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# Standardization and value addition of RTE (Ready to Eat) snack and soup powder from underutilized perennial leafy vegetables

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**Abstract**
The present study aimed to develop and evaluate value-added food products prepared using selected traditional and nutritious ingredients. The products included preparations made with Moringa, Ivy gourd, Mudakathan, Lachakottai, and Chekurmains. The study focused on assessing their nutritional potential and consumer acceptability. Standardized recipes were prepared under hygienic conditions. Sensory evaluation was carried out using a panel of judges. The products were assessed for appearance, colour, texture, flavour, taste, and overall acceptability. The collected data were analysed using appropriate statistical methods.

The findings indicated significant variation in sensory scores among the developed products. The perennial leafy vegetable Chekurmains received the highest overall acceptability score. All products were found to be acceptable for regular consumption. The developed recipes were rich in nutrients and suitable for promoting healthy eating habits. The use of locally available ingredients enhanced the nutritional quality of the products. These foods can serve as affordable alternatives for improving dietary diversity. The study highlights the importance of traditional vegetables in value-added food preparation. Consumer acceptance suggests good potential for commercialization. The products may contribute to better nutritional security. They can also support the utilization of underused indigenous ingredients. Further studies may evaluate shelf life and nutrient retention during storage. Large-scale consumer trials are recommended to validate the findings. Promotion of these products may improve public awareness of nutritious traditional foods. The study concludes that the developed food products are both nutritious and highly acceptable. These findings support the inclusion of traditional ingredients in daily diets and future food product development.

**Keywords:** Perennial leafy vegetables, Value Addition, Ready to Eat, Soup Powder, Idly Podi, extruded product, sensory evaluation

## Introduction

Green leafy vegetables occupy an important place among the food crops as they are rich source of carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron and phosphorous (Sushmita and pallavi., 2024) [19]. Even though the nutritional properties of popular vegetables are known, there are still ample numbers of vegetables that are obscure to humanity (Ahmed *et al.* 2025) [1]. These perennial greens contain a handful of vital nutrients, trace minerals, antioxidants and medicinally important bioactive compounds.

In nature, there are many underutilized greens of promising nutritive value, which can nourish the ever-increasing human population (Kanneboina *et al*. 2022) [2]. Many of them are resilient, adaptive and tolerant to adverse climatic conditions. Although, they can be raised comparatively at lower management costs even on poor marginal lands, they have remained underutilized due to lack of awareness and popularization of technologies for utilization (Praneetha *et al.* 2025) [14]. *Moringa oleifera* (Moringa) is a nutrient-rich tropical tree valued for its protein, vitamins, and minerals, especially beneficial for mothers and children. Traditionally used in Ayurvedic and Unani medicine, it contains a range of bioactive compounds. Its health benefits include anti-diabetic, antioxidant, anti-inflammatory, and cardio protective properties (Kumar *et al*. 2019) [10]. *Sauropus androgynus* (Chekurmanis), commonly known as Thavasikkeerai in Tamil, is a perennial shrub belonging to the Phyllanthaceae family, often referred to as "multivitamin green" due to its exceptional nutritional value. Its bioactive components offer protective effects against cancer, cardiovascular and renal disorders, neurological issues like Alzheimer's, and other ailments (Anju *et al.,* 2022) [2]. *Coccinia indica* (Ivy gourd), commonly known as Kovakkerai is a climbing perennial herb from the Cucurbitaceae family, native to India, Asia, and Africa. It is widely recognized for its antidiabetic and hypoglycemic properties and is used in traditional medicine for various ailments (Sivasudha and Ilavarasi, 2013) [17]. *Cardiospermum halicacabum* **(**Mudakathan). It is widely known in English as balloon vine or love-in-a-puff and belongs to the Sapindaceae (Soapberry) family, commonly used in traditional medicine for its anti-inflammatory and joint-pain-relieving properties (Praneetha *et al*. 2025) [14]. *Pisonia alba* (Lettuce tree) is commonly known as Latcha Kottai is a perennial tree from the Nyctaginaceae family. It is an edible, medicinal, and ornamental shrub/tree often grown in Tamil Nadu and other parts of South India for its nutrient-dense (Yasaswini *et al*. 2024) [19]. Although perennial greens have been used in the preparation of various medicines, their use as a vegetable has not been explored. Extracts produced from its leaves, stems and roots are widely available as herbal supplements. They can be available in the form of capsules, powders, or syrup form. Since the raw form of the greens cannot be stored for a long time and also not available in all vegetable markets

throughout the year, it is dehydrated and made into powder, and could be made widely available in the market for consumers (Aurobindo *et al.* 2025) [1]. Taking these aspects into consideration, the present study aims to standardize the value-added products from perennial leafy vegetables and shelf life and nutrient retention in storage.

**Materials and Methods**

The experiment was done at Adhiyamaan College of Agriculture and Research, Athimugam, Krishnagiri district, Tamil Nadu, in the year 2026, March-July. The trial was conducted under the guidance of the Department of Horticulture with the implementation of all the scientific methods of estimation.

The leaf samples were collected from the ACAR campus and from the own fields of the staffs and students.

**Sample collection**

Leaves of five selected vegetables were collected from the fields of Adhiyamaan College of Agriculture and Research (Moringa, Chekurmanis and Modakathan) and from staff and students' field (Latchakottai and ivy gourd)

**Sample preparation**

Leaves were thoroughly washed in water two to three times to remove the adhering dust and impurities and were dying in three methods. Leaves were dried in sun, shade and oven till they turned crisp and brittle. Leaves were then turned to homogeneous powders in a mixer and were passed through a fine sieve.

**Nutritional composition of dehydrated Perennial Leafy Vegetables**

The nutritional assessment of different dehydrated samples of Perennial leaf powder for the following parameter *viz*., Protein (g/100g) was determined by Lowrys method, Vitamin C (mg/100g) estimated by ascorbic acid method and Iron (mg/100g) estimated by Spectrophotometer method. All this analysis is determined using the standard laboratory procedures.

**Development of Value-Added Products**

Perennial leaf powder based value-added products were formulated as per standard procedures. Three value-added products such as idly powder, extruded product and Soup powder were developed from dried Perennial vegetable leaves. The preparation included different levels of incorporation of the food groups and dried PL leaves. The best accepted products were taken for shelf-life study.

**Preparation of murukku from Underutilized Perennial Leafy Vegetables**

*Moringa oleifera, Sauropus anddrogynus, Coccinia indica, Cardiosperum halicacabum* and *Pisonia alba* are incorporated with ragi flour and rice flour to prepare murukku. Ragi, rice flour, besan, butter, chilli powder, salt, cumin, leaf powder was mixed and preparation of dough and keep it aside for 10 min for conditioning. Dough was extruded with murukku presser to desired shapes. Fried in preheated oil and cooled. The developed products were packed in air tight container and evaluated for storage stability (Kumar *et al*. 2019) [10].

**Preparation of perennial greens soup powder**

Tomato, garlic and small onion, weighing 500grams, were selected and thoroughly washed. The vegetables are then chopped into small pieces and blanched for 5 minutes. Following blanching, they were dried in hot air oven at 51 0C for 24 hours. Once fully dehydrated, the vegetables were ground into fine powder and stored separately. For the formulation of soup powder, the required quantities of ingredients were weighed as follows:100 grams of leafy vegetables powder,2 grams of cumin,10 grams of tomato,15 grams of onion powder,4 grams of black pepper,2 grams of salt and 5 grams each of selected perennial leafy vegetable powder. The cumin and black pepper were coarsely ground before mixing. All the ingredients were thoroughly blended and packed into air containers for storage (Nadhi *et al*. 2020; Kamaladeep *et al*. 2023) [6, 11].

**Preparation of Idly Podi from Underutilized Perennial Leafy Vegetables**

Dry roast the urad dal in a heavy pan on low to medium heat until it turns golden brown and releases a nutty aroma. Remove and set aside to cool. Repeat the same process for the Chana Dal, Sesame seeds, groundnuts, red chillies, mung bean, red gram, Bengal gram, Puffed Bengal gram, pepper, garlic, asafoetida, curry leaves, salt and perennial leafy vegetables powder. urad dal (Split Black Gram): 40g, Chana Dal (Split Bengal Gram): 30g, groundnut:10g, Red graml:25g, Puffed Bengal gram:5g, Sesame Seeds (White or Black): 2g, Dry Red Chilies: 15g, Curry Leaves: 5g, Garlic cloves (peeled &roasted):10g, Salt: 2g and Perennial leafy vegetables (*Moringa oleifera, Sauropus androgynus, Coccinina indica, Cardiospermum halicacabum, Pisonia alba*):10 grams (Pallavi *et al*. 2010) [13].

Allow all the roasted ingredients to cool down completely. Add the ingredients to a mixer jar along with asafoetida and salt. Grind the mixture on the pulse mode until it reaches a slightly coarse texture. Do not grind continuously, as the oils from the nuts and seeds will make the powder clumpy. After grind add perennial leafy vegetables powder and mixing. Store the powder in an airtight glass or ceramic container at room temperature (Shigihalli, S., 2019) [16].

**Sensory Evaluation**

The standardized products were evaluated using the nine-point Hedonic Rating Scale. The sensory attributes evaluated included Appearance, Colour, Flavour, Texture, Taste and Overall acceptability

**Organoleptic evaluation of developed products during shelf-life study**

All the samples of Idly powder, Soup powder and Extruded product along with its control were analysed for changes in organoleptic characteristics during storage by a panel of 10 semi trained members. A 9-point hedonic scale was used for organoleptic evaluation. The products were evaluated for their appearance, texture, colour, flavour, taste and overall acceptability. The organoleptic evaluation was carried out on initial, $15^{th}$ $30^{th}$ and $60^{th}$ day for all the products.

**Cost calculation of the developed products**

Cost was calculated for the best accepted products i.e. Idly powder, soup powder and Extruded product considering cost of the ingredients purchased from market and 30 per cent overhead charges which includes labour charge,

electricity, machinery, packaging cost, etc. then the total price was calculated per 100 g of the products.

**Result and Discussion**

The drying method had a significant influence on the recovery of dried leaves from the five perennial vegetable species. Variations in the final dried weight among shade drying (D1), tray drying (D2), and sun drying (D3) were observed due to differences in moisture removal rate, drying temperature, and the structural characteristics of the leaves. Vitamin C is a heat sensitive and easily oxidizable nutrient; therefore, the drying technique plays a crucial role in its retention. Differences in temperature, exposure to light, oxygen, and drying duration influence the extent of vitamin C degradation during the drying process. Shade drying and tray drying appear to be the better methods for retaining iron in most of the leaves, while sun drying tends to reduce the iron content more often. Shade drying generally favored protein preservation because of its gentle drying conditions, while tray drying and sun drying showed leaf-specific effects depending on the thermal sensitivity and structural characteristics of each leaf.

**Effect of drying methods on Perennial leafy vegetables**

Dry yield of Perennial leafy vegetables In Moringa (C1) the highest dried weight obtained through tray drying indicates better retention of dry matter (Table 1), likely because controlled drying conditions minimized excessive moisture loss while preserving leaf solids. The Chekurmanis leaves (C2) responded well to sun drying, possibly due to their thicker leaf structure and higher initial moisture content, which allowed efficient dehydration without excessive loss of dry matter (Ponmari *et al*., 2011) [12]. In Ivy gourd (C3) the tray drying produced the highest dried weight, indicating improved retention of leaf solids under controlled drying conditions. The lower recovery in shade and sun drying may be due to slower drying or greater degradation of leaf tissues during the drying process (Samja and Aparna, 2013) [15]. For Latchakottai (C4) tray drying was more effective in preserving the dry matter of Latchakottai leaves than the other drying methods. For Mudakathan (C5), the higher dried weight obtained under sun drying suggests that this method was more suitable for Mudakathan leaves, resulting in greater dry matter recovery.

**Table 1:** Effect of drying methods on Dry yield (g) of Perennial leafy vegetables

| CROPS [5] | Drying Methods | | | Mean |
|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_3$ | |
| $C_1$ | 15.00 | 30.00 | 15.00 | 20.00 |
| $C_2$ | 35.00 | 35.00 | 40.00 | 36.67 |
| $C_3$ | 15.00 | 25.00 | 15.00 | 18.33 |
| $C_4$ | 15.00 | 25.00 | 16.00 | 18.67 |
| $C_5$ | 25.00 | 30.00 | 35.00 | 29.67 |
| Mean | 21.00 | 29.00 | 24.20 | 24.73 |
| S.E (d) Factor A: 3.89 Factor B: 7.78 Interaction: 0.30 | | | | |
| C.D. Factor A: 13.06 Factor B: 26.12 Interaction: 3.41 | | | | |
| Factor A: Crops Factor B: Drying methods | | | | |
| $C_1$ = Moringa $D_1$ = Shade drying | | | | |
| $C_2$ = Chekurmanis $D_2$ = Tray drying | | | | |
| $C_3$ = Muddakathan $D_3$ = Sun drying | | | | |
| $C_4$ = Ivy gourd | | | | |
| $C_5$ = Latchakottai | | | | |
| Interaction: Factor A (Crops) × Factor B (Drying methods) | | | | |

**Vitamin C content of perennial leafy vegetables**

The vitamin C content of the dried perennial vegetable leaves varied considerably among the three drying methods, namely shade drying (D1), tray drying (D2), and sun drying (D3). Among the five perennial vegetables, Moringa (C1) exhibited the highest vitamin C content under shade drying (3.92 mg/100 g), followed by tray drying (1.47 mg/100 g) and sun drying (0.87 mg/100 g). The higher retention under shade drying can be attributed to the lower drying temperature and reduced exposure to direct sunlight, which minimizes oxidation and thermal degradation of ascorbic acid. Similarly, Chekurmanis (C2) recorded 3.01 mg/100 g of vitamin C under shade drying, while tray drying and sun drying retained 1.75 mg/100 g and 1.50 mg/100 g, respectively. The gradual decline in vitamin C content with increasing drying intensity indicates that higher temperatures and prolonged exposure to sunlight accelerate the degradation of ascorbic acid.

**Table 2:** Effect of drying methods on Vitamin C content of dried perennial leafy vegetables (mg/100g)

| CROPS [5] | Drying Methods | | | Mean |
|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_3$ | |
| $C_1$ | 3.92 | 1.47 | 0.87 | 2.09 |
| $C_2$ | 3.01 | 1.75 | 1.50 | 2.09 |
| $C_3$ | 2.1 | 0.91 | 0.73 | 1.25 |
| $C_4$ | 1.08 | 1.40 | 0.87 | 1.12 |
| $C_5$ | 0.52 | 0.35 | 1.67 | 0.85 |
| Mean | 2.13 | 1.18 | 1.13 | 1.48 |
| S.E (d) Factor A: 0.68 Factor B: 1.36 Interaction: 0.92 | | | | |
| C.D. Factor A: 1.58 Factor B: 3.16 Interaction: 4.99 | | | | |
| Factor A: Crops Factor B: Drying methods | | | | |
| $C_1$ = Moringa $D_1$ = Shade drying | | | | |
| $C_2$ = Chekurmanis $D_2$ = Tray drying | | | | |
| $C_3$ = Muddakathan $D_3$ = Sun drying | | | | |
| $C_4$ = Ivy gourd | | | | |
| $C_5$ = Latchakottai | | | | |
| Interaction: Factor A (Crops) × Factor B (Drying methods) | | | | |

**Iron content of perennial leafy vegetables**

Different drying method affects the iron content of the leaves, with shade drying and tray drying generally giving higher values than sun drying. Overall, the iron content ranges from 3.82 to 9.85 mg/100 g, showing noticeable variation depending on both the crop and the drying method (Table 3). Moringa has the highest iron content under shade drying at 9.85 mg/100 g, followed closely by tray drying at 9.79 mg/100 g, while sun drying reduces it to 6.30 mg/100 g. Ivy gourd and Latchakottai also show much lower iron values under sun drying compared with shade or tray drying, which suggests that controlled drying methods help preserve iron better. Chekurmains is the main exception in the table, because sun drying gives a higher iron value (8.34 mg/100 g) than both shade drying (6.64 mg/100 g) and tray drying (5.61 mg/100 g). Muddakathan also shows only a small difference between shade drying and sun drying, while tray drying is slightly lower. This indicates that the effect of drying is not exactly the same for every leaf type.

**Table 3:** Effect of drying methods on Iron content of dried perennial leafy vegetables (mg/100g)

| CROPS [5] | Drying Methods | | | Mean |
|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_3$ | |
| $C_1$ | 9.85 | 9.79 | 6.30 | 8.65 |
| $C_2$ | 6.64 | 5.61 | 8.34 | 6.86 |
| $C_3$ | 8.34 | 6.55 | 4.28 | 6.39 |
| $C_4$ | 7.00 | 7.74 | 3.82 | 6.19 |
| $C_5$ | 8.34 | 6.05 | 6.07 | 6.82 |
| Mean | 8.03 | 7.17 | 5.76 | 6.99 |

S.E (d) Factor A: 1.27 Factor B: 2.54 Interaction: 0.32
C.D. Factor A: 2.92 Factor B: 5.84 Interaction: 1.75
Factor A: Crops Factor B: Drying methods
$C_1$ = Moringa $D_1$ = Shade drying
$C_2$ = Chekurmanis $D_2$ = Tray drying
$C_3$ = Muddakathan $D_3$ = Sun drying
$C_4$ = Ivy gourd
$C_5$ = Latchakottai
Interaction: Factor A (Crops) × Factor B (Drying methods)

**Table 4:** Effect of drying methods on protein content of dried perennial leafy vegetables (mg/100g)

| CROPS [5] | Drying Methods | | | Mean |
|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_3$ | |
| $C_1$ | 238 | 222 | 234 | 231.33 |
| $C_2$ | 182 | 190 | 188 | 186.67 |
| $C_3$ | 182 | 178 | 178 | 179.33 |
| $C_4$ | 170 | 169 | 166 | 168.33 |
| $C_5$ | 183 | 158 | 210 | 183.67 |
| Mean | 191.0 | 183.40 | 195.20 | 189.87 |

S.E (d) Factor A: 9.94 Factor B: 19.88 Interaction: 1.97
C.D. Factor A: 22.94 Factor B: 45.88 Interaction: 10.52
Factor A: Crops Factor B: Drying methods
$C_1$ = Moringa $D_1$ = Shade drying
$C_2$ = Chekurmanis $D_2$ = Tray drying
$C_3$ = Muddakathan $D_3$ = Sun drying
$C_4$ = Ivy gourd
$C_5$ = Latchakottai
Interaction: Factor A (Crops) × Factor B (Drying methods)

**Protein content of perennial leafy vegetables**

In Moringa, Shade drying was the most effective method for preserving the protein content of moringa leaves. The low-temperature drying process minimized protein denaturation, while tray drying caused a slight reduction due to heat exposure. Sun drying also maintained good protein retention but was slightly less effective than shade drying because of direct exposure to sunlight (Ami *et al.*, 2025) [3]. Tray drying showed better protein retention in Chekurmanis leaves, indicating that controlled hot-air drying effectively removed moisture while maintaining protein quality. Shade drying and sun drying also preserved protein reasonably well, with only slight variations among the methods. Shade drying was found to be more suitable for preserving the protein content of ivy gourd leaves. Tray drying and sun drying resulted in similar protein retention, suggesting that moderate heat and sunlight had only a minimal effect on the protein stability of these leaves (Sudipta *et al.*, 2020) [18]. The protein content of Latchakottai leaves was only slightly affected by the drying methods. Shade drying provided marginally better protein preservation, while tray drying and sun drying showed very little difference, indicating that the proteins in these leaves were relatively stable under different drying conditions. Sun drying was more effective in retaining the protein content of Muddakathan leaves compared to the other drying methods. Shade drying showed moderate protein retention, whereas tray drying resulted in comparatively lower protein preservation, possibly due to the effect of heat on protein stability.

**Organoleptic evaluation of value-added product**

**Idly powder**

The sensory evaluation results indicate that all five underutilized perennial leaves were well accepted, with overall acceptability scores ranging from 8 to 9. Chekurmanis and Moringa received the highest overall acceptability score, [9] reflecting excellent performance in appearance, flavour, and taste (Fig.1). Latchakkottai and Ivy gourd obtained an overall score of 8, with Ivy gourd recording a comparatively lower texture score. [7] Modakathan also achieved an overall acceptability score of 8, although its taste score [7] was slightly lower than the other samples. Colour scores were consistently high [8, 9] across all leaves, indicating good visual appeal. Overall, the results suggest that Chekurmanis and Moringa were the most preferred leaves based on sensory characteristics, while the remaining leaves were also considered acceptable for the development of value-added food products.

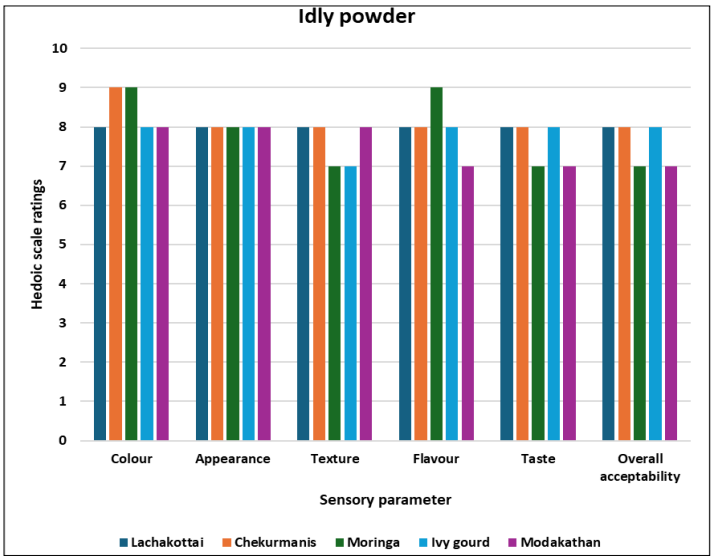


**Fig 1:** Organoleptic evaluation of Idly powder

**Extruded product**

The organoleptic evaluation of value-added extruded product (Murukku) prepared with different perennial leaves showed good consumer acceptability. Chekurmanis and Moringa incorporated murukku received the highest scores for colour, indicating their attractive appearance after processing (Fig.2). All formulations obtained similar scores for appearance, suggesting that the incorporation of leaf powders did not adversely affect the visual quality of the product. For texture, Latchakottai, Chekurmanis, and Modakathan murukku were rated slightly higher than Moringa and Ivy gourd. Moringa murukku received the highest score for flavour, whereas Latchakottai, Chekurmanis, and Ivy gourd showed good flavour acceptability. Taste and overall acceptability were highest for Latchakottai, Chekurmanis, and Ivy gourd murukku, indicating better consumer preference, while Moringa and Modakathan received slightly lower scores. Overall, all murukku formulations were found to be organoleptically acceptable, demonstrating the potential of perennial leaf powders in developing nutritious value-added snack products.

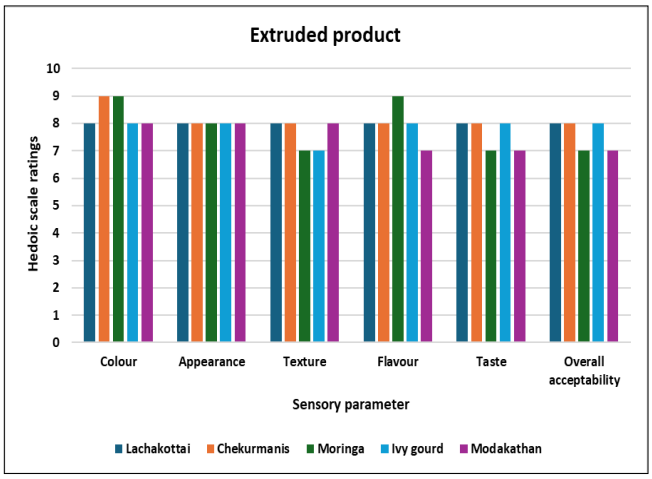


**Fig 2:** Organoleptic evaluation of Extruded product

**Soup powder**

The organoleptic evaluation of the value-added soup powder prepared using different perennial leaves indicated good sensory acceptability among all formulations. Latchakottai, Chekurmanis, Moringa, and Ivy gourd soup powders received high scores for colour, reflecting their appealing appearance, while Modakathan scored slightly lower. For appearance, Chekurmanis and Modakathan soup powders were rated higher, indicating better visual appeal after preparation (Victoria *et al.,* 2023) [20]. Texture was well accepted in Latchakottai, Chekurmanis, Moringa, and Modakathan, whereas Ivy gourd received a slightly lower score (Fig3). Chekurmanis and Moringa soup powders obtained the highest scores for flavour and taste, suggesting greater consumer preference. The overall acceptability was highest for Chekurmanis and Moringa soup powders, followed by Latchakottai, Ivy gourd, and Modakathan. Overall, the results indicate that all soup powder formulations were organoleptically acceptable, with Chekurmanis and Moringa showing the greatest consumer preference due to their desirable sensory characteristics (Yashasvi *et al* 2022) [5].

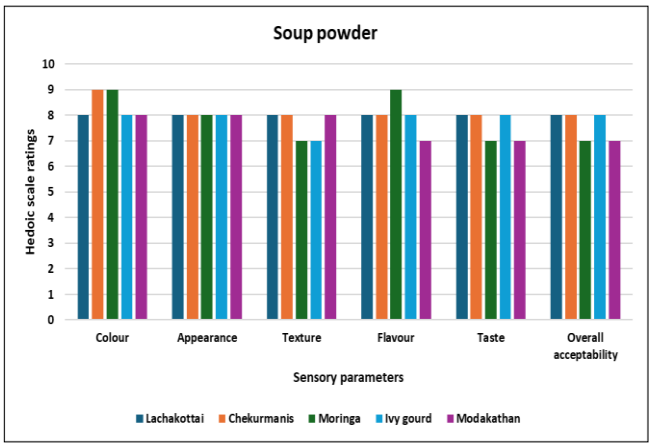


**Fig 3:** Organoleptic evaluation of Soup powder

**Storage parameters of products**

The developed value-added products, namely ragi murukku, Idly powder, and soup powder, fortified with underutilized perennial vegetable leaves (Ivy gourd, Moringa, Latchakkottai, Chekurmanis, and Modakathan), were stored under normal ambient conditions (27 ± 2°C) in laminated airtight pouches and glass containers to evaluate their storage stability. The products were periodically assessed for their physical, microbiological, and sensory quality during storage.

**Soup powder**

The organoleptic evaluation of soup powder stored in airtight laminated pouches and glass containers for 15, 30 and 60 days showed that the sensory qualities were well maintained throughout the storage period. A slight decline in colour, appearance, flavour, taste, and overall acceptability was observed with an increase in storage duration, particularly after 30 days. Among the packaging materials, glass containers retained the sensory attributes better than airtight laminated pouches, with higher scores for colour and flavour during storage. This may be due to the better protection offered by glass against moisture and air penetration (Khairunnaisi and Balkas 2025) [9]. Chekurmanis and Moringa soup powders showed the highest overall acceptability during the storage period (Kannangara *et al.,*2018) [7], while Latchakottai, Ivy gourd, and Modakathan also remained within the acceptable range. Overall, the results indicated that all soup powder formulations were organoleptically acceptable up to 60 days of storage, and storage in glass containers was found to be more effective in preserving the sensory quality of the products.

**Extruded product**

The organoleptic evaluation of the value-added murukku stored in airtight laminated pouches and glass containers for 15, 30 and 60 days revealed that the sensory quality was maintained throughout the storage period (Plate 1a & 1b.) A slight reduction in colour, appearance, texture, taste, and overall acceptability was observed with increasing storage duration, particularly in the products stored in airtight laminated pouches. This decline may be attributed to gradual moisture absorption, which can reduce the crispness and freshness of the product. Murukku stored in glass containers retained its sensory attributes better than those stored in airtight laminated pouches (Handayani *et al.,* 2022) [5]. The better moisture and air barrier properties of glass helped preserve the product's crisp texture, colour, and taste throughout the storage period. Among the formulations, Chekurmanis murukku consistently recorded the highest sensory scores during storage, followed by Latchakottai, Moringa, Ivy gourd, and Modakathan. Although a slight decline in sensory scores was observed after 30 days, all murukku formulations remained within the acceptable range on the 9-point hedonic scale., Overall, the results indicate that all value-added murukku samples remained organoleptically acceptable for up to 30 days, with glass containers being more effective than airtight laminated pouches in preserving the sensory quality during storage.

**Idly powder**

the organoleptic evaluation of value-added Idly powder stored in airtight laminated pouches and glass containers for 15, 30 and 60 days indicated that the sensory attributes remained acceptable throughout the storage period. A gradual decline in colour, appearance, flavour, taste, and overall acceptability was observed with increasing storage duration, particularly in the samples stored in airtight laminated pouches. Among the packaging materials, glass containers were more effective in preserving the sensory

quality of the Idly powder, maintaining higher scores for colour, flavour, taste, and overall acceptability during storage. This may be attributed to the superior barrier properties of glass, which protect the product from moisture absorption and oxidative changes. Among the different formulations, Chekurmanis and Moringa Idly powders consistently received higher sensory scores throughout the storage period, indicating better consumer acceptability. Latchakottai, Ivy gourd, and Modakathan Idly powders also maintained satisfactory sensory quality with only a slight reduction in scores after 60 days of storage. Overall, the results demonstrated that all Idly powder formulations remained organoleptically acceptable for up to 60 days, with glass containers proving to be a better packaging material than airtight laminated pouches for maintaining the sensory characteristics of the product during storage.

The Storage study demonstrated that the developed ragi murukku, Idly powder, and soup powder enriched with underutilized perennial vegetable leaves possessed good storage stability under normal ambient conditions (27 ± 2°C). Only minor changes in moisture content, colour, flavour, texture, and microbial load were observed during storage, and these changes did not adversely affect the overall quality or acceptability of the products. The use of laminated airtight packaging effectively minimized moisture absorption and maintained product quality. The findings indicate that the incorporation of Ivy gourd, Moringa, Lachakkottai, Chekurmanis, and Modakathan leaves into value-added products not only enhanced their nutritional quality but also produced shelf-stable products suitable for storage and commercialization under normal environmental conditions.

## Conclusion

The present study concludes that underutilized perennial leafy vegetables can be successfully incorporated into value-added food products such as murukku, idly powder, and soup powder without compromising their sensory quality. Among the developed products, Moringa soup powder received the highest overall acceptability, while Lachakottai and Chekkurmanis-based idly powder showed superior sensory scores for texture, flavour, taste, and overall acceptance. The storage studies demonstrated that the products remained microbiologically safe and organoleptically acceptable for up to 90 days under ambient conditions when packed in laminated airtight containers. Only minor changes in moisture, colour, and texture were observed during storage, which did not significantly affect product quality. The incorporation of these nutrient-rich leafy vegetables enhanced the nutritional value of the products and promoted the utilization of locally available, underexploited plant resources. Therefore, these value-added products have good potential for commercial production, improved dietary diversity, and nutritional security, while also encouraging the conservation and wider use of traditional leafy vegetables.

## References


1. Ahmed AM, Fatima AK, Tariq J, Ibrahim Z. Ready-to-eat and ready-to-cook foods current developments, nutritional value and consumer acceptance. J Curr Res Food Sci. 2025;6(2):79-86.
2. Thattantavide A, Rai NKS, Kumar A. (L.) Merr.: a multipurpose plant with multiple uses in traditional ethnic culinary and ethnomedicinal preparations. J Ethn Foods. 2022;9(1):1-29.
3. Ami M, Mohini P, Ranna C. Estimation of protein content in some selected plants using the lowry's method. Indian J Appl Pure Biol. 2025;40(1):709-714.
4. Aurobinda B, Sunil kumar D, Nityamanjari M, Disha B. Beyond the Harvest: Value addition and Processing of vegetable crops in India. Food Sci Rep. 2025;6(7):14-17.
5. Handayani Y, Aminah S, Yanis M. Characteristics of Moringa leaf powder as fortification and consumer acceptancy. IOP Conf Ser Earth Environ Sci. 2022;1027(1):58-64.
6. Kamaldeep K, Monika S, Julie DB. Formulation and quality evaluation of tomato-brocoli blended instant vegetable soup mix. Plant Arch. 2023;23(2):6-11.
7. Kannangara PT, Jayavardhana, Sarananda KH. Sensory attributes and self-life evaluation of an instant soup powder fortified with moringa (Moringa oleifera Lam.) leaves. J Food Agric. 2018;11(2):230-253.
8. Kanneboina S, Anila Kumari B, Jyothsna E. Standardization and value addition of millet based ready to eat (RTE) snack with an uncommon green leafy vegetable. Environ Ecol. 2022;40(3B):1422-1427.
9. Khairunnaisi AM, Balkas AT. Sensory evaluation of Agarwood leaf extract powder with different leaf-based powder available in the market. IOP Conf Ser Earth Environ Sci. 2025;1470(1).
10. Kumar D, Yadav RK, Sinha S. Value addition in horticulture crops. Issues and opportunities. Indian Hortic. 2019;64(4):26-29.
11. Nadhi J, Kiran B, Harpreet K. Evaluation of antioxidant activity of developed instant soup mix using vegetable leaf powders from unconventional greens. Int J Curr Microbiol Appl Sci. 2020;9(1):711-721.
12. Ponmari G, Sathish Kumar R, Lakshmi PTV. Effects of drying treatment on the contents of antioxidants in Cardiospermum halicacabum Lin. J Pharm Biosci. 2011;2(4):304-313.
13. Pallavi J, Beena M. Bioavailability of iron from the leaf powder of dehydrated less utilized green leafy vegetables. Asian J Exp Biol Sci. 2010;1(4):845-854.
14. Praneetha S, Kousalya R, Mythilli E. Value-added product development: soup powder from selected perennial greens and its sensory profiling. Madras Agric J. 2025;4(6):112-118.
15. Samja S, Aparna SG. Development and Popularisation of Agathi leave (Sesbania grandiflora) Incorporated food products. IOSR J Environ Sci Toxicol Food Technol. 2013;7(5):1-10.
16. Shigihalli S. Development of value-added product from ivy gourd (*Coccinia indica* L.) Glyceamic Ind in ivy gourd chappati. Bengaluru: University of Agricultural Science, GKVK; 2019.
17. Sivasudha T, Ilavarasi A. Chemical constituents and antimicrobial activity of Indian green leafy vegetable Cardiospermum halicacabum. Indian J Microbiol. 2013;53(2):208-213.
18. Sudipta S, Monoj M, Pranabesh G. Quantification of total protein content from some traditionally used edible plant leaves: a comparative study. J Med Plant Stud. 2020;8(4):166-170.
19. Sushmita Y, Pallavi S. Utilization of underutilized green leafy vegetables in the development of value

added products. Int J Nutr Lifestyle. 2024;4(3):2583-3499.
20. Victoria TM, Davas NC, Alex W. Textural, cooking quality and sensory acceptability of noodles incorporated with moringa leaf and sardine powders. Eur J Nutr Food Saf. 2023;15(10):1-20.
21. Yasaswini P, Vijayalaxmi KG, Sainivasappa KN. Development and nutritional assessment of functional food with agathi (Sesbania grandiflora) flowers. Mysore J Agric Sci. 2024;58(4):389-397.
22. Yashasvi R, Sumithra M, Priyanka J. Formulation and quality evaluation of Moringa leaves powder and development of value-added products. Pharma Innov J. 2022;11(10):1605-1615.