ROLE OF β-CAROTENE RICH PRODUCTS IN IMPROVEMENT OF VITAMIN- A STATUS OF PRE SCHOOL CHILDREN

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ABSTRACT

Vitamin A deficiency is widely prevalent in our country, especially among the pre-school age children. Surveys carried out in the southern and eastern parts of the country reveal that at least 30-50% of the children in pre-school age group have night blindness manifestation of vitamin A deficiency. Supplementation study was carried out on 45 pre-school children of 2-6 year age for a period of 3 months. Three supplements (β-carotene rich) were selected for supplementary feeding based on their organoleptic scores and nutritive value. Forty-five children showing symptoms of moderate deficiency of vitamin A based on clinical assessment were selected with the help of trained doctor. Dietary intake and anthropometric measurements were also taken as criteria for the selection of vitamin A deficient children who were divided into three groups of 15 children each so that all groups had similar dietary intake and anthropometric measurements. Estimation of serum retinol level of selected children was done with the help of trained doctor. Three groups were given any one of the three selected supplements, and group-I served as control, which was given supplement I. Children of group II and III were fed supplements II and III, respectively. At the end of 3 months of feeding trial, the nutritional and vitamin A status of children fed with three supplements was again assessed. Feeding trial indicated that there was a significant reduction in clinical symptoms of various nutritional deficiencies in experimental children after supplementation. The experimental group II and III showed significantly higher increase in serum retinol level than the group I, which was taken as control. The β-carotene rich supplements were found suitable for improving vitamin A status among children.

Key words: Supplementation, Feeding, Organoleptic, Anthropometric, Serum retinol, Deficiency.

INTRODUCION

Vitamin A deficiency is a problem of public health significance in over 70 countries (UNICEF, 1995). It is prevalent in parts of most African and Asian countries, and in some areas of Latin America and the Western Pacific. Over 78 million children under five years of age are affected by vitamin A deficiency, putting them at risk in terms of their health and survival, and about 3 million of these children have some form of vitamin A related eye disease, ranging from night blindness to irreversible partial or total blindness. However, in India, vitamin A deficiency is presently a public health problem only in selected geographical pockets, although there is wide variation within the status, and a declining trends in vitamin A deficiency have been observed during the last three decades. In a national survey of the prevalence and causes of blindness conducted in 1971-74, the vitamin A deficiency accounted for 0.3% of the total causes of blindness in the country and this proportion declined to 0.04% in a similar survey conducted in 1986-89. There are also reports from the tertiary case hospitals that the number of cases of keratomalacia has declined significantly. In developing countries, vitamin A deficiency is very common among the underprivileged population.

Supplementary nutrition means identifying and fulfilling the deficiencies of calories, protein, minerals, and vitamins in the existing family diet and taking other measures for nutritional correction and rehabilitation (Jamir, 2002). Although the Indian diet, which is being routinely given in underprivileged families, is poor in vitamin A, with appropriate modification and diversification, it can be made...
vitamin A adequate. Varieties of food products are
provided as supplements in the Integrated Child
Development Services scheme. Locally available
food commodities as well as food products provided
by World Food Programme are utilized. The type of
food varies from state to state but usually consists of
a hot meal cooked at anganwadi, containing a
varied combination of pulses, cereals, oils, vegetables
and sugar (NIPCCD, 2002).

Some commercial supplementary foodstuffs
prepared using expensive technology are available
in the market but are being used only by
economically affluent elites since the cost of these
commercial products are beyond the reach of
common man. Hence, need of the day is to identify
nutrient rich foodstuffs which are not very expensive.
The use of locally available low cost foodstuffs
patterned around the dietaries of the children has
been suggested as viable remedial measures. Gopalan (1990) suggests that an increased intake
of β-carotene rich food in habitual diet may also be
preferred to massive synthetic vitamin A dosage and
it is better to consume vitamin A rich vegetables such
as beet leaf, spinach, drumstick leaves, amaranth
leaves, coriander, mint, carrot, tomato, and yellow-
fleshed fruits like papaya and mango, which contain
large amount of β-carotene. India has rich dietary
resources and a combination of different foodstuffs
can provide adequate quantity of vitamin A in
sustainable manner. Simply, there is a need to
supplement these green leafy vegetables and yellow-
fleshed fruits in various recipes to make them popular
among vulnerable groups and to introduce these
nutritious recipes in intervention programme to
overcome nutritional problems. The green leafy
vegetables and yellow-fleshed fruits are available only
for a short period but these can be dried for long
storage, as dehydrated green leafy vegetables are
rich source of β-carotene.

MATERIAL AND METHODS

The present study was carried out in the
Department of Food and Nutrition, CCS Haryana
Agricultural University, Hisar. Using simple home
scale techniques different food products were
developed from locally available β-carotene rich
vegetables and fruits and fed to pre-school children
with moderate vitamin A deficiency. The impact of
feeding these supplements on nutritional and vitamin
A status of pre-school children was studied after three
months of feeding trial.

Clinical assessment

Clinical examination of an individual is the
least sensitive method used to evaluate individual’s
nutritional status. This method of assessment is based
on the recognition of certain physical signs believing
to be related to inadequate nutrition, which can be
seen or felt in superficial epithelial tissues especially
the eyes, skin, or organ near the surface of body. In
present study, general appearance of respondents,
hairstyle, eyes and skin were observed with the help of
trained medical practitioner of primary health center.

Biochemical assessment

Assessment of serum retinal was done by
collecting a blood sample from all the subjects with
the help of a doctor and analyzing for serum retinal
by spectrophotometric method.

Development of supplements

The three supplements developed for feeding
trial are given below:

Supplement I: Namakpara and biscuit without
incorporation of amaranth and
carrot powder, respectively

Supplement II: Namakpara incorporated with
Amaranth powder

Supplement III: Biscuit incorporated with Carrot
powder

Method of preparation of supplements:

Supplement I

Sieved the refined flour (Control= 100g). Added
salt, ajwain and ghee in mixture and kneaded dough
using water. Rolled the dough into thin layer and cut
into small square pieces. Heated the oil and deep
fried the Namakpara until golden brown in colour.
And for biscuits creamed ghee and sugar with milk.
Added refined flour (Control= 100g), ajwain , salt
and baking powder were mixed and the dough was
rolled and cut into biscuit’s shape with help of cutter
and baked at 150°C for 15-20 min.
Supplement II

Sieved the refined flour (sample I= 90g, sample II= 80g), and dried leaf powder (sample I=10g, sample II= 20g) together. Added salt, ajwain and ghee in mixture and kneaded dough using water. Rolled the dough into thin layer and cut into small square pieces. Heated the oil and deep-fried the Namakpara until golden brown in colour.

Supplement III

Creamed ghee and sugar with milk. Added refined flour (sample I= 90g, sample II= 80g), ajwain salt, baking powder and dried carrot powder (sample I=10g, sample II= 20g) were mixed and the dough was rolled and cut into biscuit's shape with help of cutter and baked at 150°C for 15-20 min.

Nutritional evaluation of acceptable products:

On the basis of sensory evaluation products named Amaranth Namakpara (10% powder level) and carrot powder biscuit (20% powder level) were selected for nutritional evaluation.

For nutritional evaluation, the organoleptically tested products were ground in mixer-grinder and dried in oven at 50±5°C to constant weight. Dried samples were packed in polyethylene bags and analyzed. Proximate composition was estimated by A.O.A.C. method. Beta-carotene was estimated by using column chromatography method (A.O.A.C., 1995).

Supplementation of vitamin A rich supplements in diet of selected children (experiment groups) for three months (Feeding trial)

Based on dietary assessment, anthropometric measurements and clinical assessment, the forty-five pre-school children suffering from moderate deficiency of vitamin A were selected. Biochemical estimation of serum retinol was done with help of local doctor. Further, they were divided into three groups based on supplements given to them. Three types of supplements were given to different groups. First group served as control and was fed a supplement of Namakpara and biscuit (75g) without incorporation of amaranth and carrot powder, respectively. Each child in second group received a packet containing 75 g amaranth powder Namakpara, and children of third group received a packet of 93 g carrot powder biscuit daily. Feeding trial was conducted for three months. Home visits were made to check any problem regarding digestion or difficulty with intake of supplementary food. At the commencement of trial 15 children were selected in each group but finally the feeding trial was completed with 14, 14 and 13 respondents in group-I, II and III, respectively due to drop outs.

Statistical analysis

Statistical analysis of data was done by using complete randomized design (Panse and Sukhatme, 1961), and t-test and z-test were used for analyzing the data.

RESULT AND DISCUSSION

Chemical composition of supplements

Different supplements varied in protein percent from 10.20 to 14.14. Supplement II given to group II contained maximum amount of protein (14.14%) followed by supplement I (11.51%), and III (10.20%). Fat percent for different supplements ranged from 19.46 (supplement III) to 24.06 (supplement II). For supplement I, it was 20.86%. Fat percentage in supplement II and III was 24.06 and 19.46, respectively. Supplement II that was given to group II contained maximum amount of ²-carotene (3.56 mg/100 g) followed by supplement III (2.86 mg/100 g) and I (1.36 mg/100 g) given to group III and I, respectively. The ascorbic acid content of supplements I and III was 1.62 and 1.31 mg /100 g, respectively. It was found maximum in supplement II, which was 5.64-mg/100 g. The supplement II had maximum content of iron that was 8.49 mg/100 g. The values of this mineral was 6.62 mg/100 g in supplement III and it was 5.32 mg/100 g in supplement I which was given to group I (Table 1).

Impact on vitamin A status of children

The outcome of the nutritional feeding was evaluated from records of nutrient intake, clinical examination and serum retinol level before and after the feeding trial of 3 months.
Table 1: Nutrients composition of different supplements consumed by experimental children selected for feeding (% dry weight basis)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Protein(%)</th>
<th>Fat(%)</th>
<th>β-carotene (mg /100g)</th>
<th>Ascorbic acid (mg/100g)</th>
<th>Iron (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Supplement I)</td>
<td>11.51±0.99</td>
<td>20.86±1.14</td>
<td>1.36±0.10</td>
<td>1.62±0.17</td>
<td>5.32±0.09</td>
</tr>
<tr>
<td>Group I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Supplement II)</td>
<td>14.14±0.38</td>
<td>24.06±0.17</td>
<td>3.56±0.04</td>
<td>5.64±0.08</td>
<td>8.49±0.02</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Supplement III)</td>
<td>10.20±0.29</td>
<td>19.46±0.06</td>
<td>2.86±0.01</td>
<td>1.31±0.02</td>
<td>6.62±0.06</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>3.13</td>
<td>3.52</td>
<td>0.33</td>
<td>0.55</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Values are mean ±SE
Supplement I= Namakpara + Biscuit without incorporation of amaranth and carrot powder, respectively
Supplement II= Amaranth powder Namakpara, Supplement III= Carrot powder Biscuit

Table 2: Effect of supplements on nutrients intake of experimental children of three groups (2-6 year)

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>RDA</th>
<th>Supplement I (Group I)</th>
<th>Supplement II (Group II)</th>
<th>Supplement III (Group III)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean intake</td>
<td>Total intake</td>
<td>Mean intake</td>
<td>Total intake</td>
</tr>
<tr>
<td></td>
<td>Through</td>
<td>with supplement</td>
<td>Through</td>
<td>with supplement</td>
</tr>
<tr>
<td>Energy (Kcal)</td>
<td>1465</td>
<td>818.35</td>
<td>1179.66</td>
<td>1179.66</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>25</td>
<td>23.35</td>
<td>38.98</td>
<td>38.98</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>26</td>
<td>21.14</td>
<td>29.77</td>
<td>29.77</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>400</td>
<td>380.64</td>
<td>481.25</td>
<td>481.25</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>15</td>
<td>7.42</td>
<td>13.08</td>
<td>13.08</td>
</tr>
<tr>
<td>Β-carotene (μg)</td>
<td>1600</td>
<td>397.00</td>
<td>1417.00</td>
<td>1417.00</td>
</tr>
</tbody>
</table>

Values are mean ±SE
Supplement I= Namakpara + Biscuit without incorporation of amaranth and carrot powder, respectively
Supplement II= Amaranth powder Namakpara, Supplement III= Carrot powder Biscuit

Impact on nutrient intake

For the group fed supplement I, the mean energy intake through diet before supplement was 818.35 kcal/day, and with supplementation, it was 1179.66 kcal per day (Table 2). It was 55.8% of their RDA before supplementation and 80.4% of their RDA after the feeding of supplement. With supplement II, the percent RDA increased from 58.0 to 86.5. Mean daily intake through diet for this group was 850.35 kcal, which increased to 1267.59 kcal with supplement. Mean energy intake through diet was 819.61 kcal for the group fed supplement III that increased to 1175 kcal/day with supplement. The percentage of the RDA for this group increased from 55.9 to 80.2. Total fat intake with supplements increased for all the three groups. Mean intake of fat through diet was 23.35 g/day for group I and it increased to 38.98 g/day with supplement I. With supplement II and III, the mean daily fat intake of group II and III increased from 21.28 and 21.07 g/day to 39.32 and 35.44 g/day, respectively (Table 2).

Total protein intake with supplements increased more than RDA for three groups. For group I, the mean intake through diet was 21.14 g/day and it increased to 29.77 g/day with supplement I. With supplement II, the total protein intake of group II was 31.74 g/day as compared to its mean intake of 21.14 g/day through diet. Mean intake of group III through diet was 21.69 g/day. With supplement III, it increased to 29.12 g/day.
Mean intake of calcium through diet was 380.64 mg/day for group I, and with supplement I, it increased to 481.25 mg/day. Supplement II increased the calcium intake of group II to 498.10 mg/day as compared to 364.14 mg/day intakes through diet. For group III, the mean calcium intake through diet was 381.92 mg/day. With supplement III, it increased to 449.18 mg/day.

Mean intake of iron through diet was 7.42 mg/day for group I and it increased to 13.08 mg/day with supplement I. Mean daily intake for group II increased from 41.4 to 83.8% RDA. With supplement II, the intake was 6.21 mg/day through diet and 12.57 mg/day with supplement. The percent RDA for this group increased from 50.7 to 83.3% (Table 2.)

For the group fed supplement I, the mean β-carotene intake through diet before supplement was 397 μg/day and with supplementation, it was 1417 μg/day. The percent RDA for this group increased from 24.8 to 88.5%. Beta-carotene intake with supplement II and III increased more than the RDA for group II and III. For group II, the mean intake through diet was 428.85 μg per day. It increased to 3098.85 μg per day with supplement II. With supplement III, the β-carotene intake of group III was

### Table 3:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group I (Supplement I)</th>
<th>Group II (Supplement II)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td><strong>Eye</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Night blindness</td>
<td>3(21.4)</td>
<td>3(21.4)</td>
</tr>
<tr>
<td>Pale conjunctiva</td>
<td>6(42.8)</td>
<td>6(42.8)</td>
</tr>
<tr>
<td>Night blindness</td>
<td>1(7.14)</td>
<td>1(7.14)</td>
</tr>
<tr>
<td>Corneal xerosis</td>
<td>2(14.2)</td>
<td>3(21.4)</td>
</tr>
<tr>
<td>Xerophthalmia</td>
<td>1(7.14)</td>
<td>1(7.14)</td>
</tr>
<tr>
<td>Bitot’s spot</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Skin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follicular hyperkeratosis</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Xerosis</td>
<td>1(7.14)</td>
<td>1(7.14)</td>
</tr>
<tr>
<td>Pellicular dermatosis</td>
<td>3(21.4)</td>
<td>2(14.2)</td>
</tr>
<tr>
<td>Good</td>
<td>3(21.4)</td>
<td>2(14.2)</td>
</tr>
</tbody>
</table>

**Table 4:** Effect of different supplements on Serum retinol level of experimental children of three groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of children</th>
<th>Initial (μg/100ml)</th>
<th>Final (μg/100ml)</th>
<th>Increase (μg/100ml)</th>
<th>pcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Supplement I)</td>
<td>14</td>
<td>11.29±0.45</td>
<td>12.53±0.56</td>
<td>1.23±0.89</td>
<td>1.36</td>
</tr>
<tr>
<td>Group I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Supplement II)</td>
<td>14</td>
<td>10.82±0.35</td>
<td>16.82±0.44</td>
<td>6.00±1.01</td>
<td>1.07**</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Supplement III)</td>
<td>13</td>
<td>10.34±0.55</td>
<td>13.32±0.42</td>
<td>3.98±1.11</td>
<td>1.12**</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are mean ±SD

**Significant at 1% level of significance

NS= Non significant

Figures in parentheses indicate percent increase in serum retinol level as compared to initial value

Supplement I = Namakpara+ Biscuit without incorporation of amaranth and carrot powder, respectively

Supplement II = Namakpara incorporated with Amaranth powder

Supplement III = Biscuit incorporated with carrot powder
2553.15 μg per day as compared to its mean intake of 413.15 μg per day through diet. The study shows that the supplements with incorporation of vegetable powders made up the deficiencies in diets to some extent and helped in improving vitamin A status (Table 2).

**Impact on presence of deficiency signs and symptoms**

All the children of supplemented groups were examined for vitamin A deficiency signs and symptoms. The number of children showing deficiency signs in each group was compared to symptoms prior to feeding trial. There was no decrease in night blindness in all three groups. The number of children having pale conjunctiva remained same in group I after supplementation but the number was decreased in group II and III. Before supplementation period, seven children in group II and six children in group III had pale conjunctiva of eye. The number of such children decreased from seven to five in group II and six to four in group III. The number of children decreased from two to one in group II and III with corneal xerosis after supplementation. After supplementation, not a single child showed symptom of bitot’s spot.

The number of children having skin xerosis remained unchanged in group I and II but in case of group III, the number was decreased from six to four after supplementation. Before supplementation period, eight children in group I, six in group II and one child in group III had follicular hyperkeratosis. The number of such children decreased from eight to seven in group I and six to four in group II. The number remained same in case of third group. The percentage of children falling in good category increased from 14.2 to 35.7 in group II and from 23.0 to 46.1 in group III. Before supplementation, four children in group II and three in group III had signs of pellagrous dermatosis. After supplementation, the number of such children decreased from four to three in group II and three to two in group III.

Devadas et al. (1979) reported that children given a low cost vegetable protein supplement were better than controls in terms of clinical assessment. Chandrasekhar and Beulah George (1990) reported disappearance of vitamin A deficiency symptoms in papaya-supplemented groups of slum children of Coimbatore. Chahal, S. (1995) observed that nutritional supplements based on groundnut helped in improving clinical picture of children. A variety of foods are provided as supplements in the ICDS scheme. Locally available foods as well as food commodities provided by world food programme is utilized. The type of food varies from state to state but usually consists of hot meal cooked at anganwadi, containing a varied combination of pulses, cereals, oils, vegetables and sugar (NIPCCD, 2002).

The initial serum retinol level of three supplemented groups was almost same, that was 11.29±0.45, 10.82±0.35 and 10.34±0.55 μg/100 ml, respectively in group I, II and III. After feeding of supplements, the increase in serum retinol level was observed mainly in II and III group. The maximum increase was observed with supplement II, in which the mean serum retinol level increased from 10.82±0.35 to 16.48±0.44 μg/100 ml.

With supplement III, the mean serum retinol level increased from 10.34±0.55 to 15.32±0.42 μg/100 ml, while with supplement I, it differed non-significantly, i.e., increased from 11.29±0.45 to 12.53±0.56 μg/100 ml. The increase observed in group II and group III was significantly (P ≤0.01) higher than that of group I. Supplement II and III were rich in b-carotene content as compared to supplement I (Table 4). After feeding of three months, there was increase in serum retinol level in group II and III, which were fed supplement II and III, respectively as compared to group I, which got supplement I. Final values of serum retinol level of group II and III were significantly higher (P ≤ 0.01) as compared to group I. Chandrashekhkar and George (1990) reported that supplementation with b-carotene rich papaya improved the serum vitamin A level of 36.0% of the cases to normal in slums of Coimbatore. The serum retinol level of papaya group increased from 11.5 to 18.9 μg/100 ml. Continuation of supplements over longer periods will undoubtedly improve the situation favorably.
CONCLUSION

It was concluded from the study that Beta-carotene rich supplements were found suitable for improving vitamin A status among children. There was significant reduction in clinical symptoms of experimental children after supplementation. Group II and III showed significantly higher increase in serum retinol level than group I. Hence, it is concluded that these products could be recommended for supplementation in under nutrition intervention programmes for combating vitamin A deficiency, which is a major problem in rural areas of India.

REFERENCES


