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# Development and evaluation of sensory, nutritional and microbial properties of malted barley soup premix

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**Abstract**
The increasing consumer demand for health oriented and convenient food products has led to the development of functional food formulations that offer both nutritional value and ease of preparation. This study aimed to develop malted barley based soup premix incorporating lentils, drumstick leaves and herbs (lemongrass, mint and basil) to create a nutritious and functional food product with antioxidant and antimicrobial properties. The soup premix formulations were prepared using varying proportions of malted barley flour, lentil flour, drumstick leaves and herbs. Sensory evaluation indicated that the formulation with 40% barley, 45% lentil, 10% drumstick leaves and 5% herbs ($T_2$) was the most preferred with superior scores for color, consistency, taste and overall acceptability. The nutritional composition of the best treatment ($T_2$) revealed high levels of protein (16.92g), carbohydrates (70.76g), iron(9.96mg), calcium (119.16mg) and antioxidants, including beta carotene (3316.11µg) and flavonoids (131.06mg) indicating its potential as a functional food. Shelf life evaluation demonstrated microbial stability and minimal changes in sensory attributes over a 90 day storage period with slight declines observed after 45 days. These findings suggest that the developed malted barley soup premix offers a convenient, health promoting food option with a stable shelf life and significant antioxidant and nutritional benefits, making it a valuable addition to the growing demand for health oriented, ready to cook products.

**Keywords:** Oxidative, Microbial stability, Functional food, Acceptability and Nutritious.

## Introduction

Barley (*Hordeum vulgare*) is one of the most ancient cereal grains, renowned for its nutritional composition including high levels of dietary fiber, vitamins, minerals and bioactive compounds such as beta glucans. Its antioxidant properties further contribute to its potential in combating oxidative stress (Zhang et al., 2020) [21]. The process of malting enhances the digestibility and bioavailability of nutrients, improving the functional and nutritional qualities of barley (Chauhan *et al*. 2021). Lentils (*Lens culinaris*) with their high content of plant based protein and dietary fiber have been shown to aid in managing blood sugar levels and improving gut health (Singh *et al.,* 2020). Lentils are rich in micronutrients such as iron and folate which are vital for cell regeneration and maintaining optimal metabolic health (Abdulla *et al*., 2021). Additionally, lentil offer cardio protective benefits making them a valuable addition to functional food formulations (Rekha *et al.,* 2021) [15]. Drumstick leaves (Moringa oleifera) are highly regarded for their impressive nutrient profile, including vitamin A, C and E as well as iron and calcium (Adebayo *et al.,* 2019). These leaves are also known for their anti-inflammatory, antioxidant and antimicrobial properties which can support immune function and protect against chronic diseases (Saini *et al.,* 2020) [16].

The incorporation of herbs like lemongrass, mint and basil leaves in to the soup premix further enhances its health benefits. Lemongrass (*Cymbopogon citratus*) has been shown to have antioxidant, anti-inflammatory and antimicrobial properties (Gupta *et al.,* 2021) and is known to improve digestion and support detoxification. Mint (*menthe spicata*) is another herb renowned for its digestive health benefits as it can help relieve gastric discomfort and improve bowel movement (Bukhari *et al.,* 2022). Basil leaves (*Ocimum basilicum*) often referred to as ‘’holy basil’’ or tulsi possess anti-inflammatory, antioxidant and antibacterial properties which have been linked to immune boosting and stress reduction (Singh *et al.,* 2020). These herbs not only impart unique flavors but also offer numerous health benefits such as improving immune function and promoting digestive health.

In recent years, the demand for health oriented and convenient food products has grown significantly with ready to cook soup premixes emerging as a popular choice. These premixes not only offer ease of preparation but also allow for the retention of nutrients and sensory qualities of the ingredients used (Patil *et al.,* 2020) [14]. Sun-drying, a traditional food preservation method has been widely recognized for its ability to retain the nutritional and sensory properties of ingredients while extending their shelf life. Studies have demonstrated that sun dried vegetables and grains exhibit excellent nutrient retention and microbial stability making them ideal for use in premixes (Kumar *et al.,* 2019). Soup premixes incorporating sundried ingredients have been explored for their nutritional and sensory qualities. For instance, Singh *et al.* (2018) evaluated

soup premixes containing sundried vegetables and found them to be highly acceptable in terms of sensory attributes and nutritional value. This study aims to develop a malted barley based soup premix that combines the nutritional richness of barley and lentils the medicinal properties of drumstick leaves and the health promoting compounds found in lemongrass, mint and basil. The objective is to create a product that provides a convenient, functional food solution with antioxidant and microbial stability. The study will evaluate the sensory, nutritional and microbial properties of the premix to ensure its commercial viability and consumer acceptance.

## Materials and Methods

### Procurement of Raw materials

The ingredients used for preparing malted barley soup premix included barley grains, drumstick leaves, lentil, herbs (mint, lemongrass and basil) and spices. All raw materials were procured from the local market ensuring freshness and quality.

### Preparation of Malted barley Flour

Barley grains were cleaned, soaked in water for 12 hours and allowed to sprout for 4 days in a clean, ventilated area. The sprouted grains were then sun dried under hygienic conditions until the moisture content reduced to 4-5%. The dried grains were ground into a fine powder and sieved to obtain malted barley flour.

### Preparation of Dehydrated ingredients

**Drumstick leaves:** fresh leaves were washed thoroughly, blanched for 3 minutes and sun dried until the moisture content to 6-8%. The dried leaves were crushed form.
**Lentils:** Lentils were cleaned and ground into flour.
**Herbs and spices:** Fresh herbs were cleaned, sun dried and ground into fine powders. spices were similarly processed.

### Formulation of Malted barley soup premix

The soup premix was formulated using malted barley flour, drumstick crushed leaves, lentil flour, herbs and spices in different proportions to create 3 treatments ($T_1$, $T_2$ and $T_3$). three soup premix formulations were prepared with varying proportions of barley, lentil, drumstick leaves and herbs. $T_1$ consisted of 50% barley, 40% lentil, 5% drumstick leaves and 5% herbs. $T_2$ had 40% barley, 45% lentil, 10% drumstick leaves and 5% herbs. $T_3$ included 30% barley, 50% lentil, 15% drumstick leaves and 5% herbs. All ingredients were mixed into a fine powder to create uniform premixes. Based on sensory evaluation, $T_2$ was identified as the best treatment. For reconstitution, 10g of soup mix was dissolved in 150 ml of water and boiled for 5 minutes while stirring. The prepared soup premix was served hot for sensory evaluation.

### Sensory evaluation

The sensory attributes, including appearance, consistency, flavor, taste and overall acceptability were evaluated by a semi trained panel using a nine-point hedonic scale.

### Physico-chemical and Antioxidant analysis

The Organoleptically best treatment ($T_2$) was analysed for moisture, ash, protein, fat, carbohydrate and fiber content using FSSAI methods. Antioxidant properties such as beta carotene, DPPH activity and flavonoid content were also evaluated.

### Shelf life evaluation

The best treatment was stored in low density polyethylene (LDPE) pouches at ambient temperature. The soup premix was analysed at 15 day intervals over 90 days for moisture content, peroxide value, microbial load (TPC, yeast and mould) and sensory attributes.

### Statistical Analysis

The data were analysed using ANOVA to determine significant differences among treatments with critical differences (CD) calculated at $p<0.05$.

## Results and Discussion

The study evaluated the malted barley soup premix ($T_2$) for its sensory attributes, nutritional composition, antioxidant properties and storage stability. The results of these evaluations are discussed in detail, supported by findings from other relevant studies.

### Sensory evaluation

This fig. 4.1 presented that the sensory evaluation of malted barley instant soup premixe across three treatments ($T_1$, $T_2$, $T_3$) demonstrated that $T_2$ consistently achieved the highest scores across all sensory attributes including color and appearance, consistently, taste and flavor and overall acceptability. For color and appearance, $T_2$ scored 8.05, significantly higher than $T_1$ (6.25) and $T_3$ (6.17) showcasing its ability to maintain visual appeal. Mwangi *et al.* (2023) [12] highlighted that proper drying methods are essential to preserving color stability as inadequate techniques may lead to undesirable changes over time. In terms of consistency $T_2$ also outperformed the other treatments with a score of 8.05 compared to 6.6 ($T_1$) and 6.15 ($T_3$). This indicates that $T_2$ retained its smooth texture effectively an attribute critical for consumer satisfaction. Taste and flavor were highest in $T_2$ with a score of 8.25 compared to $T_1$ (6.0) and $T_3$ (5.92). This demonstrates $T_2$'s ability to preserve the distinct sweet flavor imparted by the malting process. Muthui *et al.* (2024) emphasized that the malting process enhance the flavor profile but improper storage or processing can lead to volatization of key flavor compounds thereby diminishing sensory appeal over time. For overall acceptability, $T_2$ scored 8.25 significantly higher than $T_1$ (6.1) and $T_3$ (5.97). The cumulative effect of superior color, consistency and flavor made $T_2$ the most preferred treatment. This aligns with findings by Mwangi et al. (2023) [12] and Muthui et al. (2024) which underscore the importance of proper drying and storage techniques in maintaining sensory attributes in malted barley based soup premix.

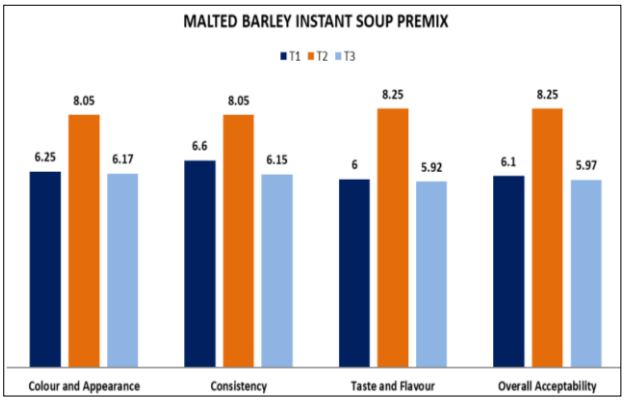


**Fig 1:** Average sensory scores of different sensory attributes of treatments of prepared Malted barley soup mix

### Nutritional composition

**Table 1:** Nutritional content of Organoleptically best treatment of Malted barley soup mix

| Chemical Properties | Amount Observed |
|---|---|
| Moisture (%) | 4.75 |
| Ash (%) | 5.18 |
| Fiber (g) | 0.84 |
| Fat (g) | 2.39 |
| Carbohydrate (g) | 70.76 |
| Protein (g) | 16.92 |
| Energy (kcal/g) | 372.23 |
| Iron (mg) | 9.96mg |
| Calcium | 119.16 mg |
| β carotene | 3316.11µg |
| DPPH | 8.42 |
| Flavonoid | 131.06 |

This table 1 presented the nutritional content and chemical properties of malted barley soup highlight its beneficial attributes, making it a valuable addition to a balanced diet. With a moisture content of 4.75%, this soup exhibits a concentrated nutrient profile. Similar research by Oluwafemi *et al.* (2022) [13] found that the moisture content in sun dried malted barley soup mix ranged from 7% to 10% depending on the drying duration and environmental conditions. The nutritional composition of the malted barley soup premix ($T_2$) indicated it is a highly nutritious product, with significant levels of protein (16.92g), carbohydrates (70.76g) and energy (372.23kcal) per 100g. This nutritional profile is with findings by Singh *et al.* (2017) [20] highlighted the potential of barley based products to provide a rich source of protein and energy making them suitable for addressing malnutrition and improving dietary quality. The high levels of iron (9.96 mg) and calcium (119.16mg) are particularly beneficial for preventing iron deficiency anaemia and promoting bone health as suggested by Gupta *et al.* (2018) emphasized the micronutrient benefits of cereal based foods. the antioxidant evaluation of the malted barley soup premix showed high levels of beta carotene (3,316.11ug) and flavonoids (131.06 mg) confirming its potential to fight oxidative stress. Antioxidants are known to play a significant role in reducing the risk of chronic diseases such as cardiovascular disease and cancer. Sharma *et al.* (2020) reported similar findings for barley based products noting that high antioxidant levels contribute to health benefits by mitigating oxidative damage. The presence of beta carotene and flavonoids in the malted barley soup premix supports it's as a functional food with health promoting properties. According to Farooq *et al.* (2022), the flavonoid content in sun dried malted barley soup mix was reported to range from 15mg to 25mg of quercetin equivalents (QE) per 100g. Sun drying appears to preserve flavonoids effectively, likely due to the mild temperatures that reduce the degradation of these sensitive compounds. Similarly Eze *et al.* (2022) reported results, with DPPH activity ranging from 47% to 52% indicating a moderate antioxidant capacity. Another study by Ogunleye *et al.* (2023) found that DPPH values were around 50%, demonstrating that sun drying does not significantly affect the antioxidant capacity of barley. Overall, the nutritional profile of malted barley soup positions it as a nutrient dense option that not only offers sensory appeal but also supports health and wellness.

### Storage stability

**Table 2:** Storage stability of Organoleptically best treatment of Malted barley soup premix ($T_2$)

| Storage period (Days) | Moisture content (%) | Peroxide value (meq $O_2$/kg) | Total plate count (TPC-log CFU/g) | Yeast/Mold count (CFU/g) |
|---|---|---|---|---|
| 0 | 8.3 | 0.94 | $1.2 \times 10^2$ | NIL |
| 15 | 8.0 | 1.00 | $0.76 \times 10^3$ | NIL |
| 30 | 7.7 | 1.03 | $3.4 \times 10^3$ | NIL |
| 45 | 7.3 | 1.08 | $3.4 \times 10^3$ | NIL |
| 60 | 6.9 | 1.13 | $3.4 \times 10^3$ | NIL |
| 75 | 6.7 | 1.18 | $6.5 \times 10^3$ | NIL |
| 90 | 6.7 | 1.23 | $6.5 \times 10^3$ | NIL |

This table 4.2 presents the microbial analysis conducted to assess the shelf life of malted barley soup over a 90 days period. The total plate count (TPC) begins at $1.2 \times 10^2$ CFU/g on day 0 and gradually increase to $6.5 \times 10^3$ CFU/g by 90 day. Despite this increase in microbial load over time, the TPC values remain well below the BIS (Bureau of Indian Standards) guideline of $10^4$Cfu/g, indicating that the soup remains microbiologically safe throughout the 90 days. Similarly study by Ajayi *et al.* (2022) found that the TPC in dried malted barley soup mixes was found to range from 2.0 to 4.5 log CFU/g. the study indicated that environmental factors, including temperature and air quality during the drying process, significantly impacted the microbial load. Higher TPC values were observed in samples dried in open, uncontrolled environments compared to those dried in covered settings. Another study by Olatunde *et al.* (2023) recorded that TPC values between 2.3 and 4.7 log CFU/g in sun dried malted barley soup mixes. This study noted that the sun drying process introduced variability in microbial counts due to the inconsistent drying time and fluctuating humidity levels. Crucially, the yeast and mold counts were consistently absent (NIL) across all time points, from day 0 to day 90. This is within the BIS standards, which permit up to $5 \times 10^4$CFU/g for yeast and mold. The absence of any yeast or mold growth highlights the soup's strong resistance to fungal contamination, further supporting its shelf stability. Similarly research by Adebayo *et al.* (2022) found that yeast and mold counts in sun dried malted barley soup mixes were range between 0.5 and 2.2 log CFU/g. This study attributed higher fungal contamination to prolonged drying times in humid conditions, which promoted the growth of molds. The storage stability of the malted barley soup premix was evaluated through parameters such as moisture content, peroxide value, and total plate count (TPC) and yeast/mold count. The results showed a gradual decrease in moisture content from 8.3% to 6.7% over the 90 day period which contributes extended shelf life by inhibiting microbial growth. Moisture reduction is crucial in preventing spoilage and maintaining product stability. The peroxide value increased slightly from 0.94 to 1.23 meq $O_2$/kg over the storage period but it remained well below the safe threshold of 5 meq $O_2$/kg, indicating that the product remained stable in terms of oxidative rancidity. Gupta et al. (2018) highlighted that product rich in antioxidants like malted barley are less prone to oxidation which was corroborated by our results. These results are in with the findings of Sharma and Verma (2021) noted that low moisture content and antioxidant properties are effective in preventing microbial growth and ensuring product safety overtime.

**Table 3:** Average scores of various sensory attributes of Malted barley soup mix best treatment at different storage period

| Treatment | Colour & Appearance | Consistency | Taste & flavour | Overall Acceptability | Change |
|---|---|---|---|---|---|
| T2 (0 days) | 8.2 | 8.2 | 8.4 | 8.4 | No Change |
| T2 (15 days) | 8.2 | 8.2 | 8.4 | 8.4 | No Change |
| T2 (30 days) | 8.2 | 8.2 | 8.4 | 8.4 | No Change |
| T2 (45 days) | 8.2 | 8.2 | 8.3 | 8.4 | Slightly Change |
| T2 (60 days) | 8.1 | 8.2 | 8.2 | 8.3 | Slightly Change |
| T2 (75 days) | 8.0 | 8.2 | 8.0 | 8.2 | Slightly Change |
| T2 (90 days) | 7.8 | 8.2 | 7.9 | 8.0 | Slightly Change |

This table 4.3 and fig 4.2 summarizes the sensory evaluation of malted barley soup premix in the best treatment ($T_2$) over a 90 day storage period revealed stable attributes during the first 30 days with scores for color and appearance, consistency, taste and overall acceptability consistently remaining at 8.2 or higher. Notably, no changes were observed during this initial period. However, by day 45, slight declines were recorded particularly in taste which dropped to 8.3, while overall acceptability remained at 8.4. Further declines were evident by day 90, with taste decreasing to 7.9 and overall acceptability to 8.0 indicating gradual sensory deterioration over time. Proper storage conditions play a critical role in maintaining sensory qualities**.** Fernandez *et al.* (2023) emphasized that airtight containers and cool temperatures significantly preserve flavor and overall acceptability in barley based soup premix. Similarly, Gupta *et al.* (2023) observed that soups stored under optimal conditions retained higher sensory scores over extended periods compared to those stored under suboptimal conditions.

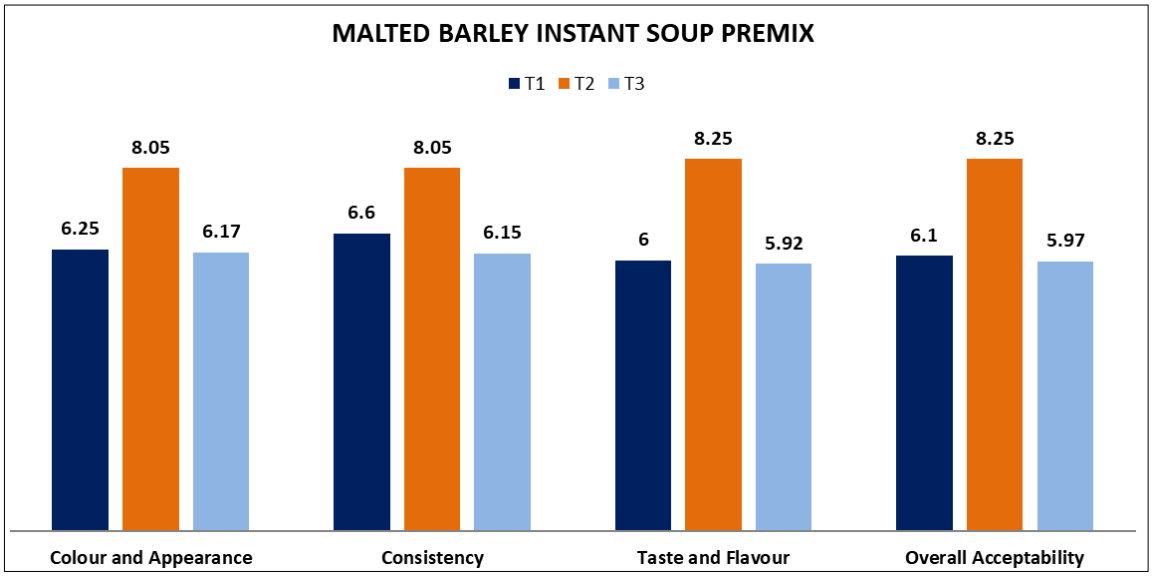


**Fig 2:** Average scores of various sensory attributes of Malted barley soup mix best treatment at different storage period

**Summary and conclusion**

This study aimed to develop malted barley based soup premix by incorporating lentils, drumstick leaves and herbs such as lemongrass, mint and basil. The objective was to create a functional and convenient food product with high nutritional value, antioxidant properties and microbial stability. Three formulations ($T_1$, $T_2$ and $T_3$) were evaluated for sensory attributes, nutritional composition and shelf stability. Among the three formulations, $T_2$ (40% barley, 45% lentils, 10% drumstick leaves and 5% herbs) emerged as the most preferred treatment based on sensory evaluation with the highest scores for color, consistency, flavor and overall acceptability. The malting process and sun drying techniques were instrumental in enhancing the flavor, nutrient retention and shelf stability of the soup premix. Nutritional analysis revealed that the malted barley soup premix ($T_2$) was a nutrient dense product with significant levels of protein (16.92g), carbohydrates (70.76g), energy (372.23kcal/100g), iron (9.96mg) and calcium (119.16mg). The antioxidant evaluation showed high levels of beta carotene (3,316.11ug) and flavonoids (131.06mg) demonstrating the product's potential in combating oxidative stress and promoting health. Storage stability analysis over 90 days indicated that the product maintained acceptable sensory and microbial quality. Moisture content decreased slightly from 8.3% to 6.7% and the peroxide value remained well below the safe threshold (1.23 meq O2/kg) indicating resistance to oxidative rancidity. Microbial load (TPC) stayed within permissible limits with no yeast or mold growth detected throughout the storage period. the findings align with existing literature emphasizing the importance of proper processing and storage techniques in preserving the sensory, nutritional and functional properties of food products. This research highlights the potential of malted barley soup premixes as a convenient, health oriented food solution that meets the growing demand for functional foods.

In conclusion, the development of a malted barley soup premix incorporating lentils, drumstick leaves and herbs offers a highly nutritious and functional food product with excellent sensory attributes, antioxidant properties and extended shelf life. $T_2$ was identified underscores the significance of sun drying and malting techniques in enhancing the nutritional and sensory qualities of food

products. Future research could explore the scalability of production and consumer acceptance across different demographics to establish the commercial viability of this innovative soup premix.

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