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Development of Calcium Rich Instant Herbal Porridge mix by Incorporating Drumstick Leaves (*Moringa oleifera* L.)

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ABSTRACT: Herbal porridge is a unique breakfast food popular among Sri Lankans and it is used as a reputed remedy for treating different diseases. Calcium deficiency is a widely found nutrient deficiency problem in Sri Lanka and post reproductive aged women and vegans are highly vulnerable to having Ca deficiency. Thus, the main objective of the present study is to develop calcium rich instant herbal porridge mix by incorporating drumstick leaves which is a rich source of calcium. Drumstick leaf herbal porridge mix was developed with drumstick leaf powder, soya flour, maize, rice, and spices was subjected for sensory evaluation with use of 25 semi-trained sensory panelists, and the best drumstick leaf powder concentration was selected. Nutritional properties and the shelf-life of the selected product were also determined. The product containing 8%(w/w) of drumstick leaf powder was selected as the best product considering its significantly higher (P<0.05) sensory properties, and it was found to be contain 71.28% carbohydrate, 12.76% crude protein, 2.83% crude fat, 0.74% crude fiber, 2.07% minerals, and 10.32% moisture. Also, the calcium content of the developed sample was 164.75 mg/ 100 g of porridge sample, and it can be recommended as a high calcium breakfast supplement for the target group. The product can be stored either in laminated polythene or PP 300 gauge packing materials for two months without addition of any artificial preservative.

Key words: Calcium deficiency, drumstick leaf powder, herbal porridge mix

I. INTRODUCTION

Calcium is one of the most important minerals for human health. It plays a key role in human nutrition while helps in formation and maintenance of healthy teeth and bones. It also helps in blood clotting, transmission of nerve impulses, and regulation of heart's rhythm. The recommended dietary allowance (RDA) for calcium ranges from 1200 – 1500 mg/day in different nations [1]. However, as it has been reported by Ediriweera *et al*, [2], the dietary intake of Ca by an average Sri Lankan is 528.3 mg/day. Furthermore, they have found that only 18.8% of Si Lankan population has achieved the RDA of Ca while 4.8% of the rest is been using Ca supplements to reach the recommended levels. These values emphasize that many Sri Lankans are suffering from Ca deficiencies that results poor Ca absorption excessive loss of Ca from teeth and bones, and eventually causing osteoporosis. Drumstick or *murunga* (*Moringa oleifera* L.) is a popular underutilized vegetable crop in dry zone of Sri Lanka. The leaves, fruits, flowers, and immature pods of this tree are edible, and they are a part of traditional diets in many tropical and subtropical countries including Sri Lanka. When compared with other plant sources, drumstick leaves are having the highest amount of Ca [3], which is even 17 times more than the amount found in milk [4]. Other than that, both dry and fresh leaves of drumstick are a rich source of protein, iron, β-carotene, and vitamin B and C [5]. *Kola-kenda*, or porridge made by herbal extracts, is a unique, popular breakfast food among many Sri Lankans. It is typically prepared by using rice, herbal extracts, and coconut milk, and thus, a semi-solid nutritious food with high palatability. But, due to the busy life-style of people, and inconvenience associated with preparation, consumption of herbal porridge is been moved away. Hence, production of nutritionally balanced, instant herbal porridge mix would be highly demanded and beneficial. Due to its high availability, very low cost, and been a good source of Ca and other macro and, micronutrients, drumstick leaves could be successfully used as a herbal extract in preparation of instant herbal porridge mix.

Considering these interesting characteristics and absence of any value added product made from drumstick in the local market, the objective of the present study was to develop an instant herbal porridge mix rich in calcium by incorporating drumstick leaves.

II. MATERIALS AND METHODS

A. Materials

Drumstick leaves used throughout the study was harvested from Peradeniya, Sri Lanka, and transported to the laboratory. Rice, maize, soya bean, and spices used in preparation of herbal mix were purchased from the local market. All the other chemicals used throughout the study were analytical grade.

B. Preparation of the herbal porridge mix

Freshly harvested drumstick leaves were cleaned and dried in a cabinet tray drier (Phoenix, TM10, Japan) at 55°C until the final moisture content was less than 10% (w/w). The dried leaves were grinded using the micro pulverizer, and were sieved (sieve no. 100) to get a fine powder. Cleaned and soaked soybean, maize and precooked rice were also dried until the final moisture content was less than 10% (w/w), and powdered as described before. Moreover, cinnamon, garlic and ginger were also dehydrated and grounded to a fine powder. All the prepared powders were labeled and packed separately in polypropylene (300 gauges) bag until use.

The best combination of rice, soybean, maize, and spices for the preparation of porridge mix was determined through preliminary trial and error method. Further, consumable range of drumstick leaf powder was determined using triangle method. Three percentages of drumstick leaf powder such as 6%, 8% and 10% (w/w) was selected to develop the porridge mix and they were used to select best combination of porridge mix by in cooperating rice, soybean, maize, and spices through sensory analysis.

C. Sensory evaluation of herbal porridge mix

The sensory evaluation of the herbal mixes were carried out after reconstitution of the herbal porridge, and were presented to the panelists at room temperature under normal lighting conditions in transparent glasses coded with random three-digit numbers. Colour, taste, odour, texture, and overall acceptability of the samples were evaluated using five-point hedonic scale with 25 semi-trained panelists. All the evaluation sessions were carried out at the Department of Food Science and Technology, University of Ruhuna, Mapalana, Sri Lanka. The sensory evaluations were done to determine the best composition of the herbal porridge mix, and to compare the consumer preference for the developed herbal mix against commercially available *Gotukola* (*Centella asiatica)* porridge mix.

D. Nutritional analysis of the developed product

The moisture, ash, crude fat, crude fiber, and crude protein contents of the developed herbal porridge mix and commercially available *Gotukola* porridge mix were examined as described in AOAC, 2000 [6]. The calcium content of the developed product was determined with using the flame system of the atomic absorption spectrophotometer (Varian Spectra 240FS) as described in AOAC, 1990 [7]. All the measurements were taken in triplicates.

E. Shelf-life analysis of the developed product

Prepared instant herbal porridge mix was packed air tightly in laminated polythene, and polypropylene bags of gauge 150 and 300 separately, and were stored for a period of two months in a cool dry place at ambient temperature. The total plate count, yeast and mold count, *E. coli* count, moisture content, and pH of the stored products were examined in every two weeks interval up to two months of period.

F. Statistical analysis

Sensory tests were conducted using completely randomized design (CRD) and samples were completely randomized across all panelists in order to avoid or minimize the effect of erroneous results occurring due to the order of samples. Results of sensory evaluations were analyzed by Kruskal wallis non parametric one-way ANOVA test using STATISTIX for Windows (version 10). The data on proximate analysis was analyzed by *t*-test using Mini Tab software for Windows (Version 14).

III. RESULTS AND DISCUSSION

A. Sensory evaluation of developed product

The results of the sensory study was showed that the herbal porridge with 8% (w/w) drumstick leaf powder recorded the highest mean rank values for its sensory attributes (Table 1). Further, results showed that the treatment 1 (6% (w/w) drumstick leaf powder) and 3 (10% (w/w) drumstick leaf powder) were significantly different ($p<0.05$) from treatment 2 in terms of taste, texture, odor and overall acceptability. It is obvious that the increase and decrease of the drumstick leaf powder concentration from 8% (w/w) has a significant effect on the organoleptic quality of the porridge. Therefore, treatment 2 which was composed by 8% (w/w) drumstick leaf powder, 60% (w/w) rice, 20% (w/w) soya flour, 10% (w/w) maize, 1% (w/w) garlic, 0.5 % (w/w) ginger, and 0.5% (w/w) cinnamon was selected to develop the herbal porridge mix.

Table 1: Mean rank values of sensory attributes of different level of drumstick leaf powder.

Treatment	Color	Taste	Texture	Odour	Overall acceptability
T1	31.7^{b} ±1.01	23.0^{b} ±0.89	25.8^{b} ±0.87	30.3^{ab} ±1.14	26.8^{b} ±0.74
T2	47.1^{a} ±1.05	49.8^{a} ±0.81	47.4^{a} ±0.9	43.3^{a} ±1.07	51.0^{a} ±0.73
T3	21.6^{a} ±0.75	27.7^{a} ±0.73	27.3^{a} ±0.72	27.0^{a} ±0.99	22.8^{a} ±0.75

T1- 6% drumstick leaf powder, T2- 8% drumstick leaf powder, T3- 10% drumstick leaf powder. Means with different superscripts are significantly different at 0.05 significance level.

Table 2: Mean rank values of sensory attributes of the developed drumstick leaf *kola-kenda* mix against commercially available *gotukola-kenda* mix.

Treatment	Color	Taste	Texture	Odour	Overall acceptability
Drumstick leaf *kola-kenda* mix	33.2^{a} ±0.65	24.3^{a} ±1.12	26.0^{a} ±0.61	28.2^{a} ±0.95	27.4^{a} ±0.82
Commercially available *kola kenda* mix	17.8^{b} ±1.06	26.7^{a} ±1.11	25.0^{a}± 1.12	22.8^{a}±1.18	23.6^{a} ±0.99

Values with the same superscript do not show a significant difference at the probability level of 5%.

Moreover, the mean rank values of commercially available herbal-gotu kola porridge mix and developed product are shown in Table 2. The results revealed that there was no significant difference ($p>0.05$) between two herbal porridge mixes for all the sensory attributes except for the color. Even though, there was no significant difference between two products, the developed product showed highest mean rank values for sensory attributes except taste. The reason for having low acceptability on taste for the developed product may be the excluding of coconut milk powder to the herbal mix in order to increase the keeping quality of mixture by avoiding the rancidity. However, coconut milk powder has been added to the commercially available porridge mix along with artificial preservatives to prevent the rancidity. Therefore, it can be suggested to add the coconut milk at the time of reconstitution of drumstick leaf porridge in order to increase the consumer acceptability on taste of the product. Similar study on herbal porridge mix from *Heen bovitiya* was suggested that instant porridge products reconstituting with coconut milk gave organoleptically more acceptable product than products reconstituted with water [8].

B. Nutritional quality of the developed drumstick leaf herbal porridge

The proximate composition and the Ca content of both developed product and commercially available porridge mix are shown in Table 2 and Figure 1 respectively. Generally, herbal porridge is considered as a food source that loaded with micronutrients and it improves overall health while providing energy to the body.

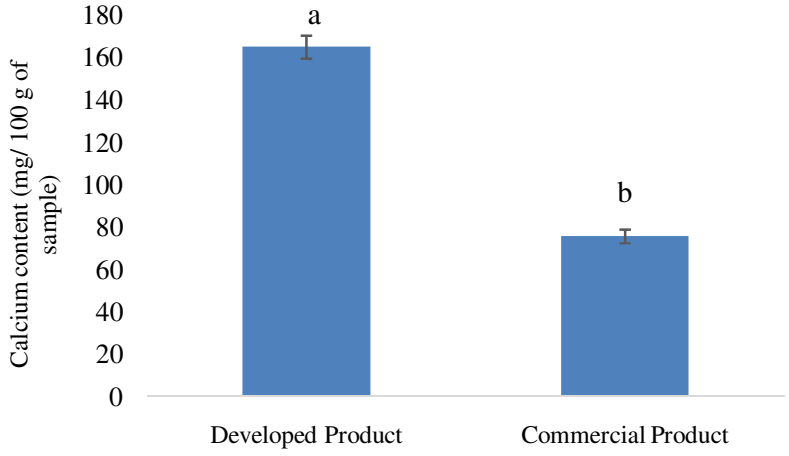

Fig. 1. Calcium content of developed porridge sample and commercially available porridge sample. Assays were performed in triplicate: the bars indicate averages, and the error indicates standard deviation. Means with different superscripts are significantly different at 0.05 significance level.

Both developed product and commercially available product have no significant difference (P>0.05) for proximate composition. However, drumstick leaves porridge can be considered as a good product which can provide an appreciable amount of fat, fiber, carbohydrate, moisture and ash with moderate amount of protein. According to Senadeera *et al* [9], herbal porridge can be considered as low glycemic food for healthy individuals even they contain high amount of carbohydrates. Thus, the developed product also can be safely consumed by healthy individuals as a breakfast supplement.

The results of the Ca content showed that the drumstick leaf herbal porridge has significantly higher (P<0.05) amount of Ca compared to the commercial product. These results are in accordance with the Ca content of dried drumstick leaves and *gotukola* leaves where 2009 mg/ 100 g of dried leaf powder [10], and 1495 mg/ 100 g of dried leaf powder [11] respectively. Moreover, since 100 g of the instant drumstick herbal mix is sufficient for 6 servings, consumption of the developed herbal mix will contribute 2.5% of the daily Ca requirement of Sri Lankans. Thus, consumption of the drumstick leaf porridge mix will be a good remedy for the calcium deficiency problem in Sri Lanka.

C. Shelf-life analysis of the developed product

The Moisture content of the developed product packed in three different packing materials increased during the storage time period (data not shown). However, the porridge packed in laminated polythene showed comparatively slow increment than the other packaging materials (polypropylene gauge 150 and 300). It is evident that the low moisture permeability of laminated polythene attribute to maintain the desired quality of the dried food products [12]. Visibly, the color and odor of the developed porridge mix was highly preserved in the laminated polythene package during the storage period. A similar study carried out on storage of porridge showed that moisture increment in polypropylene is higher than the laminated polythene [13].

Table 3: Proximate composition of developed and commercial porridge samples.

Constituent	Developed sample	Commercial sample	Porridge
Carbohydrate	71.28±0.15[a]	80.32±0.53[a]	
Crude Protein	12.76 ±0.67[a]	10.38±0.35[a]	
Crude Fat	2.83±0.71[a]	2.00±0.95[a]	
Crude Fiber	0.74±0.00[a]	0.78±0.01[a]	
Minerals	2.07±0.01[a]	1.74±0.11[a]	
Moisture	10.32±0.04[a]	4.78±0.71[b]	

Means with different superscripts are significantly different at 0.05 significance level. All values are the means ± SD of triplicates.

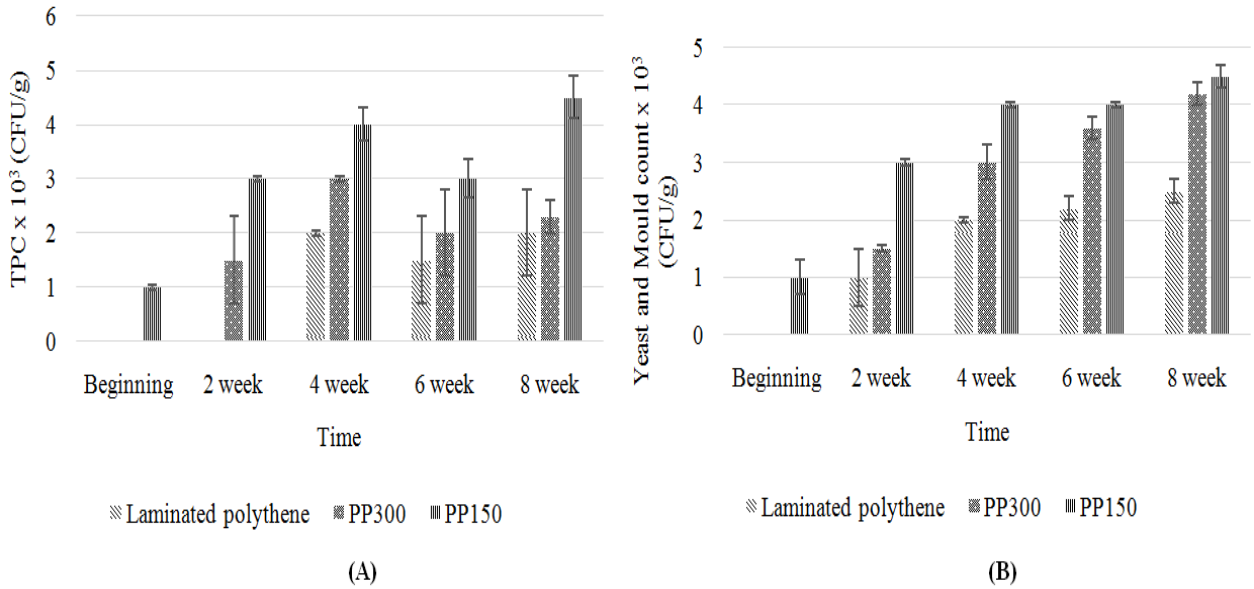

Fig. 2. Effect of packaging materials on total plate count (A) and yeast and mold count (B) of herbal porridge samples during the storage period. Assays were performed in triplicate: the bars indicate averages, and the error indicates standard deviation.

Total plate count and the yeast and mold count of the developed porridge mix packed in all three types of packing materials increased with storage period (Fig. 2). Furthermore, the highest increase in the microbial counts was observed in the porridge mix packed in polypropylene gauge 150 which is due to the rapid increase in the moisture content during the storage. In contrast, the least microbial counts were observed in the Porridge mix packed in laminated polythene packs. Moreover, both yeast and mold count and total plate count did not exceed the 2×10^5 CFU/g and 1×10^5 CFU/g which is the SLSI recommended values for dried products respectively until the two months of storage period [14].

IV. CONCLUSION

Drumstick leaf powder can be effectively used for the development of herbal porridge mix rich in Ca. The highest sensory properties were observed in the product which consisted of 8% (w/w) drumstick leaf powder, 60% (w/w) rice, 20% (w/w) soya flour, 10% (w/w) maize, 1% (w/w) garlic, 0.5 % (w/w) ginger, and 0.5% (w/w) cinnamon. Developed drumstick leaf herbal porridge can be stored for two months of period under ambient temperature (28 °C) without changing its quality parameters.

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