ID: GAURJ-26-012

Instant and functional soup mixes: Formulation, nutrition, functionality and shelf stability - A comprehensive review

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Received: 30/09/2026 Accepted: 15/10/2026

ABSTRACT

Growing consumer demand for convenient meals and healthier food options has created interest in instant and functional soup mixes. This review evaluates soup-mix formulations, nutritional composition, functional properties, and shelf life. A systematic review was conducted of peer-reviewed studies published between 2013 and 2026 in major scientific databases. Findings indicate that incorporating millets, legumes, vegetable powders, and bioactive compounds can increase protein, dietary fibre, vitamins, minerals, and antioxidant content. For context, IFCT 2017 reports that raw finger millet provides 7.2 g protein, 11.2 g total dietary fibre, and 364 mg calcium per 100 g, while raw Bengal gram dal provides 21.55 g protein and 15.15 g total dietary fibre per 100 g. In one millet-based composite flour study, adding cowpea leaves, carrot, pumpkin seed, and skimmed milk powders was associated with higher protein, crude fibre, calcium, and vitamin A than in millet flour alone. Millet-based formulations were reported to be more nutritious than traditional formulations. Key functional properties included water absorption capacity of 2.52–9.97 g/g, solubility of upto 76%, and viscosity of 7,000 cP or greater; these properties influence rehydration and sensory quality. Product quality was also affected by processing methods, including drying, grinding, and blending. Shelf life was associated with moisture content below 10% and water activity below 0.6, conditions that facilitate microbial safety. Soup mixes may help mitigate nutrient deficiencies and chronic lifestyle diseases. However, differences in processing techniques and the lack of standardized methods remain challenges for developing consistent functional soup products.

Keywords: Instant soup mix, nutrient deficiencies, lifestyle diseases, nutritional composition, functional properties, shelf stability

INTRODUCTION

Modern trends in diet tend to be strongly determined by rapid urbanization, changes in lifestyle and women's employment. Due to busy schedules and not sufficient time to prepare food, market demands products like ready to eat, ready to cook and instant foods. The products are perfectly suited for today's lifestyle as they simplify preparation and have an extended shelf life. The rationales for the development and increasing consumption of ready to cook and ready to eat products such as soups and puddings are scientific and technological developments, work automation, extremely busy schedules of people and increasing consciousness of optimal nourishment (Verma and Chawla, 2020). The instant soup market is projected to be $10,425.71 million in 2025. The market will likely expand to USD 13,327.34 million in 2032 at a CAGR of 3.6%, attributed to rising consumer demand for fast food products. Dehydrated and powdered food products have witnessed significant development in the last two decades. Shelf stable powder products with satisfactory sensory and nutritional properties are now feasible due to innovative

food processing technologies featuring dehydration, spray drying and freeze drying. Soup mixes are among the most common powder-based food products attributable to their good taste, easy preparation and wide usability. Instant soup powders are indeed an easy meal choice as they do not call for much effort in their preparation and typically require just the addition of hot water. The soup mixes generally consist of dried or powdered preparations with vegetables, cereals, pulses, seasonings and flavour enhancers, to be prepared by simply adding water.

Different types of soup mixes vary according to the preparation techniques employed to make them. These include dehydrated soup mixtures, ready to cook soup bases and instant soup powder. Instant soup powders require only hot water to prepare, while dehydrated soup mixes and ready-to-cook soup bases may need to be cooked before serving (Ahmed *et al.,* 2024).

Traditional soup mixes have been developed especially with taste and convenience in mind. However, many traditional soup mixes are inadequate in nutrients and relatively high in sodium. Functional soup mixes are rich in wholesome proteins, dietary fibres, nutrient rich materials and bioactive components that may be beneficial for boosting nutritional value and maintaining health. Micronutrient malnutrition is still one of the most prevalent health problems. Essential micronutrients such as zinc, vitamin A and iron, when incorporated into functional foods, may significantly correct deficiencies in important nutrients. Therefore, nutritionally enriched functional soup mixes can be an effective means to deliver the essential micronutrients by means of convenient foods (Venkatesh *et al.,* 2021).

The increasing incidence of lifestyle diseases such as diabetes, obesity, high blood pressure and heart disease, along with the problems arising from deficiencies of vital nutrients are another significant factor contributing to global health care problems. Many people believe that a modification in diet can be crucial to prevent these diseases as well as in coping with them. Soup mixes that contain high fibre, low sodium, high quality protein and bioactive substance content may help form healthy eating habits and combat diseases.

This review aims to analyse the development of functional soup products, study the evolution of soup mixes as convenient foods and suggest ways in which they can be used for addressing lifestyle diseases and deficiencies of micronutrients. It also aims to identify gaps in research and opportunities to develop functional soup mixes with improved nutritional value.

MATERIAL AND METHODS

This review employed a structured systematic literature review approach to ensure clarity, consistency and scientific integrity throughout. The process involved identification of various databases, development of search strategies, proper screening of studies and synthesis of findings. Various literature was reviewed on instant and functional soup mixes including formulation, nutritional composition, functional properties, processing methods and shelf stability. A detailed literature search was performed using the major scientific databases such as PubMed, Scopus, Web of Science and Google Scholar. Various studies were identified using the keywords like “instant soup mixes”, “functional soup mix formulation”, “nutritional composition of soup mixes”, “dehydrated food products”, “functional properties of soup mixes” and “shelf stability of soup mixes”. Peer reviewed journal articles, review papers and book chapters published in English from 2013 to 2026 that discussed formulation, ingredient functionality, nutritional aspects, processing methods and storage stability of soup mixes were studied. Studies on functional ingredients such as millets, legumes, vegetable powders and bioactive compounds were also studied. Editorials, conference abstracts without full text, non-peer reviewed sources and studies not related to soup mixes were excluded. The screening process was conducted according to PRISMA guidelines. Initially, 268 records were identified in all databases. Duplicates (n=52) were removed and 216 records were screened by title and abstract, resulting in the exclusion of 127 irrelevant studies. Finally, 89 full text articles were included for final review. Data was extracted manually and studies were categorized into formulation strategies, functional ingredients, processing techniques, nutritional composition, functional properties and shelf-life stability.

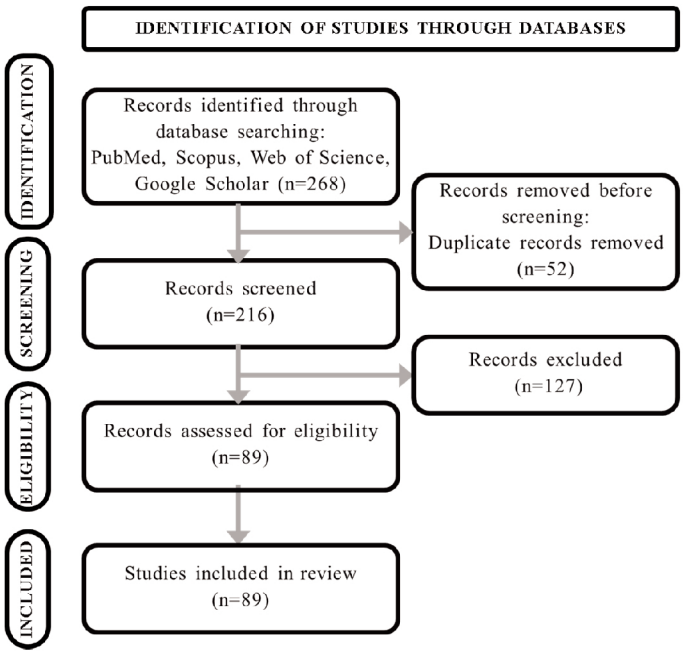


Fig 1: PRISMA Flow Diagram

RESULTS AND DISCUSSION

From the findings sufficient information was obtained about formulations, nutritional composition, functionality and shelf life of instant and functional soup mixes. The selected publications show various advances made in the development of nutritionally enhanced soup mixes to satisfy the modern demand. It has been found that functional ingredients such as millet, legume, vegetable powders and other bioactive compounds help to enhance nutritional content and improve overall health benefits. In addition to that, different processes used and ingredient compositions also affect the physical, chemical and sensory attributes of the final soup mix. The following sections below will detail current research trends and technological developments in soup mix.

1.1. Formulation of soup mixes

1.1.1. Need for Soup Mix Formulation

The creation of soup mixes is an essential element in manufacturing consumer friendly and nutritionally balanced foods that have stable properties. The correct composition ensures compatibility of the ingredients, leading to desirable characteristics, including taste, consistency, viscosity and nutritional properties. According to Fellows (2017), the shelf life, reconstitution characteristics and overall performance depend on the formula used in food manufacturing. Chong *et al.* (2013) suggest that for stability, quality and acceptability to be assured, the formula for dehydrated foods should take into account interactions between ingredients.

Another factor to consider when you develop soup mixes is ingredient compatibility. The combination should work to strengthen each other's physical and sensory characteristics to ensure the final product is appealing. The interaction among the starches, proteins, vegetable powder, and seasoning plays a significant role in the viscosity, texture and stability of the soup mixes. The functional characteristics of food powders depend on ingredient compatibility, particle characteristics and system dynamics (Onwulata, 2019). The proper mixture of ingredients is important to attain the desired level of thickness, texture and consistency upon reconstitution. Another significant aspect of food powders is sensory acceptability. The acceptability of soup mixes largely depends on sensory characteristics such as taste, flavour, appearance and mouthfeel. As noted by a study by Meilgaard *et al.* (2016), the sensory perception, including flavour and texture, is largely based on the approval of consumers about food products.

However, when developing a soup mix, nutrition must be considered along with sensory attributes. Nutrition is very stage specific throughout life and food products should be formulated to suit this need (Brown *et al*., 2017). The IDF (2021) says, The effective management of diabetes includes a key step of changing dietary intake, especially the management of the quality and quantity of carbohydrates. In conclusion, a good soup mix needs an all inclusive approach that considers nutritional factors, sensory science and

ingredient functionality. These factors need to be optimised to develop soup mixes that will satisfy customer demands, in terms of high quality, sensory attributes and health benefits.

1.1.2. Methods Based on Functional Formulation

As demand for health promoting foods increases, the manufacture of soup mixes has evolved to include ingredients other than the traditional ones which provide additional health benefits. High protein soup mixes are made with protein sources such as legumes, pulses, soy, dairy and fish protein hydrolysates. These soups are required for people whose intake of protein is greatly increased such as in children, the elderly and those with malnutrition problems. Research shows that adding the above mentioned ingredients significantly improve the health benefits and properties of the soup mixes (Burd & Murphy, 2022). The formulated vegetable soup powder was improved with the addition of soy flour, mushroom powder and moringa leaf powder. It was reported that the inclusion of soy flour, mushroom powder and moringa leaf powder caused a great enhancement in the protein content of the vegetable soup powder, thus establishing the formulated vegetable soup powder as a nutrient packed food item. The addition of soy flour in mushroom and moringa based soup powders resulted in an increase in protein content of the formulated soup powder from 10.66% to almost 19.97% (Farsana *et al*., 2017).

Dietary fibres is very important for proper digestion and have been proven to be useful in preventing various chronic diseases like diabetes and heart diseases. Foods with high fibre content are commonly used in high fiber soup recipes and these foods include whole grain, millets, oats, vegetable powders and legume flours. According to studies, consumption of instant soups prepared from millets increases the dietary fiber and antioxidant content in comparison to commercial soup mixes. The study on the role of developing high dietary fiber content in the development of instant soups formulated from millets, like finger millet and pearl millet, it was noted that adding the mentioned foods increases the fiber content, minerals and antioxidants in instant soups compared to commercial soups. Moringa leaf and soybean flour to vegetables improves the dietary fibre content in vegetable soup powders. This study proves that adding some plant products improves the nutritional value of instant soups(Farsana *et al*., 2017).

Sodium consumption in excess amounts has been associated with hypertension and other cardiovascular disorders. As a result, low sodium soup recipes have been formulated by lowering the amount of sodium contained in such recipes while incorporating other flavour enhancers, including vegetables, spices and herbs. In a research study aimed at exploring the effects of herbs and spices on low sodium soup recipes, it was noted that the use of ingredients such as garlic, onions, basil and pepper significantly improved the flavour of such soup recipes. Herbs and spices are viable alternatives in flavour enhancement in low sodium soup recipes (Dotsch *et al*., 2017). Research conducted by Desmond (2017) with the aim of investigating the role played by potassium chloride in the improvement of flavour in low sodium soup recipes indicated that potassium chloride is a good alternative flavour enhancement. It was reported that potassium chloride could potentially be used as a substitute to lessen the sodium content of soup recipes without impacting their sensory quality. The potassium chloride might impart a bitter taste in too great a quantity. Other ingredients derived from vegetables like tomato powder, mushroom powder and seaweed are additionally employed in these recipes to add flavour. Vegetables can also be added to provide umami flavours (McClements, 2020).

Gluten free soups are made for patients who are suffering from celiac disease or gluten intolerance. A study regarding the formulation of gluten free mushroom instant soup via the substitution of rice flour with quinoa seed flour showed that the nutritional quality of gluten free mushroom instant soup could be improved *via* the increase in the use of quinoa flour. The nutritional value of the soup, in terms of protein content, crude fibre, minerals, polyphenols and antioxidants, could be increased via the substitution of rice flour with quinoa flour in the production of gluten free instant soups. The sensorial qualities of the soup did not change due to the substitution of rice flour (Saed *et al*., 2023). An investigation regarding the formulation of gluten free fermented instant soup powder using mung bean flour and rice flour demonstrated that the nutritional quality of gluten free instant soup could be increased through the substitution of rice flour with mung bean flour in gluten free instant soups. The sensory acceptability of formulated gluten free instant soup is good, indicating that the nutritional value of instant soup can be improved by replacing rice flour with mung bean flour in the formulation of gluten free instant soups for people with celiac disease (Yildiz and Savlak, 2022).

Studies on the production of nutraceutical instant soup powder using jamun seed powder, fenugreek seed powder, mushroom powder and finger millet flour specially designed for diabetic patients, established that the developed instant soup powder contained higher amounts of

proteins and dietary fibres that would help regulate blood sugar levels. Hence, such instant soup powder can be useful in the nutritional management of diabetes (Ghuse, 2023). High fibre low sodium vegetable soup formulations have been studied and it was observed that if sodium intake is reduced and dietary fibre intake is increased through whole grains, legumes and vegetables, cardiovascular wellness would be enhanced. These formulations contain important nutrients, including antioxidants and soluble fibres, which are associated with healthy lipid profiles and reduced risks of hypertension (Dötsch *et al*., 2017). Studies regarding food compositions in therapy for patients with renal diseases point out the importance of controlling protein, sodium and potassium in foods meant for kidney patients, especially kidney friendly soups that have stable levels of potassium. (Kalantar-Zadeh *et al*., 2020).

Table 1: Functional Role of Ingredients in Soup Mixes

Class	Ingredients	Key Components	Functional Role	Nutritional significance	References
Cereals	Rice flour, Wheat flour, Corn flour	Starch, carbohydrates	Provides bulk, structure and thickening. Improves viscosity	Energy source, moderate protein	Lazaridou & Biliaderis, 2014
Millets	Finger millet, Foxtail millet, Barnyard millet, Kodo millet	Dietary fibre, phenolics, minerals	Enhances viscosity, water absorption and functional properties	High fibre, antioxidants, low glycemic index	Nithiyanantham *et al*., 2019; Gahalawat *et al*., 2024
Pulses and Legumes	Lentil, Chickpea, Green gram, Horse gram	Protein, fibre, micronutrients	Improves texture, emulsification and protein enrichment	15-26% protein, fibre, minerals	Maphosa & Jideani, 2017; Noori *et al*., 2025
Vegetable Components	Carrot, Beetroot, Tomato, Spinach, Broccoli	Vitamins (A, C), antioxidants, pigments	Provides natural colour, flavour and antioxidant activity	Vitamin C, β carotene, phenolics	Ying *et al*., 2021; Suvetha *et al*., 2025
Leafy Vegetable Powders	Moringa leaf powder	Iron, calcium, fibre, protein	Enhances nutrient density and functional value	Increased protein (~13.67%), micronutrients	Ansari *et al*., 2020
Root & Tuber Powders	Potato, Sweet potato	Starch	Thickening, improves mouthfeel and consistency	Carbohydrates, energy	Chandrasekara & Josheph, 2016
Protein Sources (Plant-based)	Soy protein isolate, Pea protein	High quality protein	Protein enrichment and improves emulsification	Essential amino acids	Magdum *et al*., 2026; Farzana *et al*., 2017
Protein Sources (Animal based)	Milk powder, Whey protein	Casein, whey proteins	Enhances creaminess, texture and protein quality	High biological value protein	Jamshidvand *et al*., 2023
Mushroom Powder	Edible mushrooms	Protein, umami compounds	Improves flavour (umami), enhances acceptability	Protein, bioactive compounds	Farzana *et al*., 2017

Class	Ingredients	Key Components	Functional Role	Nutritional significance	References
Dietary Fibre Additives	Inulin, Oat fibre (β glucan)	Soluble fibre	Improves viscosity, stabilizes texture, acts as prebiotic	Cholesterol reduction, glycemic control	Irshad, 2025; Lazaridou & Biliaderis, 2014
Probiotics (Encapsulated)	*Lactobacillus spp.*	Beneficial microorganisms	Enhances gut health but requires encapsulation for stability	Digestive health benefits	Ranadheera *et al*, 2017
Natural Colourants	Beetroot powder, Turmeric	Betalains, curcumin	Improves visual appeal	Antioxidant activity	Shahidi & Ambigaipalan, 2018
Seasonings & Flavor Enhancers	Garlic, Onion, Basil, Pepper	Essential oils, volatile compounds	Enhances taste, aroma and palatability	Minimal nutritional role but improves intake	Dötsch *et al*., 2017
Salt Replacers	Potassium chloride	Minerals	Reduces sodium while maintaining taste	Supports cardiovascular health	Desmond, 2017
Umami Enhancers	Tomato powder, Mushroom powder, Seaweed	Glutamates	Improves flavor perception in low sodium soups	Enhances palatability	Hayabuchi *et al.* (2020)
Preservatives	Natural/chemical preservatives	Antimicrobial agents	Extends shelf life, prevents spoilage	Maintains product safety	McClements, 2020
Thickening & Stabilizing Agents	Xanthan gum, Guar gum, Modified starch, Maltodextrin	Hydrocolloids	Improves viscosity, stability and reconstitution	Texture enhancement	Gao *et al*., 2024

1.1.3 Process Optimization for Soup Mix Formulation

Some measures that are applied when making soup mixes to improve the quality and shelf life of products include the processes of drying, grinding, mixing and packaging. There are some methods and techniques that should be considered while manufacturing soup mixes to ensure preservation of nutrients, improvement of the rehydration capability and overall product quality. The initial step of making soup mix is washing the selected raw material, which can be cereals, pulses, vegetables, or spices. As a result of washing, dust, stones and broken seeds are removed from the raw materials. The process ensures that the food safety of the product, as well as its quality and prevention of contamination during processing, is ensured. In this respect, a study demonstrates that appropriate washing of raw food materials decreases the amount of contaminants of physical, chemical and biological nature before additional processing (Oghbaei and Prakash, 2016). In the study related to cereal processing, one finds out that harvesting grains should be washed thoroughly in order to remove dust, weed seeds, insects and damaged kernels because not cleaned grains may be contaminated by bacteria, insects and fungi during storage and further processing (Sinkovic *et al*., 2023).

Blanching is a technique of briefly immersing vegetables in boiling water or hot steam and then rapidly cooling them. Blanching will neutralise enzymes responsible for spoilage, preserve colour, improve quality and texture and reduce microbial load. Studies on vegetable processing have shown that blanching is effective in inhibiting enzymatic reactions that may lead to browning of plants. In one of the studies on blanch assisted drying, blanching was found to reduce the activities of polyphenol oxidase and peroxidase

to 76% (Nwankwo and Osinachi, 2021). Such inhibition prevented the development of undesirable colour and improved quality (Adetoro *et al.,* 2021).

A study on vegetable dehydration revealed that blanching was important in increasing the safety of the dried product against microbial contamination (Marwati and Wanitha, 2021).

Drying is an important step in the preparation of soup powder mixes. This process reduces the moisture content and therefore improves shelf life. Research on food dehydration shows that drying will ensure that moisture content is reduced below a point where microbial growth will thrive thus increasing stability and prolonging their lifespan (Natumanya *et al.,* 2021). In traditional drying with trays, food items are placed in trays and dried with hot air. This technique is primarily employed in the production of blends for soups of vegetables, cereals and pulses. drying for a long time so that the heat sensitive nutrients are not lost in the process. Fellows (2017) says that the tray drying technique is recommended for solid foods such as grains and vegetables because the process will be effective in drying by cutting and spreading these materials uniformly. The effect of high temperature on food products may be long term influencing their nutritional value and sensory desirability. During the drying process some heat sensitive nutrients including some vitamins such as vitamin C, may break down.

Moreover, according to research by Chong *et al*. (2013), failure to control drying conditions may lead to undesirable changes such as discolouration, shrinkage and textural hardening in the product. Spray drying is one of the most common methods of moisture removal from liquid or semi liquid foods. This technique breaks the food into very small pieces and puts it in a hot air chamber. Fine powders are formed by the rapid evaporation of water. Spray drying is used by many manufacturers of powdered soups and flavour enhancers (Mujumdar, 2014). If not controlled properly, heat sensitive components can be damaged by heat. Another type of drying technology is lyophilisation or freeze drying. This technology involves freezing the food and then drying it in a vacuum state through sublimation. It may cost more, but the process is far better at retaining flavour, colour and nutrition than any other dehydration method. The extremely low temperatures used during the process make freeze drying one of the best processes for preserving the food quality in terms of flavour and nutritional content (Fellows, 2017). Additionally, Chong *et al.* (2013) found in their research that freeze dried foods had negligible shrinkage and porosity, improving their ability to be reconstituted.

After drying, the materials are pulverised or ground to a small particle size by means of a hammer mill. The grinding process reduces the size of the material particles and thus makes it easier to mix the material in the soup. Size reduction is an important unit operation in the food industry since it improves the properties of mixing, heat transfer and mass transfer among food materials (Fellows, 2017). The particle size will be a critical factor in how the instant soup mixes behave upon rehydration. As per the study by Ueda *et al*. (2023), small particle sizes result in improved hydration and spread ability; this is especially important for obtaining the desired texture and mouthfeel during rehydration of the products. According to Singh & Heldman (2018), the quality, appearance and flavour of the product depend on the proper control of the type of equipment used for grinding, milling speed and milling duration.

Sieving is performed to achieve uniformity in particle sizes. Uniformity of particle size is essential to attain the desired textural qualities, dispersibility and reconstitution of the final product – soup mix (Fellows, 2017). It is also worth noting that the same observation was made by Singh & Heldman (2018), where the authors stated that the uniformity of particle size affects the flow, mixing, and reconstitution of the food system. In another study by Peleg (2017), it was shown that uniform particles in terms of narrow distribution of particle size result in good dispersibility and flowability and thus they become more important for instant food products. Sifting also prevents segregation of ingredients during storage, which means the soup mix is homogeneous in addition to all this. Particle size is important in getting a high-quality product after reconstitution.Then ingredients are well mixed in their dry form in such equipment as a ribbon blender. Blending is done to ensure uniform distribution of components and thus, the final product is uniform in composition throughout (Fellows, 2017). According to Singh and Heldman (2018) blending is also very important in maintaining the homogeneity of the product and in the efficiency of the processing system in dry food products. Moreover, the quality of the powder mixture has been identified as a significant factor in the final product, as (Fitzpatrick, 2019) has demonstrated in the research. The quality of a powder mixture was governed by various parameters such as particle size distribution and density, according to this study.

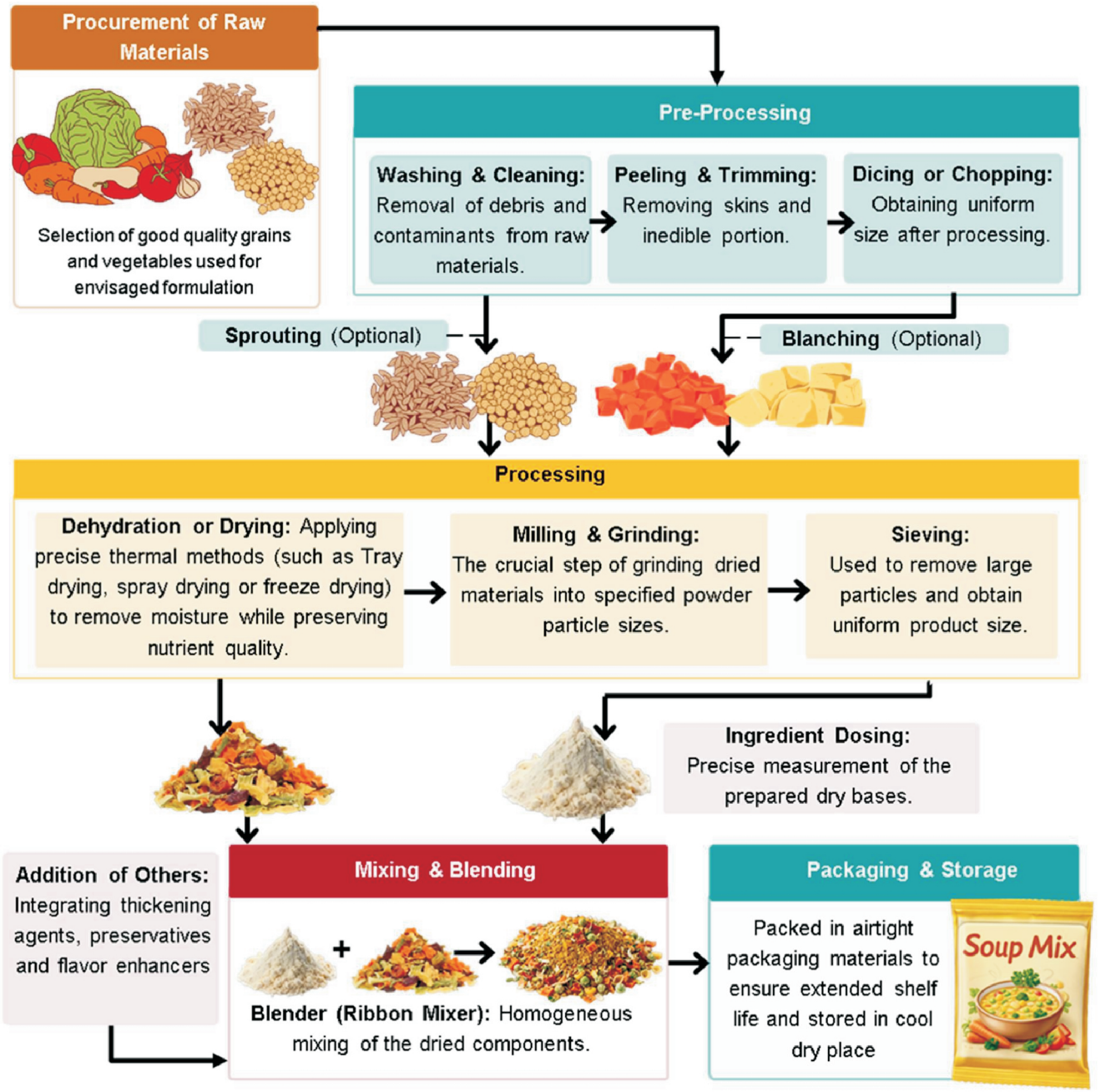


Fig 2: Schematic Representation-Process Optimization of Instant Soup Formulation

(Graphical elements were created and assembled by the authors using BioRender (RRID:SCR_018361) for figure illustration and graphical design. The scientific content, concepts, labels, organization, and interpretation were developed by the authors.)

1.1.4 Nutritional composition and their effect on processing

The nutritional composition of raw materials used in soup formulations is important for understanding their processing behaviour, stability and functionality. These nutrients are proteins, carbohydrates, fats, vitamins and minerals. These nutrients are crucial for maintaining the soup mix with a satisfactory texture, viscosity, rehydration properties and shelf life. The protein content of the soup mixes can be improved by adding protein sources like legumes, pulses, soy protein and dairy proteins. The study conducted by Damodaran (2017) shows that functional properties of proteins like solubility, water holding capacity and emulsifying ability are important in determining the

performance of protein rich soup mixes. More soluble proteins may improve the smoothness of the reconstituted soups. Protein solubility is one of the most important functional attributes affecting emulsification, foaming and dispersion behaviour in food systems (Foegeding and Davis, 2016). The emulsifying property of the proteins may also improve the sensory quality of the soup mixes. In the process of rehydration of dried soup mixes, starch and some polysaccharides absorb large quantities of water. Polysaccharides possess a high water binding capacity, which is crucial for achieving longer stability and improved final texture of reconstituted soup (Gao, 2024). Carbohydrates are important for gel formation and maintaining the gel stability of the soup mixes.

Starches upon cooling forms gels which creates good texture and mouthfeel. BeMiller (2019) states that gelatinized starch creates a structural network that aids in developing the viscosity and structural integrity in soup. Simple sugars will also impart sweetness and overall flavor to the soup. The simple sugars can react with amino acids in the presence of heat during the processing of the soups. The reaction can produce the desirable flavor of the soups. However, excessive reaction can deteriorate the quality (Damodaran, 2017). Another aspect is the influence of the carbohydrate composition on the hygroscopicity of the powdered soup mixtures. Soups high in simple sugars can readily react with moisture in the surrounding. This can lead to a decrease in the quality of the soups (Bhandari *et al.,* 2013). Fats add flavor and texture to the dish and give energy. They contain a lot of beneficial fatty acids which are mainly found in nuts, seeds and vegetable oils. Unsaturated (omega 3 and omega 6) fatty acids are good to health and can be used in preparing soup mix formulations. Along with the nutritional health benefits that come with fats, they also help give a creamy mouthfeel in emulsified foods. Like soup mixes, which are made to be creamy. Fats are necessary for emulsification and aiding in the even distribution of ingredients within emulsions (McClements, 2020). One of the major barriers for the use of fat in soup mixes is lipid oxidation which can create off flavour or rancidity (Choe and Min, 2016). Lipid oxidation can lead to quality deterioration by producing unwanted flavours and reducing the shelf life of the product. Oxidation is caused by a number of factors such as oxygen, light, temperature and the presence of unsaturated fatty acids. Limitations for some fat soup mixes include stickiness, poor flow and oxidation during storage (Bhandari *et al.,* 2013).

Normally, vitamin A comes from vegetables rich in carotenoids, like carrots and pumpkins. which is important for vision and for resisting infection. The B complex vitamins such as thiamine, riboflavin and niacin, are found in cereal grains and legumes, which are used in soup mixes. The B vitamins are involved mainly in energy metabolism. Heat processing causes significant reduction of vitamin B (Saini *et al.,* 2020). Vitamin C is an essential antioxidant that is very unstable and so is easily destroyed. Therefore, the freeze-drying processes (Zhang *et al.,* 2021) are the best way to dry vitamin C for storage. Minerals such as iron, calcium, zinc and sodium are needed in the various physiological processes. Iron and zinc play an important role in supporting the immune system and helping the body carry oxygen. According to Hurrell and Egli (2017), the amount of iron absorbed by the body depends greatly on the foods included in the diet. Across the world, iron deficiency continues to be one of the most common nutrition related health concerns. Calcium is another essential nutrient that helps maintain bone health and supports muscle and nerve functions. The addition of calcium can improve the nutritional quality of the product. This is important in fortified soups or milk based soup formulations. The World Health Organisation mentions that higher concentrations of sodium consumption can increase the risk of high blood pressure and heart diseases (WHO, 2023). Another important factor in the quality of soup. Phytochemicals are bioactive compounds found in plants with antioxidant, anti-inflammatory, and disease prevention properties. These compounds can inhibit the formation of free radicals and therefore prevent oxidative stress. Adding turmeric, garlic, spinach and herbs to soup mixes can improve both the flavour and therapeutic value (Ranadheera *et al.,* 2017). Probiotics are live microorganisms that, when ingested in sufficient numbers, provide health benefits to the consumer. But the major challenge is to keep the microorganism viable in its dry form. Microencapsulation techniques can improve the survival of probiotic bacteria during processing and storage.

By using this method probiotic bacteria can be protected from adverse environmental conditions and can be incorporated into soup powders (Anal and Singh, 2017). whereas Prebiotics are foods that promote the growth of probiotic bacteria in the human body. Prebiotics like inulin, resistant starches and dietary fibers can be added into soup mix formulations. The use of these components in formulating functional soups improves the nutritional and functional properties (Slavin, 2018).

Table 2: Nutritional composition reported for selected instant soup mixes

Nutritional Parameter	Importance in Soup Mixes	Reported Range (per 100g dry mix)	Typical Value per 25g Serving	References
Energy (kcal)	Contribute to dietary calories	300-450 kcal	75-120 kcal	Bhandari *et al*., 2013:Sinchaipanit *et al*, 2023
Carbohydrates (%)	Energy source & contributes to thickness	50 -70%	12-18%	Bhandari *et al*., 2013:Shilpa *et al*, 2026
Protein (%)	Essential for body repair and nutrition, Improves satiety	8-20% (higher in fortified soups)	2-5%	Damodaran, 2017: Sinchaipanit *et al*, 2023
Fat (%)	Enhances flavor, mouthfeel and energy density	5-15%	1-4%	McClements, 2020
Crude Fiber (%)	Improves digestive health, Adds functional benefits	2-10%	0.5-2.5%	Gao, 2024
Sodium (mg)	Enhances taste but linked to health concerns	500-1500	200-600	Hurrell and Egli, 2017: Mohamed *et al,* 2020
Potassium (mg)	Helps balance sodium and supports heart health	200-600	50-150	Hurrell and Egli, 2017: Mohamed *et al*, 2020
Calcium (mg)	Important for bone health	50-200	10-50	Hurrell and Egli, 2017: Mohamed *et al*, 2020
Iron (mg)	Prevents anemia, Important in fortified soups	2-10	0.5-2.5	Hurrell and Egli, 2017: Mohamed *et al*, 2020
Vitamins (mg/µg)	Enhances nutritional value; prone to loss during drying	Variable (depends on fortification)	Variable (depends on fortification)	Saini *et al*., 2020; Zhang *et al*., 2021

1.1.5 Functional properties of soup mixes

Processing behavior, storage stability, reconstitution qualities and sensory quality is influenced by the functional properties of soup mixes. Instant soup mixes can be easily reconstituted in hot water to form a homogenous product with good texture and mouth feel. Properties such as moisture content, water activity (aw), swelling index, water absorption capacity, dispersibility, solubility, density, flowability and viscosity should be evaluated. These factors influence shelf life during handling, processing and packaging.

Moisture content affects the stability and shelf life of soup mixes. The low moisture content of soup mixes helps to reduce microbial growth and prevents chemical and enzymatic reactions. Research shows that storage stability is high with soup mixes containing moisture contents below 5-10%. Freeze dried formulations have moisture contents of 2.5-3.4% which can improve storage stability and reduce spoilage (Kaur and Aggarwal, 2023). Water activity (a_w) is closely related to moisture content because it indicates the amount of free water available for growth of microorganisms. The microbial stability of soup mixes with $a_w < 0.6$ is best. The water activity of the baby corn soup mixes was found to be around 0.423 which indicated good storage stability (Singh and Kaur, 2020). Also low water activity in dried food powders inhibits microbial growth and preserves product quality during storage (Gayathry and John, 2024).

The hydration properties of instant soup mixes are identified by the swelling capacity and the water absorption

capacity (WAC). These properties show the ability of the powder to absorb water and swell during reconstitution. Swelling capacity is mainly due to the starch and fibre components present in cereal or vegetable powders. According to Fournaise *et al.* (2021), swelling capacity varies between 3.55-10.16% depending on the formulation and processing methods. Water absorption capacity is another parameter that shows the amount of water that a powder can hold. WAC for baby corn soup mixes was found to be 9.95 g/g showing high water absorption capacity and helps in thickening during reconstitution (Singh and Kaur, 2020). Other studies show that WAC ranges from 2.5-9.6 g/g depending on the composition and drying method (Gayathry and John, 2024).

Dispersibility and solubility are two important properties which influence the reconstitution ability of soup mixes. Dispersibility is the ability to disperse uniformly without clumping and solubility is the amount of soluble solids released into the liquid. Higher the solubility, quicker the rehydration and smoother the texture of the final soup. Research on soup mixes reported that a solubility index around 76% improves solubility and dispersibility which is achieved depending on the ingredients and drying methods used (Gayathry and John, 2024).

Bulk and tapped densities are physical properties which play an important role in packing, storage and transportation efficiency. Bulk density is the weight of powder per unit volume while tapped density is the density after mechanical tapping which settles down the particles. Bulk and tapped densities of baby corn soup mixes were found to be 396.97 kg/m³ and 536.73 kg/m³ respectively which indicates the packing characteristics of the powders (Singh and Kaur, 2020). Similar studies on soup mixes reported bulk density values ranged from 0.35-0.43 g/cm³ while the tapped densities ranged from 0.67-0.77 g/cm³ depending on the formulation and drying method. These factors directly impact packaging design, storage conditions and flow behaviour of soup mixes (Gayathry and John, 2024).

Flowability is another important property of soup mixes. The flow behaviour of soup mixes can be evaluated by Carr's index, Hausner ratio and angle of repose. Carr's index is a measure of the compressibility which is calculated from bulk and tapped densities while Hausner ratio shows how cohesive the particles are. The flowability of the soup mixes with Hausner ratios of 1.1-1.25 is generally good, while a higher Hausner ratio indicates poor flowability (Ishrat *et al*., 2020). Studies conducted by Gayathry and John (2024) suggest that the Carr index between 26-55% and Hausner ratios between 1.36-2.34 depends on the degrees of cohesiveness and flowability. A useful parameter to study the flow characteristics is the angle of repose. Low angle of repose of soup mixes indicates better flowability. Tomato soup mix exhibited lower angle of repose and improved flowability than cream soup powders (Tahmaz, 2024).

Viscosity is an important rheological property of soup mixes. The viscosity of soup depends on the presence of starch, protein, hydrocolloids and other thickening agents that hydrate and swell during cooking. Starch rich soup mixes with viscosities exceeding 7,000 cP exhibited higher thickening capacity during reconstitution. The rheological property of soup often exhibits shear thinning characteristics i.e. viscosity decreases with increasing shear rate which enhances mouthfeel (Kumari *et al*., 2023). These functional properties are important in optimising formulations of soup mixes for storage stability and processing for achieving desired textural and sensory quality upon reconstitution.

Table 3: Functional Properties of Soup Mixes and Their Importance

Functional Property	Definition	Importance in Soup Mixes	Reported Values	References
Moisture Content (%)	Amount of water present	Affects shelf life, microbial stability and caking behavior	5-10% in instant soup powders	Kaur and Aggarwal, 2023
Water Activity (a_w)	Measure of free water available for the growth of microorganisms	Determines microbial stability and shelf life	<0.6 for stable powders	Singh and Kaur, 2020
Swelling Index (%)	Ability of powder to swell upon hydration	Influences thickness and mouthfeel	3.5-10.6% depending on formulation	Fournaise *et al*., 2021

Functional Property	Definition	Importance in Soup Mixes	Reported Values	References
Water Absorption Capacity (WAC)	Amount of water absorbed per gram of soup mix	Affects reconstitution, viscosity and texture	2.5-9.6 g/g	Gayathry and John, 2024
Dispersibility (%)	Ability of soup mix to disperse uniformly in water	Prevents lump formation and ensures smooth texture	70-85% dispersibility reported	Gayathry and John, 2024
Solubility Index (%)	Percentage of soluble solids in water	Improves rehydration and uniformity	Up to 76%	Gayathry and John, 2024
Bulk Density (g/cm³)	Mass per unit volume before tapping	Influences packaging and transport	0.35-0.43 g/cm³	Gayathry and John, 2024
Tapped Density (g/cm³)	Density after tapping	Indicates packing and compressibility	0.67-0.77 g/cm³	Gayathry and John, 2024
Carr's Index (%)	Measure of compressibility	Indicates flowability of powder	26-55% (good flow)	Gayathry and John, 2024
Hausner Ratio	Ratio of tapped to bulk density	Evaluates cohesiveness	1.1-1.25 (good flow)	Ishrat *et al*., 2020
Angle of Repose (°)	Angle formed by powder heap	Indicates flow characteristics	25-35° (good flow)	Tahmaz, 2024
Viscosity (cP)	Resistance to flow in reconstituted soup mix	Determines thickness and mouthfeel	7000 cP depending on formulation	Kumari *et al*., 2023).

The reported properties describe different stages of soup-mix performance. Moisture content (5–10%) and water activity (below 0.6) relate to storage stability: moisture indicates the amount of water in the powder, while water activity indicates how much of that water is available to microorganisms (Kaur and Aggarwal, 2023; Singh and Kaur, 2020). During preparation, water absorption capacity (2.5–9.6 g/g), dispersibility (70–85%), and solubility (up to 76%) describe related but distinct behaviours: how much water the mix absorbs, how evenly it disperses, and how much of it dissolves (Gayathry and John, 2024). These measures should be considered together when assessing reconstitution, rather than treated as interchangeable indicators. Bulk and tapped density, Carr's index, Hausner ratio, and angle of repose describe powder handling and packing; viscosity (reported at about 7,000 cP, depending on formulation) describes the thickness of the prepared soup (Gayathry and John, 2024; Ishrat *et al*., 2020; Tahmaz, 2024; Kumari *et al*., 2023). Overall, the table suggests a balance is needed: a mix should remain stable and manageable as a dry powder, disperse and hydrate adequately when prepared, and produce the intended soup thickness.

1.1.6 Reconstitution capacity of soup mixes

Reconstitution capacity is an important quality of instant soup mixes. It affects how well the dehydrated soup mix rehydrates when mixed with water. Several factors influence the reconstitution of soup mixes which include particle size distribution, drying method, ingredient composition and various changes that occur during dehydration. The common parameters used to assess reconstitution capacity include rehydration ratio, water absorption capacity, solubility index, rehydration time, dispersibility and the ability to clump during mixing. These properties together determine how well soup mixes hydrates and distributes in water thereby creating a stable suspension (Zhang *et al*., 2017).

The rehydration ratio indicates how well dried soup mixes

absorb water and regain their original form after drying. It is typically expressed as the weight of the rehydrated sample divided by the weight of the dry sample. A higher rehydration ratio means better water absorption and structural recovery. In instant soup mixes containing dehydrated vegetables and cereal based ingredients, the rehydration ratio is heavily influenced by the porosity of dried material and the degree of cellular damage occurred during drying. Research has found that freeze dried vegetable powders exhibit higher rehydration ratios because their porous structure helps in rapid water absorption and expansion (Ren *et al*., 2024; Chu *et al*., 2023). Similarly studies of various dried vegetables have reported rehydration ratios ranging approximately 2.5-5.0 indicating that processing conditions significantly affect structural recovery during rehydration (Nayi *et al*., 2023). Water absorption capacity (WAC) is closely related to the rehydration ratio. It reflects how well the soup mixes binds and holds water which largely depends on hydrophilic components such as proteins, starches and dietary fibers. Soup mixes made from cereal or legume flour tend to have higher WAC because these macromolecules have many polar sites that interact with water. A study on vegetable soup reported water absorption capacities ranging from 3.5-9.5 g/g showing strong hydration properties that contribute to good soup consistency (Gayathry and John, 2024). The solubility index is another important measure of reconstitution performance. It shows the amount of soluble solids released into water. Higher solubility values result in a more uniform reconstituted soup and reduced sedimentation. Research on instant soup mixes made by spray drying indicates values often exceeding 70% for well made formulations (Suyanto *et al*., 2024).

Rehydration time is the duration required for the soup mix to fully hydrate and mix with water to form a uniform mixture. Instant soup mixes are designed for quick and easy reconstitution after the addition of hot water. Shorter rehydration times are preferred because it improves convenience and customer satisfaction. Most instant soup mixes rehydrate completely within 2-5 minutes which depends on the formulation and particle size **(**Wang *et al*., 2023). Smaller particles with larger surface areas rehydrate faster but very fine particles can lead to lump formation. Dispersibility and lump formation are closely related. Dispersibility measures how well the soup mix disperse evenly in water without clumping. Poor dispersibility can lead to lumps which can affect product quality and customer acceptability. Particle size distribution is crucial because soup mixes with uniform and moderately coarse particles disperse better than those with very fine particles. Studies on instant soup mixes have shown that improved dispersibility can be obtained through controlled drying methods that can enhance wettability and porosity (Jiang *et al*., 2025).

Ingredient composition also affects the reconstitution behavior of soup mixes. Ingredients rich in starch such as maize, rice or potato starch plays a key role in water absorption and viscosity development during reconstitution. When hot water is added starch granules gelatinise causing them to swell and lose their crystalline structure thereby increasing the soups viscosity. Partial starch gelatinisation during thermal processing enhances water absorption and improves dispersibility because the disrupted granular structure facilitates water penetration. This process enhances the body and texture of the final product. Similarly, proteins also play a major role in hydration properties. Proteins from ingredients such as legumes or milk powders also improves reconstitution by binding with water. When proteins hydrate they swell and improve water retention and texture in the reconstituted soup. Proteins can contribute to foam stability and soup viscosity but excessive protein content may reduce solubility due to hydrophobic interactions and aggregation during drying. Studies on protein rich powders have shown that higher protein levels can reduce dispersibility and solubility due to increased intermolecular interactions among protein molecules (McSweeney *et al*., 2020). Also hydrocolloids and stabilisers used in soup formulations can enhance rehydration properties by improving water retention and preventing separation. The reconstitution capacity of soup mixes depends on the complex interactions among powder structure, processing conditions and ingredient composition. Assessing parameters such as rehydration ratio, water absorption capacity, solubility index, rehydration time, dispersibility and the effects of starch and protein hydration helps optimize soup mix formulations. This ensures preparation, a pleasing texture and high consumer acceptance. (Ren *et al*., 2024).

1.1.7 Organoleptic Properties of Soup Mixes

Organoleptic or sensory characteristics are important quality factors influencing consumer acceptance of instant soup mixes. These properties are attributes of food that are sensed by human beings like appearance, aroma, taste, texture and overall acceptability. Sensory evaluation is important in the development and improvement of instant soup mixes. Since these mixes are quick meals, their sensory quality after preparation has a significant impact on market success and consumer perception of quality and taste.

The first factor that the consumers consider is the

appearance which has a great influence on the first impression of the product. Desirable appearance for reconstituted soup is attractive colour, uniform consistency, no lumps and right thickness. The color and visual attractiveness of soup mixes are determined by the ingredients used such as vegetable powders, spices and cereal flours, as well as processes during drying and extrusion (Andersen *et al*., 2019). Studies on formulations of instant vegetable soup show that retention of natural color and uniform distribution of ingredients can greatly improve consumer perception and acceptance (Kour *et al*., 2023).

Aroma is also an important sensory property that influences consumer expectation before tasting the product. The aroma of soup is derived from spices, herbs, vegetables and flavoring compounds which are added to the soup during the cooking process. The volatile flavor compounds can be affected by drying and storage conditions and may affect the aroma intensity of the reconstituted soup (Adeboye *et al.,* 2020). Taste is an important factor for overall acceptance of the product and is influenced by the balance of saltiness, sweetness, umami and other flavor elements in the soup mix. The taste profile of instant soups is shaped by ingredients such as vegetable powders, seasoning blends and flavor enhancers (Andersen *et al.,* 2019). Studies conducted on dehydrated soup powders show that proper processing techniques are effective in preserving aromatic and flavouring compounds and enhance flavor perception (Adeboye *et al*., 2020). The overall flavour of a food product is the combination of aroma and taste. Aroma compounds sensed through the olfactory system interact with taste sensations on the tongue to provide the characteristic flavour profile of soup mixes.Thus the balance between aroma and taste is very important for flavour quality and consumer acceptability (Andersen *et al*., 2019).

Texture is an important sensory factor that affects mouthfeel and consumer satisfaction. The texture of soup is influenced by its viscosity, thickness and smoothness and is mainly determined by starches, proteins and hydrocolloids present (Andersen *et al*., 2019). Research has shown that the right starch rich ingredients can improve the body and consistency of instant soups and results in increased sensory satisfaction. Overall acceptability of all sensory attributes serves as a clear indicator of product quality and consumer preference (Gomathi and Parameshwari, 2023).

The 9 point hedonic scale is commonly used in sensory evaluation of soup mixes in food product development and consumer research. The scale ranged from "1 dislike extremely" to "9 like extremely" and panelists were asked to specify their level of liking for each sensory aspect. This method is simple, reproducible and useful for the evaluation of newly developed food products. In various studies on instant soup mix formulations trained or semi trained panellists assess parameters such as appearance, aroma, taste, texture and overall acceptability using the hedonic scale to estimate consumer preference and improve formulations (Sugumar and Guha, 2022; Akasapu and Uppaluri, 2024). Results of sensory evaluation are usually statistically analysed to establish significant differences between formulations and to select the most acceptable product. Organoleptic evaluation provides consumer perceptions helping researchers develop soup mixes with improved flavor, texture and overall quality.

1.1.8 Shelf life and storage stability

Shelf life and storage stability are important parameters used to evaluate the quality of instant soup mixes. Soup mixes are generally derived from dehydrated powders and are meant for long term storage with no degradation in quality. Shelf life of soup mixes refers to the period during which the product is safe, nutritious and retains its sensory and functional qualities under specified storage conditions. The stability of dehydrated soup mixes is a function of physical, chemical, biological and environmental factors.

Moisture absorption is one of the major factors affecting shelf life. Soup mixes that are not packaged properly will absorb moisture from the environment. Higher moisture levels increase water activity which results in faster chemical reactions, increased microbial growth and texture problems such as caking or lump formation. Water activity must be controlled and moisture levels should be kept low to maintain stability and avoid spoilage. Studies have shown that the storage stability can be enhanced and bacterial growth can be inhibited by low moisture level and water activity (Wamiti *et al*., 2021; Nahar *et al*., 2023). Another important factor is the oxidative rancidity especially in soup mixes containing ingredients like milk powders, vegetable oils or spices. This type of rancidity occurs when unsaturated fats react with oxygen to form compounds that spoil flavor and nutrition. The extent of oxidation increases when exposed to oxygen, light and high temperatures. The peroxide value (PV) is widely used to estimate the level of lipid oxidation during storage and a higher PV indicates more oxidative damage. High temperature, oxygen exposure and light accelerate these oxidation reactions and thus reduce shelf life (Choosuk *et al*., 2022; Demirel, 2025). Also, quality can deteriorate during storage due to flavor loss. Most soup mixes have essential oils of spices, vegetables or seasonings. Over time, these aroma compounds can evaporate or degrade thus reducing sensory

quality. Also products can become contaminated with microbes if they are exposed to moisture. Dehydration minimizes the microbial activity but still various bacteria, yeasts and molds can survive and grow under the right conditions which thereby limits the shelf life (Nahar *et al*., 2023).

Soup mixes are very sensitive to storage conditions. Chemical and microbial changes during storage are greatly influenced by the temperature, humidity and light exposure. Temperature control is important because higher temperatures can accelerate reactions such as lipid oxidation and loss of flavour. Humidity has also to be controlled to prevent moisture pickup which can cause caking or lumping. Hence instant soup mixes are usually stored in cool, dry locations to lessen deterioration. Protection from light is important as light can promote reactions in lipids with ingredients and degrade pigments thus negatively affecting color and flavor (Giannakourou *et al*., 2025). Accelerated storage studies can be carried out for the shelf life assessment of soup mixes. In these studies the products are maintained at high temperatures and humidity to simulate long term storage in a shorter period of time. The peroxide value has often been used as a chemical indicator of lipid oxidation. The microbial quality of the product is determined by tests such as total plate counts and yeast and mold counts to ensure safety and compliance with standards. Sensory stability testing is also very important because changes in appearance, aroma, taste and texture can have a big impact on consumer acceptance (Sinchaipanit *et al*., 2023).

Packaging materials are important to maintain quality and extend shelf life by blocking oxygen, moisture and light. Materials with a high barrier such as laminated pouches constructed from layers of aluminum foil or polyethylene are effective in limiting the ingress of oxygen and water vapor. Vacuum packing and nitrogen flushing are common practices to extend shelf life. Removing air with vacuum packaging reduces oxidative reactions and slows the growth of microbes. Nitrogen flushing replaces the oxygen with inert nitrogen gas thereby reducing oxidation and maintaining quality during storage. Effective packaging systems greatly enhance the shelf life and stability of dehydrated food products. Studies have shown that suitable packaging and controlled storage environments can greatly improve the stability and quality of dehydrated food powders during storage (Kamdi & Rao, 2025). The shelf life and storage stability of soup mixes rely on a mix of product properties, environmental conditions and packaging systems. Careful management of these factors is important to ensuring safety, quality and consumer satisfaction.

1.1.9 Challenges in soup mix development

There are several technological and nutritional problems associated with the development of instant soup mixes and these can greatly affect the quality, stability and consumer acceptance of the product. Storage caking is a frequent problem because the soup mix particles stick to each other due to moisture absorption and increased adhesion. Soup mixes absorb moisture and exposure to high humidity causing moisture uptake. This leads to reduced flowability, lump formation and poor reconstitution properties. Shelf life and handling efficiency are affected which requires anticaking agents and controlled packaging conditions. Studies on soup mixes have found that caking depends on factors such as particle size, glass transition temperature and storage conditions with increased humidity speeding up the process (Chen *et al*., 2023).

Another problem is the nutrient loss during drying. This is particularly the case for traditional high temperature drying methods which can lead to loss of heat sensitive vitamins such as vitamin C and provitamin A. Also some loss of amino acids, flavor compounds and bioactive compounds may occur which can reduce the nutritional and functional quality of the final soup mix. According to studies, the antioxidant capacity and micronutrient content may fall sharply during dehydration depending on the drying temperature and time (Jeon *et al.,* 2025). Another issue with commercial soup mixes is that they are loaded with sodium which is a major public health concern. Salt is widely used to improve taste, aid preservation and appeal to consumers. But too much sodium intake can lead to health problems like high blood pressure and heart disease (Chen *et al.,* 2023). Most of the instant soups on the market have sodium levels that are above the recommended dietary limits thus creating the need for reformulation strategies. They may take the form of salt reduction, salt substitutes or flavor enhancers such as potassium chloride and umami compounds (Rose, 2026).

Another challenge is the sensory compromise often observed with fortified soup mixes. Addition of protein isolates, dietary fiber, vitamins or minerals can increase nutritional value but may have a great impact on taste, texture and appearance. This often results in a decrease in consumer acceptance during storage due to oxidation and flavor changes. Adding plant proteins or micronutrient premixes can result in off flavors, grittiness or color changes, which can affect how consumers perceive the product. It is observed that the trade off between nutritional enhancement and sensory quality is important in developing a product (Yatnatti and Vijayalakshmi, 2018). Further the soup mix formulations are compounded by problems such

as lipid oxidation, microbial stability and rehydration characteristics. These factors necessitate the use of techniques such as microencapsulation, freeze drying and optimized ingredient interactions to balance nutrition, safety and sensory quality (Chen *et al.,* 2023). Overcoming these challenges requires careful optimization of formulation, processing conditions and packaging. The use of anticaking agents, mild drying methods, sodium reduction strategies and advanced encapsulation technologies can help improve the quality and acceptance of instant soup mixes while preserving their nutritional benefits.

CONCLUSION

This review highlights the importance of instant and functional soup mixes. They are convenient and nutrient dense which can address both nutrient deficiencies and lifestyle diseases. The review shows that formulation with ingredients such as millets, legumes, vegetable powders and bioactive compounds greatly improves the nutritional and therapeutic value of soup mixes. Moreover, protein enrichment through the addition of soy and pulses increased protein levels from 10-11% to about 20%. Millet based formulations also provide dietary fiber, minerals and antioxidants. The review also details various functional properties such as water absorption capacity (2.5-9.9 g/g), solubility (up to 76%), viscosity (over 7000 cP) and dispersibility, along with their role in determining product quality, reconstitution and consumer acceptance. Various processing methods such as blanching, drying (tray, spray and freeze drying), grinding and blending are used in soup mix preparation. Shelf life of soup mixes depends on moisture content (less than 10%) and water activity (below 0.6) which has to be maintained to ensure product safety and durability during storage. Despite these advancements, challenges do exist. Differences in formulations, lack of standard protocols and limited large scale validation can affect consistency. Another challenge is to balance nutritional improvements with taste and cost effectiveness. Researchers should focus on developing standardized formulations which are suitable for various population groups such as children, elderly and patients with chronic diseases like diabetes, hypertension and malnutrition. The incorporation of new technologies such as encapsulation of probiotics and bioactive compounds along with improvised drying methods can offer improved product functionality and stability. More attention has to be given to clinical validation, consumer acceptance and raw material procurement. Instant and functional soup mixes help provide balanced nutrition in a convenient way. Ongoing research, innovation and standardization of formulation can enhance public health and nutrition security worldwide.

ACKNOWLEDGEMENT

The authors acknowledge St. Teresa's College (Autonomous), Ernakulam, Kerala, India for infrastructure and technical support.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

FINANCIAL SUPPORT AND SPONSORSHIP

This work was supported by the Department of Science and Technology, Government of India (Vigyan Dhara SEED/WS/2023/1019).

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