementation programs in alleviating vitamin A deficiency, thus, will be replaced in future by sustainable food based strategies Low et al. [8].

Orange-fleshed sweet potatoes have emerged as one of the most promising plant sources of β-carotene, the pro-vitamin A [9]. A 100-150 g serving of boiled tubers of orange-fleshed sweet potato can supply the daily requirement of vitamin A for young children which can protect them from blindness [10]. Along with the β-carotene, the pro-vitamin A, the young children and adults can also get adequate amount of calories, vitamin C and other micronutrients through increased consumption orange-fleshed sweet potato.

Conclusion

Introducing a marginal change in the diet like switching varieties is likely to be easier than introducing a completely new food. Thus, replacing the white-fleshed sweet potato varieties now grown by the farmers with new orange-fleshed cultivars like ST-14, 372-7, Kamala Sundari and CIPSWA-2 having high β-carotene would be helpful in alleviating vitamin A deficiency.

Production and distribution of planting materials among resource-poor farmers could increase the availability of orange-fleshed sweet potatoes in poverty stricken areas. In addition to the promotion of orange-fleshed sweet potato in household diets, the nutrition education regarding the function and importance of vitamin A in the diet could improve the vitamin A status to combating night blindness, the major public health concern in unprivileged areas.

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