paths from the ground level \( |1 \rangle \) to the excited level \( |3 \rangle \) (involving, for example, the direct transition amplitude \( |1 \rangle \rightarrow |3 \rangle \) and the alternative transition amplitudes \( |1 \rangle \rightarrow |3 \rangle \rightarrow |2 \rangle \rightarrow |3 \rangle \) and so on in higher-order virtual cycles). The injected microwave noise connecting level \( |2 \rangle \) to level \( |1 \rangle \) can, however, cause the electron to make a real transition \( |2 \rangle \rightarrow |1 \rangle \), and thus take it out of the above coherent (virtual) cycles. Such a noise-induced real transition necessarily causes dephasing of the otherwise coherent interference of the virtual alternatives, thereby degrading the EIT. This effect can be seen in Figure 7. Our calculation explicitly takes into account this effect of the injected classical noise within the Lindblad formalism, using the Novikov theorem.


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Development of non-dairy, calcium-rich vegetarian food products to improve calcium intake in vegetarian youth

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Vegetarians are prone to high risk of mineral deficiencies. The aim of the present study was to examine dietary habits of vegetarian children and adolescents for calcium adequacy and devise recipes to improve their calcium intake. In a cross-sectional survey in 236 Indian school children (89 boys) aged 7–19 years, diet was assessed by 24-h recall on three random days. Using plant foods, i.e. finger millet, soybean, leafy vegetables and sesame seeds, 14 non-dairy-based, calcium-rich products (NDBCRP) and 12 dairy-based calcium-rich products (DBCERP) were developed. Calcium content of all products was analysed using atomic absorption spectrophotometer. Mean calcium content per 100 g cooked weight of NDBCRP (337.5 ± 107.4 mg) and DBCERP (259 ± 88 mg) was similar (\( P = 0.12 \)). Calcium intake was found to be low in boys (507 ± 267 mg/day) and girls (421 ± 184 mg/day), which can be enhanced by NDBCRP supplement. Thus NDBCRP products have the potential to alleviate calcium deficiency in Indian adolescents.

Keywords: Calcium intake, dietary habits, non-dairy products, vegetarians.

APPROXIMATELY 99% of total body calcium is found in the skeleton\(^1\). Bone mass accrual continues from infancy through to early adulthood until peak bone mass is achieved by the second decade of life\(^2\). Therefore, adequate calcium intake is important for bone health throughout the lifespan and for the prevention of osteoporotic fractures in later years.

Calcium intake of children and adolescents in Asia, especially in India, is relatively low in comparison to their Western counterparts\(^3\). Various studies from India report low calcium intake and hypocalcaemia among young boys and girls, emphasizing the importance of increasing calcium intake in children and adolescents\(^4–7\). This could be partly attributed to the non-milk-based diets, poor dietary habits, inadequate information and knowledge about calcium-rich food and poor calcium absorption from plant foods\(^6,8\). Thus, there is a need to analyse the dietary intake and food choices of Indian children and adolescents to improve their calcium intake.

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Milk and milk products are a rich source of calcium in the diet. However, intake of milk and milk products in majority of Indian children and adolescents is reported to be meagre, whereas plant food like cereals, pulses and green leafy vegetables contributes to about 36–50% of daily calcium intake. Non-dairy-based food such as calcium-fortified soy milk, kale and broccoli has been identified as a good source of calcium in vivo studies. Indigenous Indian food rich in calcium such as millets, nuts and oil seeds, and green leafy vegetables are yet to be identified and tested for their potential in calcium enrichment of daily diet of youth. This information will certainly increase the choice of calcium-rich food in Asian diets. It is therefore necessary to utilize food-based approaches and interventional strategies to promote bone mass and prevent osteoporosis in Asia.

Plant foods like cereals, green leafy vegetables and nuts contain phytins and oxalates that bind with calcium forming insoluble salts and decrease calcium absorption. Food-processing methods like roasting and malting are shown to enhance calcium extractability from wheat, barley and green-gram preparations. Malt pre-treatment of sorghum flour has been shown to decrease phytin content of the flour and increase calcium extractability. Weaver et al. have shown that calcium absorption from leavened wheat flour product is more than that from unleavened products. Thus, using food-processing methods, absorption of calcium from plant foods can be enhanced.

For achieving optimum bone mass at skeletal maturity and for prevention of osteoporotic fractures, Indian recommended dietary allowance (RDA) for calcium intake has recently been revised. However, strategies to meet these recommendations need to be devised taking into account dietary habits of the Indian population. Therefore, the objective of this study was to: (i) assess dietary habits and calcium intake in children and adolescents, and (ii) develop non-dairy-based plant food products with high calcium content and use processes like malting and leavening for increasing calcium absorption. The acceptability of these products was also tested to judge their potential for adopting them in dietary practice.

A cross-sectional survey was conducted from November 2008 to February 2009 encompassing students from private schools and colleges in affluent areas of Pune city, India (i.e. areas without slum clusters and low-income housing schemes, but including areas with high land prices as published by Government agencies (Ministry of Urban Development, Lands Division)), who voluntarily participated in the study. In all, 236 apparently healthy children and adolescents (89 boys) aged 7–19 yrs were assessed for their age, weight, height and diet. Ethical approval was granted by the ethics committee of Hirabai Cowasji Jehangir Medical Research Institute and Jehangir Clinical Development Centre, Pune. A letter of information was given to all participants in the study, and an informed written consent from parents and assent from children were obtained.

All measurements were recorded in the morning between 8 and 10 am for all subjects. Standing height was measured to the nearest 1 mm using a stadiometer (Leicester Height Meter, Child Growth Foundation, UK, range 60–207 cm). Weight was measured using an electronic weight scale to the accuracy of 100 g (Salter). Height and weight for age Z scores were calculated using Indian reference charts.

Dietary intake was assessed by 24-h recall on three random days (non-consecutive) of a week, including Sunday. Each child was asked about the intake of food items during the day at breakfast, lunch, dinner and snacks, using standard cups and spoons by trained investigators through a face-to-face interview. The recipes of food items were also recorded. The portion size was obtained by the average of actual weights of one serving of each food item from their households. This was done for each of the food items consumed such as rice, vegetables, chapatti (unleavened wheat pancake), etc. Daily nutrient intake was calculated by applying nutritive values of cooked foods. For the consumption of raw food such as fruits and salads, the nutritive value tables of the National Institute of Nutrition (NIN), India, were applied. Percentage contribution of calcium from milk was calculated separately.

From the cohort of study subjects, 51% of the total food intake was in the form of cereals and pulses (Figure 1). Thirty-six per cent boys and girls had no intake of milk (including milk from tea) in their diet and 86.2% were not consuming any milk products such as curd or cheese. Mean milk intake in boys was 45% of RDA (500 m/day), which was significantly more than in girls (30%; P < 0.05). Therefore, the main source of dietary calcium in these children and adolescents was plant foods. Thus, based on the dietary food habits, to improve

![Figure 1. Gender-wise percentage distribution of food.](image-url)
calcium intake in the diets of children and adolescents, non-dairy-based, calcium-rich products (NDBCRP) were
developed with emphasis on: (i) selection of commonly available calcium-rich food from the nutritive value
tables; (ii) food-processing methods that would enhance calcium absorption, like malting and leavening; (iii)
comparison with dairy-based, calcium-rich products (DBCRP) to ensure high calcium content, and (iv)
acceptability of the developed food products.

A list of commonly consumed 70 non-dairy food items
in the study group as also from the Indian adolescent
population at large was prepared. With the help of nutri-
ent composition tables, calcium content in these food
items was calculated. It ranged from 40 to 1450 mg of
calcium per 100 g raw weight. The NDBCRP were
devised using food items from the list. Calcium-rich food items like finger millet flour (Elusine coracana),
soybean (Glycine max), sesame seeds (Sesamum indicum)
(with hull), dry coconut (Cocos nucifera), poppy seeds
(Papaver somniferum), dried cauliflower leaves (Bras-
sica oleracea var. botrytis), curry leaves (Murraya koenigii), cumin seeds (Cuminum cyminum), niger seeds
(Guizotia abyssinica) and garden cress seeds (Lepidium
vari. Lepidium botrytis) were selected to develop the recipes. Food-
processing methods like malting and leavening were used
to enhance calcium absorption. For malting, whole finger
millet was soaked overnight in water for 8 h. It was
allowed to germinate for two days. The germinated finger
millet was then sun-dried for one day. The dried roots
were then broken manually and the millet was milled into
fine flour for use. Leavening processes like overnight
fermentation, incorporation of yeast and steam were used.

Twelve DBCRP commonly consumed in India were
selected, such that except for dairy products other major
ingredients were similar in both the groups. DBCRP were
analysed for their calcium content for comparison with
NDBCRP.

All the 26 cooked food products were homogenized
and analysed in duplicate for nutrient content in the labo-
atory using various techniques described in NIN manu-
ual. Protein content of the food samples was estimated
using the micro Kjeldahl method and fat content by
Saxhlet extraction. Ash was estimated by igniting the food
sample in a muffle furnace at 550°C. The calorific
value of food products was estimated using proximate
principles and Atwater’s factors. The ash was dissolved
in 6 N 1:1 hydrochloric acid and calcium concentration
was analysed using atomic absorption spectrophoto-
metry. Oxalate, phytin and fibre content was estimated
using the nutritive value table for raw foods, after
adjusting for moisture content of the cooked product.

Sensory evaluation was carried out for acceptability of
the newly developed NDBCRP. The panel consisted of 10
members for sensory evaluation. The panel members
were isolated from each other. Samples were presented in
plastic dishes or bowls coded with random numbers and
served in a randomized order to all the panel members.
The samples were served at room temperature and analy-
ses were performed under normal lightening conditions.
One sample was provided at a time at an interval of
5 min. The panel members rinsed their palates with water
before and between tasting. A nine-point hedonic scale
for acceptance (with tick-boxes 9 = like extremely, 8 =
like very much, 7 = like moderately, 6 = like slightly, 5 =
neither like nor dislike, 4 = dislike slightly, 3 = dislike
moderately, 2 = dislike very much and 1 = dislike extre-
melty) was used for the independent hedonic rating of
appearance, texture, taste and overall acceptability of
each sample. Evaluation was performed at the Hirabai
Cowasji Jehangir Medical Research Institute under satis-
factory conditions.

Difference in mean calcium content of DBCRP and
NDBCRP was tested using Student’s t-test. P value < 0.05
was considered to be statistically significant. Calcium
density of the diet/products was calculated using the
formula

\[
\text{Calcium content per 1000 calories} = \frac{1000 \times \text{calcium content of the recipes}}{\text{caloric content of the recipes}}
\]

Table 1 describes the anthropometric parameters and
nutrient intake in boys and girls. Height and weight for
age Z scores were within 2 SD for both boys and girls,
indicating that the children were apparently healthy for
their age. Energy, protein, calcium and phosphorus intake
was significantly more in boys than in girls (P < 0.01).
Mean calcium intake was 63% and 53% of the Indian
RDA for boys and girls respectively (800 mg/day). Seven-
ty-seven boys (87%) and 139 girls (95%) had calcium
intake less than the RDA (800 mg/day). However,
calcium density and calcium-to-phosphorus ratio was not
significantly different in the two groups (P > 0.1).
Calcium intake from milk was 46% and 35% of the total
calcium intake in boys and girls respectively.

Table 2 describes the composition of DBCRP and
NDBCRP. Fourteen NDBCRP (NDBCRP 1–NDBCRP 14)
were matched with 12 DBCRP (DBCRP1–DBCRP12).
Finger millet, soybean and sesame seeds were the main
source of calcium in NDBCRP. All the DBCRP had
either buffalo milk or cottage cheese made from buffalo
milk. Malting and leavening were used as processing
methods for five products. Overnight fermentation was
used as a method of leavening for making finger millet
pancake (dosa). Yeast was used as the method of leavening
for making all three types of cauliflower bread.
Over-
night fermentation and steam was used as a method of
leavening for finger millet dhokla with cauliflower leaves.
Malting was used as a processing method for making
finger millet–wheat pancake (thalipeeth), finger millet–
cumin biscuits and mix flour–sesame ladoo. Six products
Table 1. Anthropometric and dietary intake in Indian boys and girls

<table>
<thead>
<tr>
<th></th>
<th>Boys (n = 89)</th>
<th>Girls (n = 147)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>16.3 ± 3.8</td>
<td>15.7 ± 3.9</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>48.0 ± 13.4*</td>
<td>43.8 ± 11.4</td>
</tr>
<tr>
<td>Weight for age Z score</td>
<td>–0.4 ± 1.0</td>
<td>–0.3 ± 1.2</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>158.3 ± 15.5*</td>
<td>151.2 ± 13.3</td>
</tr>
<tr>
<td>Height for age Z score</td>
<td>–0.6 ± 0.9</td>
<td>–0.5 ± 1.0</td>
</tr>
<tr>
<td>Energy (kcal/day)</td>
<td>1932 ± 545*</td>
<td>1651 ± 488</td>
</tr>
<tr>
<td>Protein (g/day)</td>
<td>45 ± 13*</td>
<td>38 ± 12</td>
</tr>
<tr>
<td>Calcium (mg/day)</td>
<td>507 ± 267*</td>
<td>421 ± 184</td>
</tr>
<tr>
<td>Calcium density (mg/1000 kcal)</td>
<td>267 ± 129</td>
<td>263 ± 113</td>
</tr>
<tr>
<td>Phosphorus (mg/day)</td>
<td>1020 ± 281*</td>
<td>834 ± 259</td>
</tr>
<tr>
<td>Calcium : phosphorus ratio</td>
<td>0.50 ± 0.2</td>
<td>0.51 ± 0.2</td>
</tr>
</tbody>
</table>

Data represented as mean ± SD. *P < 0.01 for comparison between boys and girls.

Figure 2. Calcium content of NDBCRP and DBCRP (mg/100 g).

which were high in calcium, namely ladoos, biscuits and dips (chutneys), were prepared using traditional cooking methods like roasting and grinding.

As shown in Figure 2, in the NDBCRP group, sesame ladoo was the richest source of calcium (549.1 mg/100 g) followed by sesame–soybean dip (chutney) (491.5 mg/100 g) and poppy seed porridge (442.2 mg/100 g). Finger millet–cumin biscuits (193.2 mg/100 g) and mix flour–sesame ladoo (199.7 mg/100 g) were the lowest sources of calcium in NDBCRP group. In DBCRP group, finger millet porridge (496.6 mg/100 g), rice porridge with poppy seeds (475.5 mg/100 g) and soybean–amaranth porridge (407.7 mg/100 g) were the richest sources of calcium in NDBCRP group. In DBCRP group, finger millet porridge (496.6 mg/100 g), rice porridge with poppy seeds (475.5 mg/100 g) and soybean–amaranth porridge (407.7 mg/100 g) were the richest sources of calcium, whereas spinach–cottage cheese vegetable (173.2 mg/100 g) and peas–cottage cheese vegetable (177.8 mg/100 g) were the lowest sources of calcium.

Table 3 represents the average nutrient composition of NDBCRP and DBCRP. The mean calcium content of NDBCRP was 337.5 ± 107.4 mg, whereas that of DBCRP was 274.3 ± 127.8 mg/100 g cooked weight. There was no significant difference in calcium content of the two groups (P = 0.12). However, there was significant difference in the energy, protein, fat, oxalate, phytin and fibre content of NDBCRP and DBCRP. Nevertheless, even after adjusting for calorie content, there was no significant difference in the calcium content of the two groups (P = 0.547).

Figure 3 shows the mean sensory scores of NDBCRP. Ten out of fourteen products were well accepted by the panel members. Finger millet pancake (dosa) and sesame–soybean dip (chutney) was the most acceptable product. Seventy per cent of the panel member reported that they ‘liked extremely’ the finger millet pancake (dosa) with sesame–soybean dip (chutney). Finger millet–wheat pancake (thalipeeth) was the second most liked product, with 50% of the panel members reporting that
Table 2. Food composition of non-dairy based, calcium-rich products (NDBCRP) and dairy-based, calcium-rich products (DBCRP)

<table>
<thead>
<tr>
<th>Code</th>
<th>Recipe</th>
<th>Description of recipe (ingredients in grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDBCRP1</td>
<td>Finger millet pancake (dosa)</td>
<td>Leavened pancake made from finger millet flour (28), soybean flour (10), sesame seeds (10), cumin seeds (2) and vegetable oil (2). Process used: malting and leavening.</td>
</tr>
<tr>
<td>NDBCRP2</td>
<td>Sesame–soybean dip (chutney)</td>
<td>Dip made from fresh coconut (50), roasted soybean (25), sesame seeds (25), cumin seeds (8) and curry leaves (5).</td>
</tr>
<tr>
<td>NDBCRP3</td>
<td>Sesame ladoo</td>
<td>Sweet balls made from sesame seeds (20), niger seeds (20), refined palm sugar (20) and clarified butter (2).</td>
</tr>
<tr>
<td>NDBCRP4</td>
<td>Poppy seed porridge</td>
<td>Sweet made from poppy seeds (100), rice (30), refined palm sugar (100) and fresh coconut (50).</td>
</tr>
<tr>
<td>NDBCRP5</td>
<td>Garden cress seed–sesame chikki</td>
<td>Sweet made from garden cress seeds (10), sesame seeds (5), dried coconut (10), refined palm sugar (25) and clarified butter (2).</td>
</tr>
<tr>
<td>NDBCRP6</td>
<td>Soybean–sesame chikki</td>
<td>Sweet made from soybean (15), sesame seeds (10), refined palm sugar (25) and clarified butter (2).</td>
</tr>
<tr>
<td>NDBCRP7</td>
<td>Cauliflower bread (plain)</td>
<td>Bread made from finger millet flour (10), soybean flour (10), refined flour (10), dried cauliflower leaves (10), sesame seeds (5) and clarified butter (5). Process used: malting and leavening.</td>
</tr>
<tr>
<td>NDBCRP8</td>
<td>Cauliflower–garlic bread (plain)</td>
<td>Bread made from finger millet flour (10), soybean flour (10), refined flour (10), dried cauliflower leaves (10), sesame seeds (5), garlic (10) and clarified butter (5). Process used: malting and leavening.</td>
</tr>
<tr>
<td>NDBCRP9</td>
<td>Cauliflower–oregano bread (plain)</td>
<td>Bread made from finger millet flour (10), soybean flour (10), refined flour (10), dried cauliflower leaves (10), sesame seeds (5), oregano (5) and clarified butter (5). Process used: malting and leavening.</td>
</tr>
<tr>
<td>NDBCRP10</td>
<td>Finger millet–wheat pancake (thali-peeth)</td>
<td>Unleavened pancake made from finger millet flour (36), wheat flour (8), jowar flour (Sorghum vulgare) (7), bengal-gram flour (7), radish leaves (15) and vegetable oil (5). Process used: malting.</td>
</tr>
<tr>
<td>NDBCRP11</td>
<td>Finger millet–cumin biscuits</td>
<td>Biscuits made from finger millet flour (30), refined flour (10), cumin seeds (5) and clarified butter (25). Process used: malting and leavening.</td>
</tr>
<tr>
<td>NDBCRP12</td>
<td>Finger millet dhokla with cauliflower leaves</td>
<td>Leavened pancake made from finger millet flour (25), soybean flour (10), cauliflower leaves (5) and sesame seeds (5). Process used: malting and leavening.</td>
</tr>
<tr>
<td>NDBCRP13</td>
<td>Mix flour and sesame ladoo</td>
<td>Sweet balls made from finger millet flour (10), soybean flour (10), bengal-gram flour (10), sesame seeds (5), dry coconut (5), sugar (15) and clarified butter (20). Process used: malting.</td>
</tr>
<tr>
<td>NDBCRP14</td>
<td>Spinach with pumpkin seeds dip (chutney)</td>
<td>Dip made from spinach (42), coriander (17), gingelly seeds (9), pumpkin seeds (8), garlic dry (8) and chillies green (8).</td>
</tr>
<tr>
<td>DBCRP1</td>
<td>Finger millet porridge</td>
<td>Sweet made from finger millet flour (5), coconut fresh (9), poppy seeds (17), buffalo milk (52) and sugar (17).</td>
</tr>
<tr>
<td>DBCRP2</td>
<td>Rice porridge with poppy seeds</td>
<td>Sweet made from rice (5), coconut fresh (9), poppy seeds (17), buffalo milk (52) and sugar (17).</td>
</tr>
<tr>
<td>DBCRP3</td>
<td>Rice porridge without poppy seeds</td>
<td>Sweet made from rice (6), coconut fresh (10), buffalo milk (63) and sugar (21).</td>
</tr>
<tr>
<td>DBCRP4</td>
<td>Garden cress seed porridge</td>
<td>Sweet made from garden cress seeds (9), dry coconut (9), buffalo milk (56), clarified butter (2) and sugar (23).</td>
</tr>
<tr>
<td>DBCRP5</td>
<td>Cheese sandwich</td>
<td>Sandwich made from white bread (70), cheese (16), green chillies (8) and coriander leaves (10).</td>
</tr>
<tr>
<td>DBCRP6</td>
<td>Spinach–cottage cheese vegetable</td>
<td>Vegetable made from cottage cheese (16), spinach (53), onion (11), tomato (11), Dry garlic (1), cumin (1) and oil (3).</td>
</tr>
<tr>
<td>DBCRP7</td>
<td>Peas–cottage cheese vegetable</td>
<td>Vegetable made from cottage cheese (46), peas (20), onion (9), tomato (14), cumin (1) and oil (5).</td>
</tr>
<tr>
<td>DBCRP8</td>
<td>Basundi</td>
<td>Sweet made from buffalo milk (90) and sugar (9).</td>
</tr>
<tr>
<td>DBCRP9</td>
<td>Rasmalai</td>
<td>Sweet made from cottage cheese (25), buffalo milk (50) and sugar (25).</td>
</tr>
<tr>
<td>DBCRP10</td>
<td>Rasgulla</td>
<td>Sweet made from cottage cheese (66) and sugar (33).</td>
</tr>
<tr>
<td>DBCRP11</td>
<td>Pudding</td>
<td>Sweet made from white bread (10), buffalo milk (70), egg (hen) (10) and sugar (15).</td>
</tr>
<tr>
<td>DBCRP12</td>
<td>Soybean–amaranth porridge</td>
<td>Sweet made from soybean flour (5), amaranth flour (3), buffalo milk (85), sugar (8) and clarified butter (7).</td>
</tr>
</tbody>
</table>
Table 3. Comparison of nutrient composition of NDBCRP and DBCRP

<table>
<thead>
<tr>
<th>Nutrient per 100 g cooked weight</th>
<th>NDBCRP</th>
<th>DBCRP</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg)</td>
<td>337.5 ± 104.4</td>
<td>274.3 ± 127.8</td>
<td>0.199</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>364 ± 115</td>
<td>259 ± 88</td>
<td>0.018</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>10.8 ± 4</td>
<td>6.6 ± 2.9</td>
<td>0.008</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>19.3 ± 10.1</td>
<td>11.4 ± 4.1</td>
<td>0.020</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>36.8 ± 12.3</td>
<td>30.1 ± 13.3</td>
<td>0.205</td>
</tr>
<tr>
<td>Oxalate (mg)*</td>
<td>177.8 (240.3)</td>
<td>1 (11.0)</td>
<td>0.000</td>
</tr>
<tr>
<td>Phytin (mg)*</td>
<td>162 (253.1)</td>
<td>4.5 (45.2)</td>
<td>0.000</td>
</tr>
<tr>
<td>Fibre (g)*</td>
<td>5.7 (7.1)</td>
<td>0.5 (1.9)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Data represented as mean ± SD. *Estimated using tables of nutritive value of Indian foods after adjusting for moisture content and data presented as median (IQR) as they were not normally distributed.

Figure 3. Sensory scores of NDBCRP based on hedonic rating scale. Data are presented as mean scores.

they ‘liked extremely’ thalipeeth. Plain cauliflower bread was not accepted well by the panel members. Ninety per cent of the panel members reported that they ‘dislike very much’ plain cauliflower bread due to its strong pungent odour and taste. Cauliflower bread with oregano and garlic was better accepted by them, as addition of garlic and oregano had reduced the pungent flavour of the bread. Like cauliflower bread, finger millet dhokla with cauliflower leaves was also ‘disliked very much’ by 90% of the panel members due its pungent odour and taste.

We have reported calcium intake in children and adolescents in Pune city; 92% of the study subjects had calcium intake below the RDA. We have developed 14 NDBCRP and demonstrated that they are at par with similar dairy products with respect to calcium content. We used food-processing methods like malting and leavening to increase calcium absorption of the products. We also found that 10 out of the 14 products were completely acceptable.

Several studies have reported that calcium intake is below the Indian RDA in children and adolescents (800 mg/day)9. Similar results were seen in our study. Moreover, diets of Indian children and adolescents are mainly cereal and millet-based6,12. Other non-dairy based, calcium-rich sources like calcium-fortified soy milk28, fortified orange juice and apple juice29 are not commonly consumed by Indian adolescents. Hence NDBCRP provide an opportunity to increase calcium content in the diets of children and adolescents, which is in line with their dietary practices. One meal per day of 200 g of NDBCRP would provide 84% of the daily RDA for Indian children and adolescents9.

Plant food sources of calcium also contain large quantities of phytates, oxalates, tannins and fibres which are known to be potent inhibitors of calcium absorption. Reports suggest that around 30% of calcium is absorbed from dairy sources as against 10% from non-dairy sources due the high phytic acid content15,30. Several traditional food-processing and preparation methods such as soaking, fermentation and germination/malting can be used at the household level to enhance the bioavailability of micronutrients in plant-based diets by increasing the physico-chemical accessibility31. Study by Navert and Sandstorm32 has shown that the phytic acid content of bread decreases to 40% by leavening. Thus, leavening helps increase calcium absorption by degradation of
phytic acid\textsuperscript{18}. Studies have also shown that the addition of malt to sorghum increases calcium absorption from 32–35\% to 102–103\% (ref. 17). Hence, NDBCRP developed using malting and leavening are expected to have high calcium absorption.

In conclusion, our data have shown that dietary calcium intake of Indian children and adolescents is below the RDA, and that the 14 NDBCRP developed in our study can be incorporated in the diet of Indian adolescents to increase their calcium intake on a day-to-day basis.


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