Development and Evaluation of a Functional Soup Premix Incorporated with Mushroom and Apple Peel Powder

ABSTRACT

This present investigation was conducted with the objective of developing and assessing the suitability of a functional ready-to-mix soup premix that is fortified with mushroom (Agaricus bisporus) and apple peel powder in combination with specific vegetables and spices. The inclusion of mushrooms is justified owing to their high nutrient content, which consists of protein, dietary fibers, vitamins, minerals, and various other bioactive components like β-glucans and phenolics with antioxidant properties. Apple peel powder was used as a source of dietary fibers, antioxidants, and valorization of wastes. The preparation of the soup premix was done by cleaning, drying, grinding, sifting, and blending the ingredients according to specified proportions. The results obtained after proximate analysis of the product were moisture content of 9.23%, protein content of 5.69%, fat content of 1.55%, ash content of 10.06%, and crude fiber content of 6.80%. Physicochemical analyses conducted on the product gave pH of 6.5, total solid content of 3° Brix, total dissolved solids content of 2.82%, and titratable acidity of 0.133%. Phytochemical analysis indicated the presence of phenolic compounds, flavonoids, tannins, and saponins, thus implying the functional capability of the product. Sensory evaluation proved to be satisfactory and microbiological analysis proved that the product is safe for consumption.

Keywords: Mushroom powder, Apple peel powder, Functional food, Soup premix, Antioxidants, Waste valorization.

1. INTRODUCTION

Functional and convenience foods are highly sought after nowadays because of the changing lifestyle of consumers, urbanization, and improved awareness regarding health issues. Function foods include foods that have some additional benefits apart from their nutritional value because of the presence of various bioactive ingredients, antioxidants, dietary fibers, vitamins, and minerals. In the category of ready to eat foods and ready to cook foods, the soup premixes have become very popular because of their ease of preparation, nutritive content, stability, and consumer appeal.

Mushroom (Agaricus bisporus) was chosen as a vital constituent in the current research owing to its great nutritive value and functional properties. Being a good source of high biological value proteins, dietary fibers, essential amino acids, vitamins (B-vitamins and vitamin D), and minerals like potassium, phosphorus, and selenium, mushrooms also have some valuable phytochemicals such as β-glucans, phenolic compounds, flavonoids, and ergothioneine with antioxidative, antimicrobial, anti-inflammatory, and immunomodulatory effects that assist in prevention of various diseases and general health improvement. Moreover, mushrooms have inherent umami taste and can be utilized as a flavor enhancing ingredient for food products without adding any artificial flavor enhancers. Also, mushrooms have very low amount of fats and calories, which makes them suitable ingredients in the preparation of nutritious convenience foods. Consequently, the utilization of mushroom powder in the soup premix could be regarded as a good strategy to enhance the soup premix's nutritive value, functional properties, organoleptic qualities, and consumer acceptability.

Apple peels form an important by-product of fruit processing industries which are normally considered as waste material. However, apple peels contain dietary fiber, polyphenols, flavonoids, and antioxidants. The inclusion of apple peel powder in foods helps improve nutritional value and provides sustainable production process in foods.

Both mushroom powder and apple peel powder were selected for use in the formulated soup premix because of their synergic interaction. The former acts as a source of proteins, minerals, and phytochemicals while the latter contains high amounts of dietary fiber and antioxidants, which are polyphenols. Such an approach not only ensures nutritional benefits but also leads to more sustainable food production using fruit processing waste products.

Incorporation of mushroom and apple peel powders into the preparation of soup premix is highly likely to contribute positively towards improving nutrient content such as proteins, fiber, and antioxidants in addition to functionality of the soup. With this consideration, this current research project is targeted towards formulation and characterization of a functional soup premix based on mushroom and apple peel powders. Therefore, incorporation of mushroom and apple peel powders in soup premix is highly expected to improve nutrition of the soup in terms of proteins, fiber, and antioxidant content. On this note, the following research was carried out to formulate a functional soup premix based on mushroom and apple peel powders.

2. MATERIALS AND METHODS

2.1 Development and Standardization of Soup Premix

2.1.1 Location and Time of Conducting Research

The above study was conducted in the Department of Food and Nutrition, Babasaheb Bhimrao Ambedkar University, Lucknow during the time January 2026 and May 2026.

2.1.2 Source of Raw Material

Fresh Agaricus Bisporus mushroom, apples, carrots, peas, onion, garlic and other required ingredients were obtained from the market of Lucknow, Uttar Pradesh. Suitable selection of raw material according to the freshness and quality of the ingredients was made.

2.1.3 Preparation of Mushroom Powder

Firstly, fresh mushrooms were washed with running water in order to remove any dirt and impurities present on the mushrooms. The sliced mushrooms were dried by tray drying process. These dried mushrooms were further grounded to make fine powder. This mushroom powder was sieved and stored.

2.1.4 Preparation of Apple Peel Powder

Fresh apples were thoroughly cleaned by washing. Then these apples were manually peeled by hand. The peels obtained from these apples were dried by tray drying method. The peels thus obtained were then grounded to form powder and sieved to give fine powder.

2.1.5 Preparation of Vegetable Powders

Vegetables like carrot, peas, onion and garlic were cleaned, washed, sliced and then subjected to dehydration individually under controlled conditions.

2.1.6 Preparation of Soup Premix

Soup premix was prepared by combining mushroom powder, apple peel powder, vegetable powders, spices, salt and thickening agent. The mixing was carried out to ensure uniformity of all the powders used in the soup premix. The prepared soup premix was later put in air-tight containers.

2.1.7 Evaluation Using Organoleptic Properties

The organoleptic analysis for the design soup premix was done using a technique known as 9-point hedonic scale technique. The samples of the prepared soup were tasted based on various parameters like color, taste, flavor, appearance, texture and acceptability of the design product to a commercial soup premix.

2.1.8 Formulation of Soup Premix

Table 1: Standard Formulation of Mushroom and Apple Peel Powder Soup Premix

Ingredients	Quantity(g)
Mushroom powder	**20**
Apple peel powder	**15**
Carrot powder	**10**
Garlic powder	**3**
Onion powder	**8**
Peas powder	**7**
Cornstarch	**30**
Salt	**4**
Coriander powder	**1.5**
Oregano	**0.5**
Chili flakes	**0.5**
Black pepper	**0.5**
Total	**100 g**

Fig. 1 Schematic Flow Diagram for the Preparation of Mushroom and Apple Peel Soup Premix

Fig. 2 Preparation of Mushroom and Apple Peel Soup Premix

2.2 Proximate Analysis

Proximate analysis was performed to evaluate the nutritional value of the prepared soup premix based on standard AOAC protocols.

2.2.1 Moisture Analysis

Moisture content was determined by performing the hot air oven test. Samples weighing approximately 5 g were dried in a hot air oven until constant weight was attained, with moisture content calculated based on the loss in weight during drying. Reduced moisture content implies improved storability of the sample.

2.2.2 Ash Content

Percentage of ash content was determined by burning the samples in a muffle furnace to 550oC, resulting in the formation of a light grey color, which indicates minerals present in the sample.

2.2.3 Protein Content

Protein content was determined using the Kjeldahl process in which the samples were treated with concentrated sulfuric acid, followed by distillation and titration to determine nitrogen content. Protein content was estimated from the nitrogen value obtained by multiplying it with the required conversion factor.

2.2.4 Fat Content

Crude fat content was analyzed using Soxhlet method, whereby samples were continuously extracted in petroleum ether for long hours. The left-over residue was dried to acquire crude fat.

2.2.5 Fiber Content

Crude fiber content was analyzed using acid and alkali hydrolysis methods. The sample was treated using dilute acid followed by dilute alkali to extract digestible fiber. Residue obtained was then dried and its weight measured before being burnt.

2.2.6 Carbohydrate Content

Carbohydrates content was analyzed using difference method. Its formula can be expressed as;

Carbohydrate (%) = 100 - (Moisture + Protein + Fat + Ash + Fibre)

2.2.7 Energy Content

Energy value of soup premix was analyzed using Atwater factors. Proteins and carbohydrates were multiplied by 4kcal/g, while fat was multiplied by 9 kcal/g.

2.3 Physico-Chemical Properties

2.3.1 Determination of pH

Determinations of the pH values of the mixture were performed using a pH meter. Calibrations were made prior to recording the readings. The determination of pH is a measure of acidity and alkalinity of a food product.

2.3.2 Determination of Total Soluble Solids (TSS)

Determinations of total soluble solids (TSS) were performed using a hand refractometer. It was indicated as %TSS.

2.3.3 Determination of Total Dissolved Solids (TDS)

The determination of total dissolved solids (TDS) was performed in the laboratory. Values were obtained in terms of percentages. Salinity of the soup was determined by titration method. A certain amount of mixture was combined with distilled water and then filtered. Titration was performed using standard $AgNO_3$ solution. Potash alum was used as an indicator wherein the reddish-brown coloration showed that the reaction had reached its endpoint. From this, the amount of sodium chloride present in the solution can be known and expressed in percentages.

2.3.4 Salt Content %

The salt content of the soup premix prepared was evaluated through titration technique. Some quantity of the premix was dissolved in distilled water and then filtered. The filtrate was analyzed using standard silver nitrate solution whereby potassium chromate was used as the indicator. Endpoint for this test was reddish-brown color. The amount of sodium chloride was determined in percent. Salt content determination was important in determining the concentration of sodium and the taste of the soup premix.

2.3.5 Titrable Acidity Measurement

The titrable acidity of the soup premix was measured against the standard NaOH solution using phenolphthalein as the indicator. The acidity was expressed in percentage.

2.4 Phytochemicals Analysis

Phytochemical analyses were conducted on the mushroom and apple peel soup premix (sample A) and the commercial soup premix (Sample B) to evaluate their respective active ingredients which could be attributed to the biological and antioxidant activities of the samples. It is pertinent to note that the phytochemical screening revealed the presence of flavonoids, phenolics, tannins, saponins, glycosides and terpenoids in sample A, and phenolics and glycosides in sample B.

2.4.1 Flavonoids

There were flavonoids in the developed soup premix (Sample A), while there were no flavonoids in Sample B. The reason could be attributed to the use of natural sources including apple peel powder, mushroom powder, and vegetables. Flavonoids act as strong antioxidants and help reduce oxidative stress.

2.4.2 Phenolics

Both Samples A and B had phenolics. Sample A was more functional than Sample B because of the presence of natural sources containing phenolic compounds. It is beneficial to have phenolics in the soup premix in order to avoid damage due to free radicals.

2.4.3 Tannins

There were tannins present in the developed soup premix only. The role of tannins in enhancing antimicrobial and antioxidant qualities makes them functional and helps in improving the shelf life of the developed product.

2.4.4 Saponins

There were saponins present in Sample A only but not in Sample B. Saponins increase the biological value of the soup premix because they possess anti-cholesterol and immunomodulatory activities.

2.4.5 Glycosides

Glycoside content was present in both developed and commercial soup premixes. Glycosides have important biological and antioxidant activities in food.

2.4.6 Terpenoids

Presence of terpenoids in the soup premix was noticed only in developed samples due to the addition of mushrooms, vegetables, and spices. Terpenoids provide antioxidant, antimicrobial, and anti-inflammatory effects improving the biological significance of the developed product. In conclusion, phytochemical evaluation indicates that the developed mushroom and apple peel soup premix is rich in phytochemical content compared to the commercial soup premix. In other words, the developed soup premix has higher levels of antioxidants and biological activity making it suitable for health benefits.

2.5 Scanning Electron Microscopy Analysis (SEM)

Surface morphology and particle structures of the dried soup premix powders were analyzed via scanning electron microscopy (SEM). Samples were dried before SEM analysis. Dried samples were attached to aluminium stubs. Different magnifications were utilized during the SEM analysis of samples.

2.6 Packaging and Labelling

The soup premix that had been developed using mushrooms and apple peel (Sample A) was then packed into a food-grade glass jar with an airtight screw cap. Glass material was used for the container because it does not react with the contents of the jar or allow any external substance, moisture, or oxygen to enter. This ensures that both the aroma and flavor of the soup premix remain intact. Also, the low moisture level of the soup premix (9.23%) contributed towards ensuring its stability during storage.

Interpretation

The effectiveness of the use of a glass jar fitted with an airtight lid was observed in preserving the quality, safety, and shelf-life of the produced soup premix. The non-reactive and impermeable nature of the glass jar prevents the entry of any form of contamination or moisture. While commercially available food products incorporate highly sophisticated packaging materials for convenience purposes, the glass jar can be viewed as an environmentally friendly and aesthetic packaging solution, especially for homemade food products.

Fig. 3 Packaging of the Product

Fig. 4 Nutritional Label of the Product

3. RESULTS AND DISCUSSION

3.1 Proximate Analysis

NOTE: Sample A - Mushroom & Apple Peel Soup Premix

Sample B - *Commercial Soup Premix*

Table 2: Proximate Analysis of Mushroom & Apple Peel Soup Premix and Commercial Soup Premix

Parameter	Sample A	Sample B
Moisture (%)	9.23	6.00
Protein (%)	5.69	5.51
Fat (%)	1.56	2.51
Ash (%)	10.06	7.24
Crude Fibre (%)	6.806	2.17
Carbohydrate (%)	66.66	76.57
Energy(kcal)	303.44	350.91

The premixed soup prepared had high nutritional value due to higher amounts of protein, fiber, and minerals in it compared to the commercially available soup.

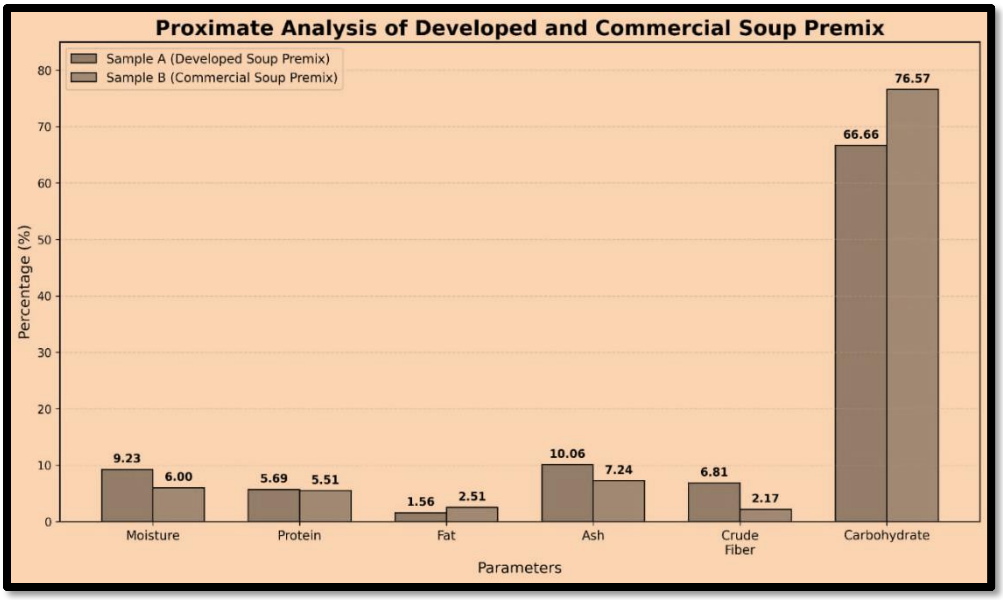

Fig. 5 Results of Proximate Analysis

3.2 Physicochemical Analysis

Table 3: Physicochemical Analysis of Mushroom & Apple Peel Soup Premix and Commercial Soup Premix

Parameter	Sample A	Sample B
pH	6.5	6.0
TSS (°Brix)	3	5
TDS (%)	2.82	3.52
Acidity (%)	0.13	0.20
Sodium (%)	2.00	2.50

Physicochemical characteristics were deemed satisfactory for the product while also possessing excellent product stability.

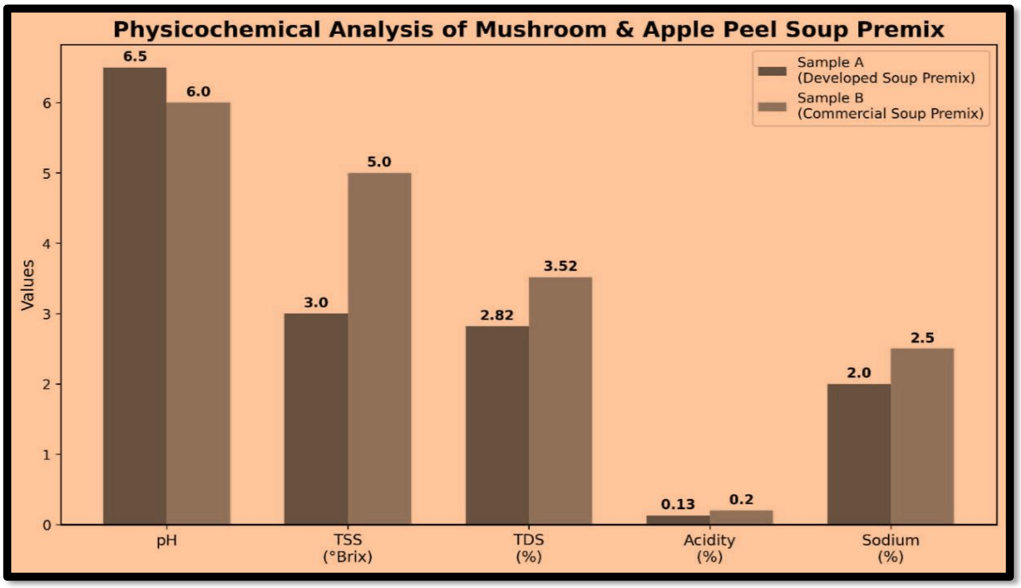

Fig. 6 Results of Physico-chemical Analysis

3.3 Phytochemical Analysis

Table 4: Phytochemical Analysis of Mushroom & Apple Peel Soup Premix and Commercial Soup Premix

Phytochemical	Sample A	Sample B
Flavonoids	+	-
Phenolics	+	+
Tannins	+	-
Saponins	+	-
Glycosides	+	+
Terpenoids	+	-

It was established that the premixed soup prepared had certain bioactive ingredients that made the product antioxidative in nature.

3.4 Analysis by Scanning Electron Microscope (SEM)

The study was carried out using the scanning electron microscope (SEM) with a view to determining the surface morphology and chemical composition of the soup premix made from the mixture of mushroom and apple peel powder. Information on the surface morphology, particle size, surface features, and organization of powdered food products can be provided using scanning electron microscopy. The surface morphology features of the soup premix are important in determining its ability to be hydrated and its texture.

The SEM images of the soup premix revealed that the particles have irregular shape with porous surfaces. The porous surfaces could be attributed to the drying procedure employed in the preparation of the mushroom powder, apple peel powder, and other vegetable powders used in making the soup. Such structures in the instant soup premix help in improving the water absorptivity of the soup. From the SEM images obtained, it is clear that the particles are distributed evenly in the soup. The surface morphology features of the manufactured soup premix might have been caused by the use of ingredients containing high amounts of fibre such as mushroom powder and apple peel powder.

This is attributed to the fact that fibre helps enhance the functionality and nutritional quality of the product. Furthermore, from the structure of the particles, it was noted that there was uniform distribution of the ingredients in the soup premix. From the elemental analysis carried out together with SEM results, it was established that the major elements present included carbon (C), oxygen (O), potassium (K), phosphorus (P), and chlorine (Cl). Two of these major elements which include carbon and oxygen are present in significant amounts, indicating the presence of carbohydrates and fibres.

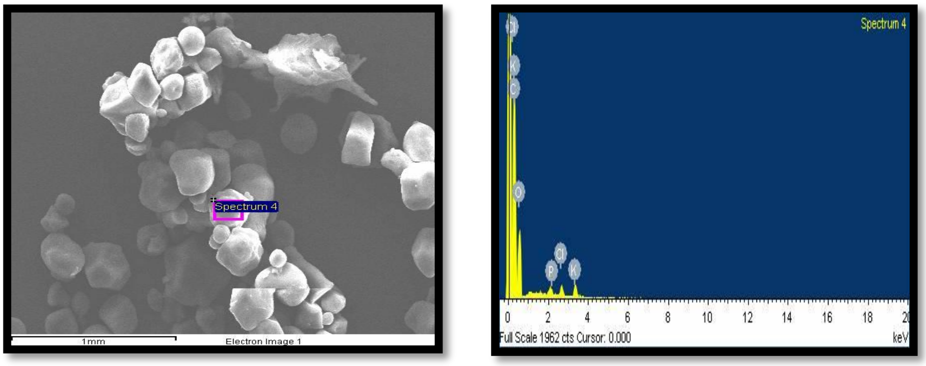

Fig. 7 Scanning Electron Microscopy (SEM) Analysis of Developed Mushroom and Apple Peel Soup Premix

Table 5: Elemental Composition of Soup Premix by EDS Analysis

Elements	Weight %	Atomic %
C K	47.60	55.65
O K	49.03	43.04
P K	0.55	0.25
Cl K	1.23	0.49
K K	1.58	0.57
Totals	100.00	-

4. EXISTING SOUP PREMIXES IN THE MARKET

In the recent years, the field of convenient foods both globally as well as in India has seen a great deal of development on account of the process of urbanization, change in food habits, fast pace of life, and high demand for ready-to-cook foods. Soup premix happens to be one of the more popular convenience foods due to reasons of their wide availability, cost-effectiveness, and long shelf life. The commercially available branded soups such as Knorr, Maggi, Ching's, and other brands from India offer many varieties of soup premixes that include tomato soup, mushroom soup, sweet corn soup, vegetable soup, hot and sour soup, and mixed vegetable soup. Such soups generally come in a powder form and only require water for preparation.

Flavouring agents, colouring agents, stabilizers, and preservatives are some of the common ingredients used in the manufacture of commercial soup premixes as means of improving their taste, shelf life, and appearance. However, although easily consumable and attractive to the consumer, commercial soups are generally sodium-rich, with low fiber content and functional ingredient.

Therefore, there will be a growing consumer interest in healthy soups that need to contain natural ingredients and have high levels of antioxidants and dietary fibers.

Over the past few years, much importance has been attached to healthy foods made up of vegetable-based products, mushrooms, herbs, fruits, and biologically active substances. Consumers are becoming more interested in healthy foods that can help in boosting their immunity, improving digestion, controlling body weight, and overall well-being. Therefore, it will be possible to prepare nutritious soups by using natural ingredients such as mushrooms and apple peel.

5. MARKET CHALLENGES

Some of the challenges in the market concerning the development and production of instant soup premix and functional foods in the market despite the increase in demand include the issue of meeting the nutrition and sensory qualities of the product. It means that there needs to be inclusion of nutritious elements in addition to sensory attributes like good aroma, color, texture, and others. Addition of certain ingredients such as mushrooms and apple peel powder in the soup formulation could affect its sensory attribute and thus the need for standardization.

Another important challenge that is associated with the market is the shelf-life aspect in the market since it is a function of natural ingredient addition without many preservatives. There are various factors such as moisture, oxidation, flavouring, and contaminations that could influence the food quality. There is a lot of competitive pressure in the convenient food market segment making the introduction of new products difficult. This is because of the presence of strong companies in the industry offering superior food quality.

In addition, increasing prices in raw material costs, packaging costs, transportation costs, and others related to quality may influence economics involved in introducing the new product. Consumer awareness about clean-label products will require improvement in packaging and processing technology on behalf of the producer. Meeting the standard set by regulatory authorities such as FSSAI will be essential.

6. FUTURE POTENTIAL

Future potential of the functional soup premix looks very bright due to increased consumer awareness regarding nutrition, healthy eating habits, and sustainable food consumption. The newly formulated mushroom and apple peel soup premix have several advantages regarding function and nutritional value owing to its fiber, antioxidants, minerals, and phytochemical composition. Incorporation of mushroom powder enhances the functionality owing to protein, vitamins, minerals, and antioxidant content. Similarly, apple peel powder contributes to fibers and phytochemicals.

Using apple peel as an added value ingredient has also proven that agro-industries' wastes are efficient enough in manufacturing sustainable foods. Not only will this reduce wastage in food materials, but it would also promote sustainable food processing. Future research can be focused on utilizing other types of fruits and vegetables' peels for the formulation of sustainable functional foods. The process may even involve improving the composition of the soup premix by adding proteins, probiotics, prebiotics, vitamins, minerals, and herbal extracts. Formulating premix-based soups that are specifically formulated for certain purposes, like low sodium, high protein, diabetic-friendly, and immunity-enhancing soups, can be considered.

Alternative methods for processing and packaging of the soup premix, such as spray drying and modified atmosphere packaging, can also be considered. The industrial-scale evaluation and commercialization of the soup premix can help in assessing its feasibility. As the focus on health-promoting and convenience food products is increasing, the formulated soup premix will become a profitable functional food in no time.

CONCLUSION

This study successfully met the objectives of formulating a ready to mix soup premix from mushroom powder, apple peel powder, and other vegetables and spices. The developed soup premix was identified to contain adequate nutritional elements, acceptable sensory properties, and stability during storage. Mushroom powder contributed more proteins and bioactive components while the apple peel powder increased dietary fiber and antioxidants in the formulated soup premix. The proximate analysis established that the formulated soup premix contained enough protein, crude fiber, and minerals whereas its fat content was low.

Physicochemical analysis proved that pH, total soluble solids, and acidity were within acceptable values while phytochemical analysis revealed that the soup premix contained phytochemicals such as phenolic compounds and flavonoids. Sensory analysis indicated acceptable results with respect to color, taste, texture, flavor, and overall acceptability. Finally, the formulated soup premix was microbiologically stable because of low moisture content and good dehydration procedures employed during formulation. The study demonstrated that there is need to use agro-industrial wastes such as apple peels to improve on food products. Overall, the developed mushroom and apple peel soup premix can be considered as nutritious, functional, and economic foods with high commercial potential.

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Author’s Bibliography

Jigyasa is studying towards her Master of Science (M.Sc.) degree in Food Science and Technology at Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow. The fields of her research interest include functional foods, food product development, food preservation, nutritional evaluation, and sustainable food processing techniques. Her research has been aimed at developing and evaluating the quality of a ready-to-mix soup premix enriched with mushroom and apple peel powder to improve nutritional aspects and achieve effective waste management with the use of agro-industrial waste. She has also taken part in academic and research-related initiatives in the field of food science and technology.

Dr. Priyanka Shankar is an assistant professor at Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow. She has supervised numerous research projects undertaken by postgraduate students in the field of food processing techniques, nutritional assessment, sensory evaluation, and sustainable food technologies. Her research efforts have largely been directed towards developing health-oriented food products enriched with bioactive compounds.

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Author's contributions

Jigyasa: Methodology, Writing - original draft; **Priyanka Shankar:** Conceptualization, Supervision, Formal analysis, investigation, Writing - review and editing.

Data Availability: The authors declare that the data supporting the findings of this study are available within the paper. The raw data files will be available from the corresponding author upon reasonable request.

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