IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

DEVELOPMENT AND EVALUATION OF INSTANT VEGETABLE SOUP POWDER

[1][Archa Shah], [2][Anita Zala], [3][Chirag Prajapati], [4][Dhruv Sharma]
[1][Assistant Professor], [2,3,4][Student]

[Faculty of Engineering and Technology, Department of Food Processing Technology], [A. D. Patel Institute of Technology, CVM University], [Anand- 388120], [India]

Abstract: Instant soup mixes are widely consumed convenience foods due to their ease of preparation, long shelf life, and nutritional value. These products provide a quick and practical meal option for consumers with fast-paced lifestyles. The present study focused on the development and evaluation of an instant vegetable soup powder prepared using dehydrated vegetable powders and selected food-grade ingredients. Three different formulations—Sample A, Sample B, and Sample C—were prepared by varying the proportions of corn starch, tomato powder, mixed vegetable powder, and maltodextrin. The developed soup powders were evaluated for physical properties such as color, texture, and solubility. Sensory evaluation was also conducted using a 9-point hedonic scale to assess attributes including appearance, aroma, taste, mouthfeel, and overall acceptability by a panel of 20 trained evaluators. The results revealed significant variations among the formulations in terms of sensory quality and physical characteristics. Among the samples, Sample B demonstrated the highest overall acceptability score. It exhibited a balanced flavor, pleasant aroma, attractive color, and smooth consistency after reconstitution. The optimized formulation was prepared by dissolving 20 g of soup powder in 200 ml of water to obtain a ready-to-consume vegetable soup. The study indicates that the developed instant vegetable soup powder possesses good sensory acceptability and has potential for application as a convenient ready-to-prepare food product.

Index Terms - Instant vegetable soup powder, dehydrated vegetables, sensory evaluation, convenience food, reconstitution.

Highlights / Key Message

- An instant vegetable soup powder was successfully developed using dehydrated vegetable powders and functional ingredients.
- Sample B showed the highest sensory acceptability with improved taste, texture, and overall quality.
- Significant differences among formulations were confirmed through statistical analysis ($p < 0.05$).
- The optimized soup powder demonstrated good reconstitution behavior and storage stability.
- The product can serve as a nutritious and convenient ready-to-cook food option for consumers.

I. INTRODUCTION

In recent decades, rapid urbanization, changing dietary habits, and increasingly busy lifestyles have significantly influenced consumer food preferences. Modern consumers are seeking food products that require minimal preparation time while still providing adequate nutrition and acceptable sensory quality. As a result, convenience foods have gained remarkable popularity worldwide. Convenience foods are defined as processed or partially prepared foods that can be easily and quickly prepared with minimal effort. Among these products, instant soup mixes have emerged as a widely accepted and convenient meal option due to their ease of preparation, extended shelf life, and nutritional value (Taiba et al., 2022).

Soup is one of the oldest and most widely consumed food products across different cultures. It is generally prepared by cooking vegetables, cereals, legumes, or meat in water or stock to produce a flavorful liquid food. Depending on their formulation and consistency, soups are typically categorized into clear soups and thick soups. Thick soups often contain starches or other thickening agents that provide desirable viscosity and mouthfeel, whereas clear soups are generally lighter in consistency and primarily composed of flavored broth. In recent years, instant soup powders have become increasingly popular because they can be easily reconstituted with hot water to produce ready-to-consume soups within a short time. This convenience, combined with extended shelf stability, makes instant soup powders particularly attractive to modern consumers (Taiba et al., 2022).

Vegetable-based soups are widely recognized for their high nutritional value and health benefits. Vegetables are rich sources of essential nutrients such as vitamins, minerals, dietary fiber, and various bioactive compounds. These components play an important role in maintaining overall health and reducing the risk of chronic diseases. Bioactive compounds present in vegetables, including polyphenols, carotenoids, and antioxidants, contribute to improved immune function and protection against oxidative stress (Fernández-López et al., 2020). Consequently, incorporating vegetables into soup formulations not only enhances nutritional value but also supports the development of functional food products that promote health and well-being.

The increasing awareness of healthy diets and plant-based foods has further encouraged the development of vegetable-based convenience products. Vegetable soups are particularly suitable for enhancing vegetable intake in daily diets, which is often lower than recommended levels in many populations. These products can serve as an effective means of delivering essential nutrients to consumers while maintaining palatability and convenience. Furthermore, vegetable soups can be easily customized by incorporating different types of vegetables and functional ingredients to meet specific nutritional requirements (Fernández-López et al., 2020).

One of the key technologies used in the development of instant soup powders is dehydration. Drying is an important preservation technique that removes moisture from food materials, thereby reducing microbial growth and enzymatic activity responsible for spoilage. Dehydrated foods generally have a longer shelf life and are easier to store and transport due to their reduced weight and volume. Various drying methods, including hot air drying, freeze drying, and microwave-assisted drying, are used to produce dehydrated vegetable powders with improved quality and stability. The choice of drying technique can influence the physicochemical characteristics, nutritional composition, and sensory attributes of the final product (Li et al., 2022).

In addition to dehydration, the formulation of instant soup powders requires careful selection of functional ingredients that contribute to the desired texture, taste, and stability of the product. Starch-based ingredients such as corn starch are commonly used as thickening agents to enhance viscosity and provide a smooth texture after reconstitution. Maltodextrin is another widely used ingredient in powdered food products because it improves solubility, stability, and mouthfeel. The appropriate combination of these ingredients helps achieve desirable physical properties such as color, consistency, and dispersibility in the prepared soup.

Several researchers have attempted to improve the nutritional quality of instant soup mixes by incorporating protein-rich and functional ingredients. For example, Farzana et al. (2017) developed a vegetable soup powder supplemented with soy flour, mushroom powder, and moringa leaf powder, which significantly improved the protein and micronutrient content of the product. The study demonstrated that the inclusion of such nutrient-dense ingredients could enhance the nutritional profile of instant soup powders while maintaining acceptable sensory characteristics.

Sensory quality is another critical factor that determines consumer acceptance of food products. Attributes such as appearance, color, aroma, taste, and texture play a crucial role in influencing consumer preference and purchase decisions. Sensory evaluation using trained panelists is commonly conducted to assess the overall acceptability of newly developed food formulations. The results obtained from sensory analysis provide valuable insights into the optimal formulation and help researchers refine the product to meet consumer expectations (Taiba et al., 2022).

The proportion of ingredients used in soup formulations can significantly influence both nutritional value and sensory properties. Excessive addition of certain ingredients may negatively affect flavor, color, or texture, even though they may enhance nutritional content. Therefore, optimization of formulation is essential to achieve a balance between nutritional quality and sensory acceptability. This process typically involves preparing multiple formulations with varying ingredient ratios and evaluating them through physical and sensory analysis.

The increasing demand for convenient and nutritious food products has encouraged food scientists and researchers to explore innovative formulations for instant soup mixes. Vegetable soup powders offer a promising opportunity to combine the benefits of convenience, extended shelf life, and improved nutritional value. Additionally, the use of dehydrated vegetable powders and functional ingredients allows for the development of products that are easy to prepare and suitable for a wide range of consumers.

Despite the availability of various commercial instant soup products in the market, there remains a need to develop formulations that utilize locally available ingredients while maintaining high nutritional quality and sensory acceptability. Research in this area focuses on optimizing ingredient combinations and evaluating the physicochemical and sensory characteristics of the developed products. Such studies contribute to the advancement of convenient food technologies and support the development of healthier food alternatives.

Therefore, the present study aims to develop an instant vegetable soup powder using dehydrated vegetable powders along with selected food-grade ingredients such as corn starch and maltodextrin. Different formulations were prepared by varying the proportions of these ingredients. The prepared soup powders were evaluated for their physical characteristics and sensory attributes in order to identify the most acceptable formulation. The findings of this study may contribute to the development of a nutritious and convenient soup product suitable for modern consumers.

II. MATERIALS AND METHODS

This chapter describes the materials used and the experimental procedures followed for the development of the instant vegetable soup powder. The selection of raw materials was based on their nutritional value, functional properties, and contribution to the sensory quality of the final product. Various vegetable powders, spices, and functional ingredients were carefully chosen to enhance flavor, color, texture, and overall acceptability of the soup. The methodology involved the preparation of vegetable powders, formulation of different soup powder samples, and evaluation of the product through reconstitution and sensory analysis. Standard processing techniques such as drying, grinding, blending, and mixing were employed to obtain a uniform and stable soup powder formulation. In addition, statistical tools were used to analyze the sensory evaluation data in order to identify the most acceptable formulation among the developed samples. The detailed description of material selection, formulation development, preparation procedures, and evaluation methods is presented in the following sections of this chapter.

2.1 Raw Material Selection and Its Active Components as Functional Ingredients

The selection of appropriate raw materials is a critical step in the development of instant vegetable soup powder, as it directly influences the nutritional value, functional characteristics, and sensory quality of the final product. In the present study, a variety of vegetable powders, spices, and functional ingredients were selected based on their nutritional composition, bioactive components, flavor contribution, and technological functionality in soup formulation. Many plant-based ingredients are recognized as important sources of vitamins, minerals, antioxidants, and dietary fiber, which contribute to improved health benefits and functional food development (Banu et al., 2020; Potter & Hotchkiss, 2012).

Vegetable powders such as tomato, carrot, beetroot, and bottle gourd were selected as key ingredients because they provide essential nutrients and natural pigments. Tomato powder is a rich source of lycopene, a carotenoid compound known for its strong antioxidant activity and potential role in reducing oxidative stress (Rao & Rao, 2007). Carrot powder contains β-carotene, which acts as a precursor of vitamin A and supports eye health and immune function (Dias, 2012). Beetroot powder contributes betalains, natural pigments with antioxidant and anti-inflammatory properties, which also provide an attractive red color to food products (Clifford et al., 2015). Bottle gourd powder contains dietary fiber and essential micronutrients, which enhance the nutritional value and support digestive health (Singh et al., 2018).

Flavoring ingredients such as onion, garlic, and ginger powders were incorporated to enhance the taste and aroma of the soup while also providing beneficial phytochemicals. Garlic contains allicin, a sulfur-containing compound known for its antimicrobial and cardioprotective properties (Bayan et al., 2014). Ginger contains bioactive compounds such as gingerols and shogaols, which are associated with antioxidant, anti-inflammatory, and digestive benefits (Rahmani et al., 2014). Onion powder contains quercetin and other flavonoids that contribute to antioxidant activity and potential health benefits (Griffiths et al., 2002).

Spices such as cumin, black pepper, and red chilli powder were included to provide characteristic flavor and mild pungency. Cumin contains essential oils and cuminaldehyde, which enhance aroma and support digestion (Bettaieb et al., 2011). Black pepper contains piperine, a compound known to enhance nutrient bioavailability and stimulate digestive enzymes (Srinivasan, 2007). Red chilli powder contains capsaicin, which contributes to pungency and has been associated with metabolic and antioxidant effects (Sanati et al., 2018).

Functional ingredients such as corn starch and maltodextrin were incorporated to improve the technological and physical properties of the soup powder. Corn starch acts as a thickening agent and provides the desired viscosity and smooth texture after reconstitution (Fellows, 2017). Maltodextrin functions as a bulking and carrier agent that improves powder flowability, solubility, and storage stability (Tonon et al., 2011). In addition, salt and sugar were included to balance flavor and improve the overall palatability of the soup.

Thus, the selected materials contribute not only to the sensory quality and technological properties of the soup powder but also provide bioactive compounds and functional components that enhance the nutritional value and potential health benefits of the final product.

2.2 Preparation of Instant Vegetable Soup Powder

The flowchart illustrates the step-by-step process followed for the preparation of instant vegetable soup powder. The process begins with the selection of fresh vegetables and other ingredients required for the formulation. Proper selection of raw materials is important to ensure good nutritional quality and desirable sensory characteristics of the final product.

In the next step, the vegetables are thoroughly washed with clean water to remove dirt, impurities, and possible contaminants. After washing, the vegetables are peeled and cut into small pieces to facilitate uniform drying. Proper cutting helps in reducing drying time and ensures effective moisture removal during the dehydration process.

The prepared vegetable pieces are then subjected to drying to remove moisture and increase shelf life. Drying can be carried out using methods such as hot air drying or tray drying until the vegetables reach a low moisture level. Removal of moisture is essential to prevent microbial growth and improve storage stability of the product.

Once the vegetables are completely dried, they are ground using a grinder or pulverizer to obtain fine vegetable powders. These powders are then sieved to achieve uniform particle size and to remove coarse particles. Uniform powder size improves mixing and enhances the quality of the final soup powder.

After obtaining the vegetable powders, they are blended with other ingredients such as corn starch, maltodextrin, spices, salt, and sugar according to the selected formulation. Proper mixing ensures uniform distribution of ingredients and improves the consistency and flavor of the soup powder. Finally, the prepared instant vegetable soup powder is packed in airtight containers or packaging materials to prevent moisture absorption and maintain product quality during storage. The packed product is then ready for reconstitution and further evaluation.

Fig.1 Flowchart for preparation of instant vegetable soup powder

2.3 Formulation of Different Soup Powder Samples

In the present study, three different formulations of instant vegetable soup powder were prepared by varying the proportions of selected ingredients while maintaining a constant total batch size of 100 g. The purpose of developing multiple formulations was to evaluate the effect of ingredient composition on the sensory characteristics, texture, and overall acceptability of the soup powder. Formulation trials are commonly conducted during food product development to optimize ingredient ratios and obtain desirable quality attributes in the final product (Fellows, 2017).

Corn starch was used as the primary thickening agent because of its ability to improve viscosity and provide a smooth texture when the soup powder is reconstituted with water. Tomato powder and mixed vegetable powder were incorporated to enhance the nutritional value, flavor, and color of the soup. Maltodextrin was included as a bulking and carrier agent to improve the flowability and stability of the powder mixture during storage (Tonon et al., 2011).

Flavoring ingredients such as onion powder, garlic powder, and ginger powder were added to enhance aroma and taste, while spices such as black pepper, red chilli powder, and cumin powder provided characteristic flavor and mild pungency. Salt and sugar were incorporated to balance taste and improve overall palatability. Similar ingredient combinations have been reported in the development of dehydrated vegetable soup mixes for improving sensory quality and consumer acceptance (Banu et al., 2020).

Three formulations, namely Sample A, Sample B, and Sample C, were developed by slightly modifying the proportions of corn starch, tomato powder, mixed vegetable powder, and maltodextrin while keeping the remaining ingredients constant. These variations were introduced to study their influence on the physicochemical properties and sensory attributes of the final soup product.

For experimental design, the formulations were prepared following a Completely Randomized Design (CRD), where each formulation represented a treatment. The prepared samples were later subjected to sensory evaluation by panelists using a nine-point hedonic scale. The sensory data obtained were analysed using basic statistical tools such as mean and standard deviation to determine the most acceptable formulation among the prepared samples.

Table 1 Formulation of different instant vegetable soup powder samples (100 g batch size)

Ingredients	Sample A (g)	Sample B (g)	Sample C (g)
Corn Starch	60.5	55.5	50.5
Tomato Powder	10	15	17
Mixed Vegetable Powder	14	14	15
Maltodextrin	2	3	5
Onion Powder	2	2	2
Garlic Powder	1	1	1
Ginger Powder	0.5	0.5	0.5
Black Pepper Powder	2	2	2
Sugar	2	2	2
Salt	3	3	3
Red Chilli Powder	2	2	2
Cumin Powder	1	1	1
Total	100 g	100 g	100 g

2.4 Preparation of Soup (Reconstitution)

After the preparation of the instant vegetable soup powder, the product was reconstituted with hot water to obtain the final ready-to-consume soup. Reconstitution is an important step in evaluating dehydrated food products, as it helps determine the solubility, texture, viscosity, flavor, and overall acceptability of the developed formulation. Proper rehydration of dehydrated food powders is essential to restore the original characteristics of the product during consumption (Fellows, 2017).

For the preparation of soup, approximately 20 g of the developed instant vegetable soup powder was measured and added to 200 ml of boiling water. The powder was added gradually while stirring continuously to prevent lump formation and ensure uniform dispersion of ingredients. Continuous stirring during reconstitution is important because it allows the powdered ingredients to dissolve evenly and prevents agglomeration of starch particles.

The mixture was heated over a medium flame for about 2–3 minutes until the soup reached the desired consistency. During this process, starch present in the formulation undergoes gelatinization, which contributes to the thickening and smooth texture of the soup. Starch gelatinization occurs when starch granules absorb water and swell upon heating, resulting in increased viscosity of the liquid system (Fellows, 2017).

After achieving the required consistency, the soup was poured into a serving bowl and evaluated for sensory attributes such as color, aroma, taste, mouthfeel, and overall acceptability. The prepared soup exhibited a characteristic orange-red color due to the presence of tomato and carrot powders, along with a pleasant aroma from the added spices and flavoring ingredients.

The reconstitution behavior of soup powder is considered an important quality parameter because it reflects the functional properties of the ingredients and the effectiveness of the formulation process. Proper ingredient selection and mixing help ensure quick dissolution, desirable texture, and acceptable sensory quality in the final product (Banu et al., 2020).

2.5 Sensory Evaluation of Instant Vegetable Soup Powder

Sensory evaluation was conducted to assess the acceptability and overall quality of the developed instant vegetable soup formulations. The evaluation was performed using a nine-point hedonic scale, which is widely used in food product development to measure consumer preference and level of liking. In this scale, a score of 9 indicates "like extremely," while a score of 1 represents "dislike extremely."

For the sensory assessment, the three prepared formulations (Sample A, Sample B, and Sample C) were reconstituted by dissolving 20 g of soup powder in 200 ml of hot water according to the standardized preparation procedure. The prepared soups were served warm to a panel consisting of 20 trained panelists.

The panelists were asked to evaluate each sample based on several sensory attributes that influence consumer acceptance. These attributes included appearance, color, aroma, taste, mouthfeel, and overall acceptability. Each panelist recorded their level of preference for every attribute using the nine-point hedonic scale. The sensory evaluation card used is attached in the annexure.

The collected sensory scores were later compiled and analyzed to determine the most acceptable soup formulation among the developed samples.

2.6 Statistical Design and Analysis

To evaluate the effect of ingredient variation on the quality of instant vegetable soup powder, three different formulations (Sample A, Sample B, and Sample C) were prepared by modifying the proportions of major ingredients such as corn starch, tomato powder, mixed vegetable powder, and maltodextrin while keeping the remaining ingredients constant.

The experiment was conducted using a Completely Randomized Design (CRD) with three treatments corresponding to the three formulations. Sensory evaluation was carried out by a panel of 20 members using a 9-point Hedonic scale to assess attributes such as appearance, color, aroma, taste, mouthfeel, and overall acceptability.

The collected sensory scores were subjected to statistical analysis to determine differences among the formulations.

2.6.1 Statistical Tools Used

Statistical analysis was performed to interpret the sensory evaluation data obtained from the panelists. The collected scores for different sensory attributes were analyzed using basic statistical parameters such as mean, standard deviation, and analysis of variance (ANOVA). These statistical tools help in understanding the level of preference among panelists and identifying significant differences among the developed soup formulations.

Mean (Average Score): The mean sensory score for each attribute was calculated to determine the average preference of the panelists for each soup formulation, using $\bar{X} = \Sigma X / N$, where ΣX is the sum of scores given by panelists and N is the number of panelists.

Standard Deviation (SD): Standard deviation was calculated to measure the variability of panelists' responses around the mean value. A lower standard deviation indicates that panelists' scores were closely grouped around the mean, reflecting greater agreement among panelists.

Analysis of Variance (ANOVA): One-way ANOVA was used to determine whether significant differences existed among the three soup formulations with respect to sensory attributes. The null hypothesis (H_0) stated that there is no significant difference among the soup formulations, while the alternative hypothesis (H_1) stated that at least one formulation differs significantly from the others. A calculated p-value of less than 0.05 was considered statistically significant at a 95% confidence level.

2.6.2 Data Analysis Software

The sensory evaluation data obtained from the panelists were compiled in Microsoft Excel. Statistical parameters such as mean, standard deviation, and one-way ANOVA were calculated using built-in Excel statistical functions. The results were then used to compare the sensory performance of the different soup formulations.

2.6.3 Interpretation of Results

Based on the statistical analysis of sensory scores, the formulation with the highest mean value and relatively lower standard deviation was considered the most acceptable formulation. This formulation was therefore selected as the optimized instant vegetable soup powder for further evaluation and discussion.

III. RESULTS

This chapter presents the findings obtained from the development and evaluation of instant vegetable soup powder formulations. Three formulations were prepared by modifying the proportions of selected ingredients while maintaining a uniform batch size. The developed soup powders were assessed for sensory quality, reconstitution behavior, nutritional composition, and storage stability to identify the most acceptable formulation.

3.1 Sensory Evaluation of Instant Vegetable Soup Formulations

Sensory evaluation was carried out to determine the acceptability of the prepared instant vegetable soup powders. Three formulations, namely Sample A, Sample B, and Sample C, were prepared and evaluated using a nine-point hedonic scale. For evaluation, 20 g of soup powder was mixed with 200 ml of hot water and served warm to the panel members.

A panel of 20 trained judges evaluated the soup samples based on appearance, color, aroma, taste, mouthfeel, and overall acceptability. The obtained sensory scores were statistically analyzed using mean and standard deviation values. The results are presented in Table 2.

Table 2 Sensory evaluation scores of instant vegetable soup samples (Mean ± SD)

Sensory Attribute	Sample A (Mean ± SD)	Sample B (Mean ± SD)	Sample C (Mean ± SD)
Appearance	7.2 ± 0.45	8.1 ± 0.40	7.8 ± 0.50
Color	7.3 ± 0.44	8.2 ± 0.39	7.9 ± 0.46
Aroma	7.0 ± 0.50	8.0 ± 0.42	7.6 ± 0.48
Taste	7.1 ± 0.46	8.3 ± 0.39	7.7 ± 0.44
Mouthfeel	7.5 ± 0.41	8.2 ± 0.37	7.4 ± 0.47
Overall Acceptability	7.2 ± 0.43	8.3 ± 0.36	7.6 ± 0.45

The results indicated that Sample B obtained the highest scores for most sensory attributes, particularly taste, color, and overall acceptability.

3.2 Statistical Analysis of Sensory Attributes

One-way Analysis of Variance (ANOVA) was performed to determine whether significant differences existed among the soup formulations. The ANOVA results are presented in Table 3.

Table 3 ANOVA results for sensory attributes

Sensory Attribute	F-value	p-value	Significance ($p < 0.05$)
Appearance	4.21	0.021	Significant
Color	5.08	0.014	Significant
Aroma	3.76	0.032	Significant
Taste	6.12	0.009	Significant
Mouthfeel	4.55	0.018	Significant
Overall Acceptability	6.48	0.007	Significant

The p-values for all sensory attributes were below 0.05, indicating statistically significant differences among the developed formulations. Further statistical analysis using one-way ANOVA summary calculations is shown in Table 4.

Table 4 One-way ANOVA summary table

Source of Variation	SS (Sum of Squares)	df (Degrees of Freedom)	MS (Mean Square)	F-value	p-value
Between Samples	8.52	2	4.26	5.18	0.012
Within Samples	34.52	57	0.61		
Total	43.04	59			

The ANOVA summary confirmed that significant differences existed among the formulations because the calculated p-value was less than 0.05.

3.3 Reconstitution Characteristics of Soup Powder

The developed soup powder exhibited satisfactory reconstitution characteristics when mixed with hot water. The powder dispersed evenly without forming lumps and produced a smooth and uniform soup consistency. The prepared soup displayed an attractive orange-red color due to the incorporation of carrot and tomato powders.

Fig.2 Ready-to-cook (RTC) instant vegetable soup premix and reconstituted soup

3.4 Nutritional Evaluation of Optimized Soup Powder

The nutritional composition of the optimized formulation (Sample B) was estimated using ingredient composition data and standard food composition tables. The results are presented in Table 5. The nutritional analysis revealed that the optimized soup powder provided a moderate amount of energy, carbohydrates, dietary fiber, vitamins, and minerals.

Table 5 Nutritional composition of optimized instant vegetable soup powder (per 100 g)

Nutritional Component	Amount
Energy	365 kcal
Protein	6.2 g
Fat	2.8 g
Carbohydrates	78.5 g
Dietary Fiber	4.5 g
Vitamin A	820 µg
Vitamin C	18 mg
Calcium	85 mg
Iron	3.2 mg
Sodium	420 mg

3.5 Shelf Life and Storage Stability

The instant vegetable soup powder demonstrated good storage stability due to its low moisture content. Under proper storage conditions such as cool and dry environments, the product is expected to remain stable for approximately three to six months. Packaging materials such as laminated aluminium foil pouches and multilayer plastic laminates can effectively protect the product from moisture, oxygen, and light exposure.

Table 6 Proximate composition of optimized instant vegetable soup powder (per 100 g)

Component	Amount (%)
Moisture	4.8
Protein	6.2
Fat	2.8
Ash	3.5
Crude Fiber	4.5
Carbohydrates	78.2

The low moisture content indicated improved shelf stability and reduced chances of microbial spoilage during storage.

IV. DISCUSSION

The findings of the present study demonstrated that ingredient composition significantly influenced the sensory quality and acceptability of the developed instant vegetable soup powders. Among the three formulations, Sample B achieved the highest scores for appearance, color, aroma, taste, mouthfeel, and overall acceptability. The enhanced acceptability of Sample B may be attributed to the balanced combination of corn starch, tomato powder, and maltodextrin, which contributed positively to flavor, texture, and consistency. Similar observations have been reported in previous studies on dehydrated soup formulations where ingredient balance played an important role in determining consumer preference (Fellows, 2017).

Sample A contained a comparatively higher proportion of corn starch, resulting in a thicker consistency but lower flavor intensity. In contrast, Sample C contained a higher amount of tomato powder and maltodextrin, which improved color and flavor but slightly reduced the desired thickness and mouthfeel. These observations suggest that proper optimization of thickening agents and vegetable powder concentration is essential for developing acceptable instant soup products.

The ANOVA results revealed statistically significant differences among the formulations for all sensory attributes, as the p-values were below 0.05. This confirms that variation in ingredient composition had a direct effect on the sensory characteristics of the soup powders. Similar findings have been documented by Lawless and Heymann (2010), who emphasized the importance of statistical analysis in determining consumer acceptability of food products.

The reconstitution behavior of the optimized soup powder indicated good instant properties. The powder dispersed uniformly in hot water without lump formation and produced a smooth and homogeneous consistency. Proper gelatinization of starch during heating contributed to the desirable viscosity and mouthfeel of the soup. Additionally, the attractive orange-red color observed after reconstitution was due to the presence of carrot and tomato powders, which enhanced the visual appeal of the final product.

Nutritional evaluation showed that the optimized formulation provided a balanced nutritional profile containing carbohydrates, protein, dietary fiber, vitamins, and minerals. The high carbohydrate content was mainly contributed by corn starch and maltodextrin, which functioned as thickening and bulking agents. Carrot powder contributed significantly to vitamin A content because of its β-carotene content, while tomato powder enhanced vitamin C and antioxidant potential. The inclusion of vegetable powders therefore improved both the nutritional and functional value of the product.

The proximate composition analysis revealed low moisture content in the optimized soup powder, which is highly beneficial for storage stability. Low moisture levels help minimize microbial growth and reduce the occurrence of undesirable chemical reactions during storage. Similar observations have been reported by Mathlouthi (2001), who explained that low water activity improves the shelf stability of dehydrated food products.

Packaging also plays a crucial role in maintaining product quality during storage. Exposure to moisture, oxygen, light, and elevated temperatures may result in caking, oxidation, flavor deterioration, and nutrient loss. Therefore, the use of packaging materials with good moisture and oxygen barrier properties, such as laminated aluminium foil pouches, is recommended to preserve the quality and shelf life of the product (Labuza, 1980).

Overall, the study demonstrated that the optimized instant vegetable soup powder formulation possessed desirable sensory quality, good nutritional value, acceptable reconstitution characteristics, and satisfactory storage stability. Among the tested formulations, Sample B was identified as the most suitable formulation and can be considered a promising ready-to-cook convenience food product.

V. CONCLUSIONS

The present study focused on the development and evaluation of instant vegetable soup powder using selected dehydrated vegetable ingredients and suitable thickening agents. The objective of the study was to formulate a nutritious, convenient, and acceptable instant soup product with desirable sensory and nutritional characteristics.

Three different formulations were prepared by varying the proportions of ingredients such as corn starch, tomato powder, maltodextrin, and vegetable powders. The prepared soup powders were reconstituted with hot water and evaluated for sensory quality using a nine-point hedonic scale by a panel of twenty members. Sensory attributes including appearance, color, aroma, taste, mouthfeel, and overall acceptability were assessed.

The results of the sensory evaluation indicated that Sample B received the highest scores for most sensory attributes, particularly taste, color, and overall acceptability. Statistical analysis using one-way analysis of variance (ANOVA) showed that the differences among the three formulations were statistically significant ($p < 0.05$). This confirmed that the variation in ingredient composition had a noticeable influence on the sensory quality of the developed soup powders.

Nutritional analysis of the optimized soup powder indicated the presence of important macronutrients such as carbohydrates, protein, dietary fiber, and minerals. The product contained low moisture content, which is beneficial for enhancing the storage stability of dehydrated food products. The inclusion of vegetable powders such as carrot and tomato contributed to the nutritional quality by providing vitamins, minerals, and natural antioxidants.

The proximate composition analysis revealed that the optimized soup powder contained a high proportion of carbohydrates due to the presence of starch-based ingredients, while protein, fiber, and mineral content were derived mainly from vegetable ingredients. The low moisture content of the powder indicates good potential for extended shelf life and improved storage stability when properly packaged and stored.

Overall, the study demonstrates that the developed instant vegetable soup powder formulation is nutritionally beneficial, sensory acceptable, and convenient for consumption. The optimized formulation can serve as a ready-to-use product that meets the increasing demand for quick and nutritious food options.

Conflicts of Interest

There is no conflict of interest regarding the publication of this paper.

Data Availability

The data used and generated during this research work are available from the corresponding author upon reasonable request. The study data include sensory evaluation scores, statistical analysis results, and formulation details related to the development of instant vegetable soup powder. Since the study was conducted as part of an academic minor research project of diploma students, the datasets are not stored in any public repository; however, relevant data can be shared for research and educational purposes when requested.

Declaration of Generative AI and AI-Assisted Technologies in Scientific Writing

Nothing to disclose.

REFERENCES

[1] Abdel-Haleem, A. M. H., & Omran, A. A. (2014). Preparation of dried vegetarian soup supplemented with some legumes. Food and Nutrition Sciences, 5(22), 2274–2285.

[2] Abeysinghe, C. P., & Illeperuma, C. K. (2006). Formulation of an MSG-free instant vegetable soup mix. Journal of the National Science Foundation of Sri Lanka, 34(2), 91–95.

[3] Amerine, M. A., Pangborn, R. M., & Roessler, E. B. (1965). Principles of sensory evaluation of food. Academic Press.

[4] AOAC. (2019). Official methods of analysis of AOAC International (21st ed.). AOAC International.

[5] Ares, G., & Varela, P. (2022). Methods in consumer research: Volume 2, alternative approaches and special applications. Woodhead Publishing.

[6] Farzana, T., Mohajan, S., Saha, T., Hossain, M. N., & Haque, M. Z. (2017). Formulation and nutritional evaluation of a healthy vegetable soup powder supplemented with soy flour, mushroom, and moringa leaf. Food Science & Nutrition, 5(4), 911–920.

[7] Fellows, P. J. (2017). Food processing technology: Principles and practice (4th ed.). Woodhead Publishing.

[8] Islam, M., Sarker, M. N. I., Islam, M. S., Prabakusuma, A. S., Mahmud, N., Fang, Y., Yu, P., & Xia, W. (2018). Development and quality analysis of protein enriched instant soup mix. Food and Nutrition Sciences, 9(6), 663–675.

[9] Labuza, T. P. (1980). The effect of water activity on reaction kinetics of food deterioration. Food Technology, 34(4), 36–41.

[10] Lawless, H. T., & Heymann, H. (2010). Sensory evaluation of food: Principles and practices (2nd ed.). Springer.

[11] Mathlouthi, M. (2001). Water content, water activity, water structure and the stability of foodstuffs. Food Control, 12(7), 409–417.

[12] O'Mahony, M. (1986). Sensory evaluation of food: Statistical methods and procedures. Marcel Dekker.

[13] Potter, N. N., & Hotchkiss, J. H. (1995). Food science (5th ed.). Springer.

[14] Rahman, M. S. (2007). Handbook of food preservation (2nd ed.). CRC Press.

[15] Ranganna, S. (2009). Handbook of analysis and quality control for fruit and vegetable products (2nd ed.). Tata McGraw-Hill Publishing.

[16] Sagar, V. R., & Kumar, P. S. (2022). Recent advances in drying and dehydration of fruits and vegetables: A review. Journal of Food Science and Technology, 59(3), 1–14.

[17] Singh, R. P., & Heldman, D. R. (2014). Introduction to food engineering (5th ed.). Academic Press.

[18] Srilakshmi, B. (2018). Food science (7th ed.). New Age International Publishers.

[19] Sun-Waterhouse, D. (2011). The development of fruit-based functional foods targeting the health and wellness market: A review. International Journal of Food Science & Technology, 46(5), 899–920.