*Report*

# Use of Carotene-Rich Foods to Combat Vitamin A Deficiency in India—A Multicentric Study by the Nutrition Foundation of India

## Summary and Recommendations

### The Problem of vitamin A deficiency in India

Vitamin A deficiency in India ranks among the four major public health nutritional problems affecting not only children but also women of the reproductive age group and others. However, a noticeable change that has occurred in the last two decades is the very marked decline in serious forms of this deficiency leading to a decline in keratomalacia and hence nutritional blindness. The problem to contend with now is the less severe but more widespread moderate deficiency leading to night-blindness and/or Bitot's spots and low serum levels of vitamin A, with their attendant functional impairment.

### What is the logical approach to combat vitamin A deficiency?

With the sharp decline seen in keratomalacia, vitamin A deficiency is no longer a medical emergency in India. Therefore, the massive dose programme that was developed specifically as a measure for keratomalacia must be phased out and efforts will have to be made to increase the intake of vitamin A through dietary improvement, which is the most logical and sustainable means of combating the problem of vitamin A deficiency. Vitamin A can be obtained in the preformed state from foods of animal sources such as meat, poultry and also milk. However, these are generally expensive and out-of-reach for the poor segments of the population. There are several vegetable foods that are rich in the pro-vitamin A carotenoids which can serve as sources of vitamin A and are also relatively inexpensive. The (3-carotene of these foods is the most important pro-vitamin A carotenoid, that is converted into vitamin A in the human body. Vegetables and fruits which are good sources of |3-carotene also contain good amounts of other micronutrients such as iron, zinc, folic acid and ascorbic acid. Thus, the food-based approach besides being the logical and sustainable one to combat vitamin A deficiency, can also take care of other deficiencies frequently seen in our population. However, for a food-based approach to be implemented satisfactorily we need to answer many questions such as what are the carotene-rich foods available in India, how often are they consumed, to what extent is the (3-carotene retained on processing and cooking, whether existing methods of cooking are satisfactory and what is the effect of seasonality on consumption pattern, *etc.* The summary which follows is a gist of the findings of the present study which addressed the above issues.

### What carotene-rich foods are available in India?

A wide variety of carotene-containing foods have been identified through the present study, 52 in all. Of particular

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interest is the finding that in all regions 60% more of these were green leafy vegetables (GLVs) while the others were roots, tubers and fruits. The P-carotene content of these foods indicates that about 30% of them were rich in P-carotene with more than 5,000//lOOg while 20% were modest source with l,000-5,000//100g. There were several uncommon GLVs cultivated locally for consumption by the rural and tribal people, the carotene values of which "/ere not known (50% of the GLVs). Some of them analyzed at the Baroda Center and some others at Coimbatore, have shown that at least a few of them can be very high in P-carotene. For instance, the kanjero leaves grown in tribal Gujarat contained 10,695//100g while drumstic leaves analyzed by Coimbatore Center were found to contain 19,690 //100g. Among the common GLVs, rich sources of carotene were amaranth tender, spinach leaves, fenugreek leaves and bengal gram leaves. The fruits, although they contained less *P* carotene than some of the GLVs, could be classified as rich sources, in view of their high acceptability and the large quantities that could be consumed.

So far, horticultural attempts in India to selectively promote good sources of *fi* carotene have been notable for their absence. The identification of the large varieties of carotene-rich GLVs and fruits in the present study must stimulate our endeavor to establish their nutrient profile, agro-climatic suitability for large-scale cultivation, increased production and promotion of their consumption.

**What are the carotene-rich foods commonly consumed in the different** regions?

Household consumption patterns revealed that preformed vitamin A from animal foods was low and contributed no more than 20-25% of the total vitamin A intake. On the contrary, the consumption of *fi* carotene containing foods contributed to 60% or more of the total vitamin A at the household level intake. Thus, it is evident that carotene-rich foods are the most important dietary sources of. vitamin A to the poorer socio-economic rural and urban population in India.

Of the 52 carotene-rich foods, 37 were available in Western India, and about 25 in the other regions. However, only a few of these were commonly consumed by the households. In the Northern and Western regions, fenugreek leaves and spinach were the most commonly consumed. Shepu leaves were typical of the Western region, while mustard and bathua leaves were typical of the Northern region. In the Southern region, drumstick leaves were consumed by a large number of households while these leaves were rarely consumed by the households studied in the Northern and Western regions.

Common to all regions was the consumption of tender amaranth *(Atnaranthns gangeticus),* carrots *(Daucus carota)* and mango fruits *(Magnifera indica).* Although coriander leaves, curry leaves and green chillies were consumed in all regions they were used mainly as garnishes and spice. These data showed that the wide variety of available carotene foods were not optimally utilized, the reasons for which are listed later. There is clearly a need to devise ways and means of utilizing the diverse food sources, especially GLVs for daily consumption.

**How frequently are the carotene-rich foods consumed?**

The frequency of consumption of the carotene-rich foods varied widely depending on seasons, which in turn was related to availability, cost and quality of the vegetables and fruits. Winter season in the

Northern and Western regions marked the highest consumption of carotene-rich GLVs, vegetables and fruits. In the Southern region, frequency of consumption was relatively higher in the south-west monsoon season. In the Eastern region, little variation was seen between the two seasons Kharif and Rabi, in the frequency of consumption. However, it must be noted that in the Eastern region, in general, all sources of carotenes except mango fruit were consumed only infrequently and occasionally, regardless of the seasonal availability.

The intake of carotene-rich GLVs was very infrequent in summer season all over the country and in the monsoon season in the Northern and Western regions. Mangoes during summer formed a part of the diet, although consumption was infrequent due to its high cost. Thus one of the important factors responsible for vitamin A deficiency was the low intake of pro-vitamin A foods during much of the year, except for the winter season.

The factors responsible for low consumption were non-availability during summer and monsoon and the reported poor quality of the pro-vitamin A sources, especially GLVs in monsoon. The increased time and effort needed to process the GLVs during monsoon also emerged as a factor affecting consumption in monsoon season. Thus low-cost technologies for the preservation of GLVs available in abundance during winter such as dehydration, may help to sustain higher levels of intake throughout the year.

Are the vitamin A and carotene-rich foods consumed in adequate quantities?

The question of adequacy of consumption was addressed by two centers. One-third of the households studied in Delhi during the monsoon and summer season had vitamin A intake less than 50% of the RDI. The percentage of households with inadequate intake of vitamin A in the winter season was much lower, only 8%. These, however, cannot be equated with adequacy for individual members within the household.

In Baroda, on the other hand, about 40% of the households had less than 50% of the RDI for p-carotene even in the winter season, indicating highly inadequate consumption of vitamin A and carotene-rich foods.

Do household level methods of processing affect P-carotene content?

Three common household level methods of processing were tested for their effect on retention of [i-carotene. The GLVs selected for cooking were colocasia leaves, fenugreek leaves, onion stalk and radish leaves by the Baroda Center and amaranthus and drumstick leaves by the Coimbatore Center. Carrots were analyzed after cooking only by the Coimbatore Center.

The methods of cooking tested were cooking in a pan covered or uncovered, pressure cooking or steaming, and sauteing or shallow frying. Significant differences were seen between methods of cooking. Sauteing and shallow frying retained the highest amount of )3-carotene, followed by pressure cooking and steaming. Cooking uncovered or covered with the lid resulted in considerable losses.

Are current methods of cooking in need of improvement?

Many current methods of cooking were seen to result in substantial losses of P-carotene and, therefore, attempts will have to be made to disseminate this information and help households choose processing methods with relatively higher retention of

(3-carotene. Further, improvements that should be attempted, are in the direction of making GLV preparations more acceptable to children. As shown in a subsequent section, children's consumption of (3-carotene was low mainly due to their dislike of the GLVs just simply prepared as a. curry by sauteing. Alternate methods of incorporating the GLVs into cereal-pulse mixes need to be considered and tested.

**What are the other constraints to the consumption of carotene-rich foods?**

All centers investigated if social or cultural taboos existed in regard to consumption of GLVs. While there were certain belief systems which led to the avoidance of GLVs by lactating women, no particular taboo with respect to pregnant women or young children appeared to be present in the groups studied. However, economic affordability emerged as an important factor influencing the consumption of GLVs and other carotene-rich foods. It was brought out by three of the four centers that children below one year of age were not offered any of the carotene foods. The other young children were offered whatever was cooked for the entire household.

GLVs and other vegetables prepared in the form of hot curries with added chillies were unsuited for children and further mothers reported that children did not like GLVs in simple cooked form which was the predominant form in which these were prepared in the household.

**How can the constraints be overcome?**

Since the households did not use many of the available GLVs and further as the recipes prepared out of common GLVs and other carotene-rich foods tended to be monotonous, some of the study centers have developed and tested recipes that provide a wider variety. The GLVs used in the recipes included frequently consumed ones such as spinach arid coriander leaves and infrequently consumed ones such as bathua leaves, drumstick leaves and radish leaves. The method of cooking involved either pressure cooking or sauteing that retained p-carotene well.

Products developed included dhebras, rotis, muthias, dais, soups and biscuits, which have all been found to be well accepted. The listed recipes can be promoted in regional and national level feeding programmes. In fact, the promotion of some of these recipes in the national ICDS programme has already been attempted on a pilot scale by the Coimbatore Center with success and this now now needs to be replicated in the programme situation.

**Seasonal calendar of carotene-rich foods**

A seasonal calendar of common and uncommon carotene-rich foods has been prepared as an outcome of this study. The calender lists all available carotene-rich foods separately for each season, winter, summer and monsoon, along with the quantity necessary for a pre-school child, pregnant woman and lactating woman to meet their (i-carotene requirements. The calendar must find wide use, and in conjunction with the recipes can lead to innovations on the part of everyone directly or indirectly involved in the control of vitamin A deficiency in India.

**How feasible is it to change dietary behavior?**

The feasibility of dietary behavior changes was studied through nutrition communication programmes by two centers. It has been very encouraging to find that the per cent households consuming carotene-rich foods and the frequency of their .consumption, both increased after the communication programme. The commu-

nication programme focussed on participatory activities. Thus the potential for dietary behavior change is a real one and will need to be pursued vigorously.

**How acceptable is red palm oil (RPO) as a source of p-carotene?**

RPO is the richest known natural source of P-carotene. p-carotene forms 56% of the total carotene in the oil which ranges from 500-1,600 ppm. However, it is not one of the traditional edible oils in India, although studies in India have established its safety. Before promoting it to the population at large we need to know if the RPO is acceptable.

Studies undertaken in three centers, as part of the present investigation showed that RPO was highly acceptable to preschool and school-aged children as well as to adult members, although in the initial stages of its introduction some did not particularly like the odor and colour. RPO was incorporated into the supplementary food offered at the ICDS in 50 anganwadi centers in Coimbatore and into the noon meal offered to preschool children in about 40 balwadis in Trivandrum. In both centers the RPO recipes were well accepted by the children and the adult pregnant and lactating women.

In Delhi, attempts were made to promote RPO at the household level which was also very successful, as 94% of the school-aged children enrolled in the study were consuming RPO at five months of intervention. The mothers in Delhi devised their own recipes for incorporating RPO without subjecting it to any heat treatment in addition to the recipes provided by the investigators. Thus these field trials showed that RPO is highly acceptable and it is feasible to promote its consumption in feeding programmes as well as at the household level.

**How much RPO is needed and what is its impact on vitamin A status?**

The amount of RPO needed was found to be very small. The trials in Coimbatore used 4 g/child/day and 8 g/ adult beneficiaries per day. In Trivandrum each child beneficiary was given 5 ml of RPO per day. The amount the mothers used in Delhi averaged 10 g/child/day.

The impact of RPO consumption was seen clearly in the subjects studied in all the centers. In Coimbatore and Trivandrum, the rate of disappearance of Bitot's spots in the experimental children receiving RPO was much higher than in the control group. In the adult subjects in Coimbatore, clinical signs of deficiency were not detected either at baseline or at final revealing that adult vitamin A status was better than that of children.

In Delhi, the RPO supplementation of school-aged children with abnormal conjunctival impression cytology (CIC) resulted in a marked improvement in CIC, with 54% of the children initially deficient becoming completely nomal at the end of six months of supplementation. A clear improvement in clinical signs was also evident in the RPO group. Of the 18 subjects who had clinical signs of deficiency at baseline, 80% became normal at the end of five months of RPO supplementation while in the control group, only 25 per cent of the subjects showed an improvement.

Thus, consumption of RPO in small quantities ranging from 4 to 10 g/day resulted in a significant improvement in vitamin A status.

**Recommendations**

The recommendations that emerge from the study are:

- There is an urgent need to selectively promote cultivation of the already

existing (3-carotene-rich foods and the uncommon alternate sources such as the oil palm.

- The consumption of carotene-rich foods, especially GLVs, prepared by appropriate methods need to be promoted using a wide variety of methods both in the national and regional supplementary feeding programmes and at the household level for which the seasonal calendar prepared in the present study will be of great value.

- Low-cost technologies for preservation of carotene foods to make them available in summer and monsoon seasons need to be developed and popularised. At the same time, analysis of fresh and processed carotene-rich foods for their (J-carotene content by appropriate methods must be pursued.

- Red palm oil which is a very inexpensive but rich source of p-carotene is highly acceptable. Incorporation of RPO into national feeding programmes and supplementary feeding programmes has been shown to be very feasible. This needs to be implemented country-wide. At the same time promotion of RPO at the household level needs to be pursued.

## NOTES AND NEWS

### ANNUAL STATE CONFERENCE AND MID-TERM SCIENTIFIC MEET OF GUJARAT STATE IAP CHAPTER

This event will be held at Surat on 7th and 8th June 1997 under the auspices of IAP Surat Branch. For further details please contact Dr. K.I. Shelat, Organizing Secretary, Niramay Children Hospital, 12/462, Limdachowk, Surat. (Tel. No.) (0261) 417361, 425210; Fax 685000.