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Development of an indigenous calcium rich food supplement

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Abstract
Introduction: The International osteoporosis foundation in 2013 estimates that incidence of osteoporosis among Indian adults has been reported to be 50 million. Nutritional deficiency, particularly of calcium can result in poor formation and mineralization of the bones. Less optimal intake of calcium by both male and female subjects has been reported. A pilot study done on urban and suburban population found that the average calcium intake was 425.30±101.71 mg/day among males and 407.14±107.96 mg/day among females as against the RDA of 600mg/day. Though a plenty of synthetic calcium supplements are available, it is important that a calcium rich food supplement that could be easily prepared at household level be made available to combat calcium deficiency. Based on the reports observing suboptimal calcium intake among the population, the present study was postulated with the following aim.
Aim: To formulate and standardize an indigenous low cost calcium rich food supplement.
Methods: Development of calcium rich supplement was attempted by addition of optimized proportions of leaves of *Sesbania grandiflora*, seeds of *Sesamum indicum*, *Eleusine coracana*, *Glycine max*, *Vigna mungo* with various processing techniques like soaking, germination, sun drying, roasting and powdering. The powdered ingredients were combined in different ratios A (15:25:30:25:5), B (15:20:30:25:10) and C (10:25:30:25:10) and were made into ladoos. The products were subjected to calcium analysis, organoleptic evaluation using standard techniques and shelf life analysis.
Results: Combination A (15:25:30:25:5) found to contain highest calcium (701mg/100 g) and received the highest overall acceptability scores 8.8 on organoleptic evaluation. The shelf life was found to be 75 days.
Conclusion: With the existing severe calcium deficiency among Indian population, incorporating low cost, indigenous calcium rich foods that could be prepared easily at household level would be beneficial in combating bone related disorders.

Keywords: Bones, calcium, *Sesbania grandiflora*, *Sesamum indicum*, *Eleusine coracana*, *Glycine max*, *Vigna mungo*

1. Introduction
In a developing country like India, there are always many concerns with regards to the dietary nutrition-related deficiencies. Calcium deficiency was not deemed to be as big a concern as was the deficiency of energy-rich foods, protein, and iron. Calcium deficiency leads to metabolic bone disease of prematurity, childhood rickets, deficient bone mass accrual in childhood and adolescence, deficiency in fetal bone mass accrual, secondary vitamin D deficiency and Osteoporosis in postmenopausal.
Calcium intake studies done in India showed the daily consumption ranged from 200 – 450 mg/day. With the intake of 400mg/day approximately 35% is absorbed and this percentage declines as the intake rises further. The ICMR committee also suggested that a minimum daily intake of 200 ml of milk would be necessary along with the remaining legume and cereal based diet. In a country like India, the consumption of milk and dairy products is increasing among the high and medium income groups, but the consumption is still to catch up in the low-income group [1]

2. Need for the Study
Incorporating low cost, naturally occurring calcium rich foods from different food groups will help in increasing the daily consumption of calcium and reduce the incidence of calcium deficiency. Therefore, a need was felt to develop a cost-effective and suitable alternative. Hence the present study was done with the following objective.

3. Objective

- To develop and standardise a calcium rich supplement using low cost and easily available ingredients.
- To analyse the nutrient composition, organoleptic characters, shelf life and consumer acceptance of the supplement.

4. Methodology

1. Selection of the Ingredients

Fresh leaves of Agathi (*Sesbania Grandiflora*), Sesame seeds (*Sesamum indicum*), Ragi (*Eleusine coracana*), Soybean (*Glycine max*) and Black gram dal (*Vigna mungo*) were selected for the study. The sources for the development of the calcium rich supplement were selected based on the following criteria's

1. Calcium rich source from various food groups
2. Low cost
3. Easy availability

Sources were collected from the same vendor's farm throughout the study period to avoid variations due to soil properties.

2. Standardisation of the Ingredients

Eleusine coracana, *Glycine max* and *Vigna mungo* were cleaned, washed and soaked in tap water seperately in ratio of 1:3 (w/v) grains for 12 h at room temperature (32±2 °C). At each 4 h interval the water was drained at each. After the period, they were drained, spread separately and were allowed to germinate for 12, 24, 36, 48 and 60 h covered with damp cotton cloth to optimize most suitable time for germination for maximum nutrient availability and digestibility. To facilitate the germination process water was sprinkled at 12 h interval.

The germinated seeds along with cleaned *Sesbania Grandiflora* leaves and *Sesamum indicum* samples were sun dried till constant weight. Using stainless steel grinder the dried samples were ground into fine powder and stored in air tight polythene bags for further analysis.

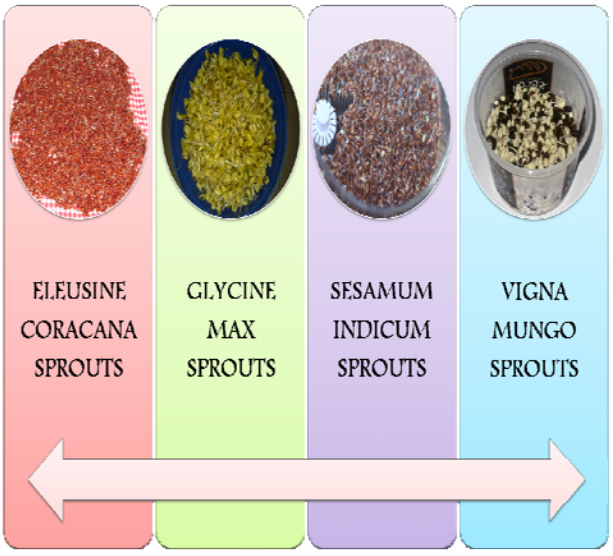


Fig 1: Sprouted samples

Fig 2: Fine powders of the samples

Fig 3: Calcium rich supplement

Fig 4: Packed sample

3. Nutritive Value of the Ingredients

Each of the ingredients was analyzed for its calcium content by standard techniques using AOAC 19th edition 2012/999.10 in a NABL accredited lab.

4. Standardisation of the Product

The ingredients were combined in different combination to achieve the maximum calcium content making use of various levls (30g, 25g, 15g, 10g and 5g) and the suitable combination was finalised. The finalised combination was mixed, roasted and prepared in form of ladoos.

5. Orgenoleptic Evaluation of the Product By Trained Panelists and Customers

Organoleptic evaluation is a scientific discipline used to stimulate, quantify and study response to those attributes of products or material as they are sensed by the perception of sight, smell, taste, touch and hearing [4]. The sensory evaluation was done using the 9-point hedonic scale

scorecard. The rating scale has nine points and these points are given word description ranging from dislike extremely to like extremely. Three ladoos of three different combinations each containing 45g of the mixture was provided for the evaluation. Trained panelist judged the sensory attributes like appearance, texture, taste, flavor, color, and overall acceptability. Ten normal healthy individuals also evaluated the sensory attributes for assessing the consumer acceptance.

6. Evaluation of time for the Preparation of the Product

To measure the easiness of the product preparation the time taken for preparing 100g of the product with higher overall acceptability scores was assessed. The time taken for preliminary preparations and the time taken for cooking the product was calculated.

7. Nutritive Value of the Product

The finalized product, which scored high in sensory evaluation, acceptance and shelf life, was subjected to nutrient analysis. Dried sample was packed in polythene bags and was analyzed for its Energy (Kcal), Carbohydrate (g), Fat (g) Protein (g), and Calcium (mg) content using David Pearson chemical analysis, DGHS manual, AOAC 19th edition 2012/920.87, AOAC 19th edition 2012/999.10 respectively in a NABL accredited lab.

8. Shelf Life Study

The developed product was analyzed for their shelf stability for a period of three months. The product was analyzed for their shelf life by storing at room temperature in glass bottle. During the storage period, the bottle was examined visually for detecting any color change or microbial deterioration every three days. At the end of each week, the stored product was evaluated for their sensory qualities also.

9. Cost Analysis

The cost analysis was also done for each ingredient and the final product. The cost of each ingredient was analyzed from the local market. Overall cost of the product was calculated based on the amount of ingredients added.

The study was approved by the institutional ethics committee Ref No: IEC/15/FEB/114/02

5. Results and Discussion

1. Nutritive Value of the Ingredients

Each of the ingredients that were finely powdered was analyzed for its calcium content using AOAC 19th edition 2012/999.10 in a NABL accredited lab. The following table 1 shows the calcium content for the ingredients per 100g.

Table 1: Calcium Content in the Ingredients Selected

Ingredients	Calcium (mg /100g)
Agathi Leaf powder (*Sesbania Grandiflora*)	1570
Sesame powder (*Sesamum indicum*)	951.3
Ragi powder (*Eleusine coracana*)	326.4
Soyabean powder (*Glycine max*)	228.5
Black gram dal powder (*Vigna mungo*)	67

When the loss of calcium content was analyzed with the raw values of NIN, it was found that there was 95% loss in Soyabean and Ragi, 65% in sesame seeds, 43% in black gram dal. Agathi leaves had an increase in the calcium content by 38%.

Similar studies were conducted in different foods and the changes in calcium was analysed, Bressani R *et al*, 2004 [2] concluded that with cooking and steeping times calcium content increased in whole maize, endosperm, and germ. The increase was higher in the germ than in the endosperm. If steeping of the cooked grain is conducted in water, the level can be controlled.

Another study done by Sebastia V *et al*, 2001[3] found that industrially processed legumes had higher dialysabilities of calcium, iron and zinc than traditionally or microwave cooked legumes. Traditional and microwave cooking reduced the mineral contents by 9.7–36.4%, 14.2–31%, 11.1–28.9% for calcium, iron zinc respectively. These cooking techniques also reduced the dialysabilities of calcium with respect to the values for the raw products.

2. Standardisation of the Product

The ingredients were combined in different combination to achieve the maximum calcium content and the suitable combination was finalised. The below table 2 shows the three variations.

Table 2: Variations

Ingredients	Variation A		Variation B		Variation C	
	Amount (g)	Calcium (mg /100g)	Amount (g)	Calcium (mg /100g)	Amount (g)	Calcium (mg /100g)
Sesbania Grandiflora	15	235.5	15	235.5	10	157
Sesamum indicum	25	237.825	20	190.26	25	237.825
Eleusine coracana	30	97.92	30	97.92	30	97.92
Glycine max	25	57.125	25	57.125	25	57.125
Vignamungo	5	3.35	10	6.7	10	6.7
Total	100	631.72	100	587.505	100	556.57

It is evident from the above tables that the variation 'A' had the maximum calcium content.

3. Orgenoleptic Evaluation of the Product

The organoleptic evaluation was done by panel members using nine-point hedonic scale. Among the developed products, product A had highest score for the overall acceptability as shown in the following figure 5.

4. Shelf Life Study

The self-life quality of the developed product was assessed for a period of 3 months in room temperature. The findings are given in the below figure 6. There was no color changes or microbial deterioration found in the supplement for 75 days.

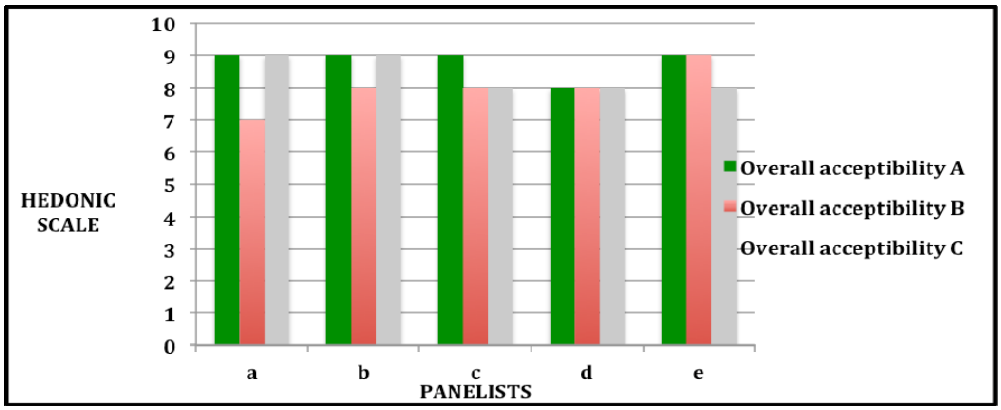
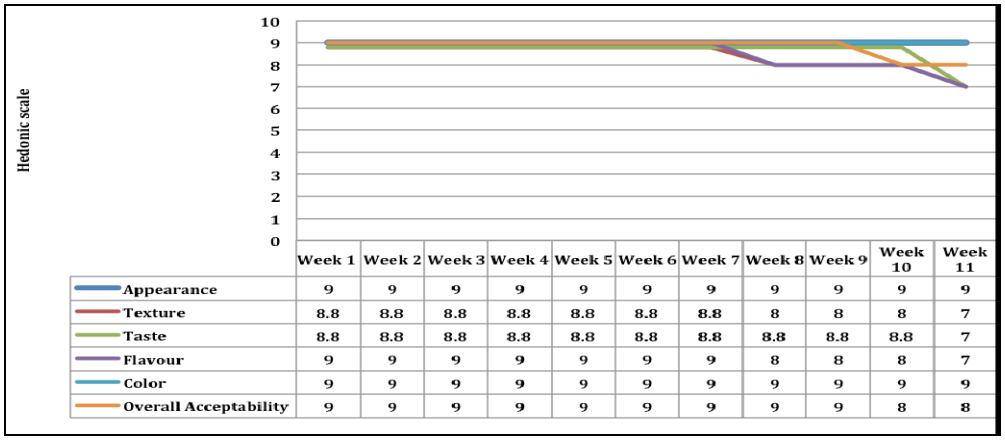


Fig 5: Orgenoleptic Evaluation



	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11
Appearance	9	9	9	9	9	9	9	9	9	9	9
Texture	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8	8	8	7
Taste	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	7
Flavour	9	9	9	9	9	9	9	8	8	8	7
Color	9	9	9	9	9	9	9	9	9	9	9
Overall Acceptability	9	9	9	9	9	9	9	9	9	8	8

Fig 6: Shelf Life Analysis

5. Evaluation of time for the Preparation of the Product

The below table 3 indicates the time taken for preparing 100g of each product. All the three combination underwent the same cooking procedure and hence the time taken to prepare the final product was same.

The pre preparation included roasting and grinding of the individual ingredients and the cooking time include the preparation of the ladoos.

Table 3: Evaluation of time Taken for Preparation

Product	Quantity (g)	Pre preparation (Minutes)	Cooking time (Minutes)	Total time (Minutes)
Calcium rich supplement	100	30	15	45

6. Nutritive Value of the Product

The developed product was again analyzed for its nutrient content using in a NABL accredited lab. Energy, Carbohydrate, Protein, fat, calcium and Phosphorus were analyzed. The below table 4 shows the final nutrient analysis of the product.

Table 4: Nutrient Analyisis of the Product

Nutrients	Content (per 100g)
Energy (Kcal)	414
Protein (g)	19.3
Carbohydrate (g)	58
Fat (g)	11.7
Calcium (mg)	701
Phosphorous (mg)	378

The calcium content of the product was foundto be 701mg/100 g.

7. Evaluation of Consumer Acceptance Through Sensory Evaluation

Among the developed products, the finalized product with highest score for overall acceptability was selected for the consumer acceptance evaluation organoleptically. They assigned different scores for the product in the score card provided and the results are given in figure 7

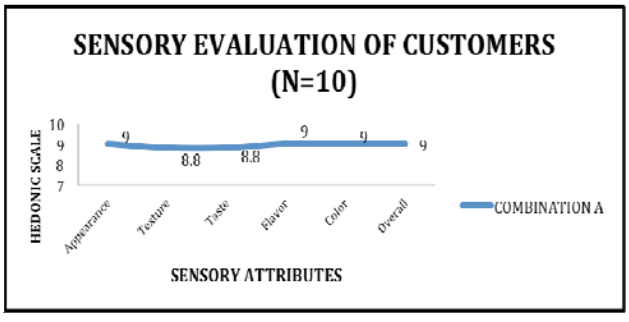


Fig 7: Orgenoleptic Evaluation by Consumers

8. Cost Analysis

Cost analysis shown in table 5 was done for the product based on the cost of the raw ingredients available in the local markets.

Table 5: Cost Analysis of the Ingredients

Ingredients	Cost (Rs)/100g
Agathi	3
Sesame	5.5
Ragi	2.4
Soyabean	45
Blackgram dal	1.1
Total	57

From the above table it is clear that 100g of the calcium rich supplement cost Rs. 57. When compared to the commercially available calcium supplements this home made supplement is cheaper.

6. Conclusion

Considering the very low intake of dietary calcium in Indian population, incorporating low cost, indigenous calcium rich foods would be beneficial in combating bone related disorders. Further studies on the effect of supplementation of this product in improving the serum calcium levels and the bone markers needs to be carried out.

7. References

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