AATCC Review

21 June 2025: Received
10 August 2025: Revised
18 August 2025: Accepted
16 September 2025: Available Online

https://aatcc.peerjournals.net/

Original Research Article

Open Access

Formulation and standardization of millet-based ready-to-cook soup mix

Rupali Das*[1], Chitrotpala Devadarshini[1], Mridula Devi[2], Sachidananda Swain[3], Diptimayee Jena[4], Soumya Sucharita Sahoo[5], Sumitra Chhotaray[6] and Hiranmayee Nayak[7]

[1]*Department of Food and Nutrition, College of Community Science, Odisha University of Agriculture and Technology, Bhubaneswar-751003, Odisha, India*
[2]*Director, Indian Council of Agricultural Research (ICAR)-Central Institute For women in Agriculture (CIWA), Bhubaneswar-751003, Odisha, India*
[3]*Senior Scientist, Indian Council of Agricultural Research (ICAR)-Central Institute For women in Agriculture (CIWA), Bhubaneswar-751003, Odisha, India*
[4]*Department of Food and Nutrition, College of Community Science, Odisha University of Agriculture and Technology, Bhubaneswar-751003, Odisha, India*
[5]*Department of Food Science and Nutrition, ASPEE College of Nutrition and Community Science, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar-385506, Gujarat, India*
[6]*Department of Food and Nutrition, College of Community Science, Odisha University of Agriculture and Technology, Bhubaneswar-751003, Odisha, India*
[7]*Department of Silviculture and Agroforestry, College of Forestry, Odisha University of Agriculture and Technology, Bhubaneswar-751003, Odisha, India*

ABSTRACT

Soup is an appetiser of semi-liquid consistency consumed by all age groups. The study faced challenges in optimizing the millet-based soup's formulation for quality and stability while ensuring consumer acceptance of this less familiar product. The present study has been designed to develop a soup mix by utilising finger millet and foxtail millet flour. A total of thirteen treatments of millet-based soup mix were formulated using 10, 20, 30 and 40 percent finger millet and foxtail millet flour individually and in mixed forms, i.e. FiM_1, FiM_2, FiM_3, FiM_4, FoM_1, FoM_2, FoM_3, FoM_4, MM_1, MM_2, MM_3, MM_4 and the control from corn starch only. All the treatments were subjected to assessment of sensory scores, nutritional composition, microbial load and shelf-life using standard procedures. The soup mix prepared with 30% finger millet flour (FiM_3), 20% foxtail millet flour (FoM_2) and 60% mixed millet flour (MM_3) was highly acceptable by panellists for their sensory scores. The FiM_3had higher content of Fibre (2.28 vs. 1.48g), total ash (1.6 vs. 0.79g), fat (0.6 vs. 0.28g), protein (3.05 vs. 1.52g), calcium (119.07 vs. 16.47mg), iron (1.64 vs. 0.64mg) and phosphorus (241.07 vs. 164.14mg) as compared to the control per 100g. Foxtail millet soup mix (FoM_3) had more total ash (1.58g), Fibre (3.52g), fat (1.51g), protein (5.08g), calcium (22.28mg), iron (1.05mg) and phosphorus (218.78mg) than that of the control per 100g. Mixed millet soup mix (MM_3) contained significantly higher concentrations of fat (1.88g), protein (7.2g), total ash (2.2g), fibre (4.35g), calcium (127.92mg), iron (2.48mg) and phosphorus (327.92mg). The microbial load of accepted treatments increased with a decrease in sensory scores throughout the storage period.

Keywords: *Finger millet, Foxtail millet, Nutritional composition, Sensory evaluation, Shelf-life, Shelf-help group.*

1. Introduction

Soup is a traditional semi-liquid appetiser which is popular all over the world due to its convenient and hygienic preparation. It is prepared by immersing solid ingredients such as meat or vegetables in liquids as stock, milk or water and allowing them to cook until the flavours seep out and a broth is formed. With the development of canning in the 19th century, commercial instant canned, dehydrated and frozen soup mixes replaced homemade options. Now a days, demands for ready-to-eat, ready-to-cook and ready-to-serve foods are appealing due to their ease of preparation and acceptability among all age group consumers[13,10]. To prevent malnutrition and alleviate swallowing issues in elderly individuals, nutrient-enriched foods like instant soup mix can be easily cooked and consumed, providing flavour stability and protection against spoilage [5]. Generally, soups are made by adding corn starch, which lacks in both macro- and micro- nutrients, as it is rich in calories. This problem can be addressed by adding other nutrient-dense bases or thickeners, such as various millet flours in place of corn starch.

Millets, belonging to the *Poaceae* family, are rich in both macro- and micro-nutrients such as protein, dietary fibre, ash, vitamins, minerals, e.g. calcium, phosphorus, iron, zinc, etc. and antioxidants, particularly ferulic acid and catechins, protecting from oxidative stress; thus, considered as smart and superfoods [18]. Millets offer nutraceutical health benefits, including improved digestive system, cholesterol reduction, heart disease prevention, diabetes protection, cancer risk reduction, energy levels and muscular system.

*Corresponding Author: ***Rupali Das***

DOI: https://doi.org/10.21276/AATCCReview.2025.13.04.437

They are also rich in fibre and non-starchy polysaccharides and have a low glycaemic index, making them ideal for diabetic patients. They also contain soluble fibre, which helps to reduce cholesterol. Millets are gluten-free, making them suitable for those with celiac disease [25]

Ragi or finger millet (*Eleusine coracana)*, mainly cultivated in Africa and India, is one of the richest sources of potassium, calcium, iron, protein, fibre and essential amino acid content. It contains 81.5% carbohydrates, 18–20% dietary fibre, 65–75% starch, 9.8% protein, 1–1.7% fat, 2.7% minerals and 4.3% crude fibre [20]. 100 g of ragi provides 305 kcal of energy, 72 g carbohydrates, 11.5 g dietary fibre, 7.3 g protein, 1.3 g fat, 344 mg of calcium, 3.9 mg of iron, 137 mg magnesium, 283 mg of phosphorus, 408 mg potassium, 14 mg sodium and 2.3 mg zinc and 13.1% moisture [6]. It's safe for celiac disease and gluten allergies, aids in blood sugar management due to its phytochemical compositions and is beneficial for depression, anxiety and insomnia. It is mostly used to prepare a weaning mix. Therefore, including Finger millet in the soup mixture improves both the soup's nutritional value and its mouthfeel.

Foxtail millet (*Setaria italica*) is a gluten-free, nutritious grain used in Asian cooking, suitable for gluten-sensitive individuals and beneficial for diabetics and expectant mothers. Its high fibre content may lower cholesterol, promote heart health and aid in weight loss. Foxtail millet provides a pertinent amount of nutritional components such as 60.9% carbohydrate, 4.3% fat, 8% fibre, 12.3% protein and 3.3% total ash [12]. Due to the coarse nature of foxtail millet grains, the digestible portion constitutes about 79% and the remaining undigestible part of the grain contains relatively high levels of fibre that help in the digestive process and help to induce bowel movement, thus producing a laxative effect that is beneficial for a healthy digestive system [4]. In addition to its nutritional properties, foxtail millet has also been shown to possess several health benefits, such as the prevention of cancer, hypoglycaemic and hypolipidemic effects [26]. All these nutritional properties have made foxtail millet an important ingredient for preparing noodles, nourishing gruel or soup, brewing alcoholic beverages, cereal porridges and pancakes in China [24].

Hence, on the verge of nutritional and health benefits, numerous attempts have been undertaken to incorporate millet flours in developing ready-to-eat soup mix by many researchers [1, 2, 7, 8, 11, 14, 17, 22]. The present study has been conducted with the following objectives:

- To formulate and standardise a soup mix by utilising finger millet and foxtail millet
- To evaluate the sensory characteristics, nutritional composition and shelf-life of standardised soup mix and to raise awareness of its nutritional benefits among Self-help groups (SHG).

2. Materials and Methods

2.1. Collection of raw ingredients

The corn starch (CS), finger millet (FiM), foxtail millet (FoM), vegetables as carrot, bean, sweet corn, garlic, green chilli, lemon and coriander leaves and spices such as garlic powder, onion powder, coriander seed, cumin seed, black pepper, black salt and salt were procured from local market of Siripur, Bhubaneswar, Odisha. All the vegetables were washed and cleaned thoroughly 2-3 times to remove dust, soil and other impurities.

2.2. Preparation of millet flour

After being bought, the foxtail and finger millet were manually cleaned to get rid of all the impurities. They were kept for drying using cabinet dryer after being washed under running water for two or three times. To make Fine flours, the sun-dried millets were ground in a pulveriser and sieved using a No. 60 sieve of thickness 1 mm. For future research, the millet flours were kept in airtight containers.

2.3. Preparation of dried vegetable mixture

The fresh vegetables such as carrot, beans, sweet corn, garlic, green chilli, lemon and coriander leaves were purchased and washed thoroughly. The outer skin of carrots, corn and garlic was discarded. The blanching of vegetables (carrots, beans and corn) was carried out. After blanching, the blanched vegetables, along with other vegetables, were dried using a tray dryer machine at 50°C. After drying, the vegetable mixture was stored in an air-tight container for further study.

2.4. Preparation of spice powder

The spices such as coriander seed, cumin seed, black pepper, were procured. The seeds were roasted at medium flame for 5 min. The roasted spices were ground into Fine powders by using an electric grinder.

2.5. Formulation of flour for the preparation of soup mix

Thirteen distinct composite flours that were formulated by combining finger millet flour, foxtail millet flour and corn starch at different proportions are shown in Table1.

2.6. Preparation of soup mix

Standardised flour, along with dehydrated vegetable mixture and spice powders, was mixed together to form thirteen different soup mixes. The quantities for spices and dehydrated vegetable mixture were given in Table 2.

2.7. Nutrient analysis of the developed soup mix

The proximate analysis of moisture, fat, protein, mineral and crude fibre was estimated by standard AOAC methods (2007). Moisture content of the developed products was determined by using the hot air oven drying methods of AOAC (2007). The carbohydrate content was calculated by using the difference method. The Kjeldahl method was used to determine the crude protein content of the developed soup mix in the KELPLUS Automatic Nitrogen Estimator System by following the digestion, distillation and titration processes (AOAC, 2007). The fat content of the food sample was estimated by the Soxhlet method of AOAC (2007). The concentration of minerals such as calcium, iron and phosphorus was determined by using the Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) method.

2.8. Sensory evaluation of the developed soup mix

All thirteen millet incorporated soup mixes and the control were evaluated by thirty semi-trained panel members for their sensory parameters such as colour, consistency, flavour, taste and overall acceptability by using a nine-point Hedonic rating scale [16].

2.9. Microbial Analysis

The microbial quality of control and accepted products was examined. The products' bacterial load was examined by using particular media.

2.9.1. Preparation of Media

Two types of media, i.e. potato dextrose sugar (39 g) and nutrient sugar (28 g), were used for the preparation of media. 1 L of distilled water was used to dissolve the standardised amount of media. After that, it is autoclaved for one hour at 121 °C (15 lbs of pressure). The pouring-in of sterilised plates has been prepared using the laminar air flow chamber. After allowing the plates to cool until the media was set, they were incubated at 30 °C for an entire night and then they were refrigerated until needed again.

2.9.2. Procedure

1 g of the sample was dissolved in ten millilitres of phosphate buffer saline. By mixing the lx diluted suspension with the 9x diluted suspension, multiple inoculum suspension dilutions were carried out. For each sample, 102 dilutions were prepared. The mean of three plates is computed by dividing each plate into five sectors. The appropriate plate labelling has been completed in order to attain traceability. Drops of a dilution equal to 1x20 µL for each sector have been applied to the sugar surface, allowing the drops to disperse. For optimal results, the pipette and tools must be kept away from the sugar's surface. In order for the potato dextrose, sugar and nutrient sugar plates to dry before inversion, they were placed upright. For 18 to 24 h, these are incubated at 30 °C to count the bacteria and yeast. It is imperative to note the opulent expansion of each industry. For high concentrations, the growth must be closely monitored over the drop area. During the process, it is necessary to combine multiple smaller colonies. The number of colonies is calculated in the sectors with the highest density of full-size discrete colonies.

2.9.3. Expression of microbial count

The microbial count has been represented by the colony-forming units per g (cfu/g), of the computed colonies in triplicate petri-dishes. The sample weight is further divided by the estimated average value of the three replicates. Multiplying the retrieved numbers by the corresponding dilution factor yields the final count.

2.9.4. Calculations

Determine the CFU per millilitre using the number of colonies forming units (CFU) in the initial aliquot sample. It is calculated as follows: "dilution × 50 × dilution factor = mean number of colonies."

2.10 Shelf-life analysis of formulated products

The formulated soup mixes were packed in two types of packaging material i.e**.** clear stand-up poly-propylene zip lock pouch of 120 µ thickness and Metallised poly-propylene pouch of 60 µ thickness. The metallised poly-propylene pouch packaging materials were sealed by hand-operated sealing machines. The shelf-life analysis of the formulated products was studied at 30-day intervals up to 90 days.

2.11. Statistical Analysis

The extracted data, the mean and standard deviation for each sample were obtained using the MS-Excel platform. A one-way ANOVA test was used to determine the significance test between the control and experimental samples. The correlation was used in a storability study.

3. Results and Discussion

3.1. Proximate composition of developed products

The data on the proximate composition of developed soup mixes were presented in Table 3.It was observed that the control contained 3.89% moisture, 0.79% ash, 0.28% fat, 1.48% crude fibre, 1.52% crude protein, 92.02% carbohydrates and 376.68% energy. With increasing amount of finger and foxtail millet flour crude fat, protein, fibre, moisture and total ash contents increased gradually. The carbohydrate and energy contents decreased significantly ($p<0.05$) in all the developed products. The moisture, ash, fat, fibre, protein, carbohydrate and energy contents of all four types of formulated finger millet products ranged from 5.13-5.66, 1.08-1.87, 0.35-0.72, 1.73-2.55, 2.24-4.54, 89.46-84.65 and 369.95-363.24 per_cent, respectively. FiM_4 contained maximum content of moisture, ash, fat, fibre and protein and minimum quantity of carbohydrate and energy. Similar results were depicted by Nivedita and Raghuvanshi (2018) and Abinayaselvi *et al*.-, (2018).[14,1]

The moisture, ash, fat, fibre, protein and carbohydrate contents of all four types of formulated foxtail millet soup mixes ranged from 4.2 to 5.12, 1.07 to 1.85, 0.65 to 1.95, 2.17 to 4.3, 2.61 to 6.25, 89.29 to 80.52 and 373.45 to 364.63 per_cent, respectively. In FoM_4, maximum content of moisture, ash, fat, fibre, protein and minimum quantity of carbohydrate and energy were found. Similar findings were suggested by Jelku *et al.*-, (2019) and Priti and Prameela (2020).[7,17]

The moisture, ash, fat, fibre, protein, carbohydrate and energy contents of all four types of formulated mixed millet soup mixes ranged from 5.23 to 5.57, 1.35 to 2.6, 0.78 to 2.43, 2.45 to 5.43, 3.33 to 9.08, 86.84 to 74.88 and 367.7 to 357.71 per_cent, respectively. MM_4 showed maximum content of moisture, ash, fat, fibre and protein and minimum quantity of carbohydrate and energy was observed. Similar findings were given by Tiwari *et al*.-, (2017), Nivedita and Raghuvanshi (2018) and Neeharika and Suneetha (2024).[22,14,9]

3.2. Sensory evaluation of the developed soup mix

Fig.3. depicts the sensory scores of developed soup mix. Among four finger millet formulated products FiM_3 showed maximum colour, consistency, flavour, taste and overall acceptability score i.e., 8.2, 7.8, 8.1,7.8,and 7.9 respectively and FiM_1 showed minimum colour and flavour score i.e.,7.4 and7.3 respectively whereas FiM_4 scored minimum consistency, taste and overall acceptability score i.e. 7.4,6.9 and 6.8 respectively. Mean value of overall acceptability of FiM_1, FiM_2, FiM_3 and FiM_4 were 7, 7.5, 7.9 and 6.8, respectively. Our result is in consistent with the report of Shanmugam and Malleshi (2007)[21] (Figure 3).

Among four foxtail millet formulated products FoM_1 soup mix showed maximum colour score i.e. 7.5, whereas FoM_2 showed maximum consistency, flavour, taste and overall acceptability score, i.e. 7.4, 7.5, 7.6 and 7.4 respectively. FoM_4 showed minimum colour, consistency, flavour, taste and overall acceptability score, i.e. 6.5, 6.4, 6.8, 6.7 and 6.7, respectively. Mean value of sensory attributes overall acceptability of FoM_1, FoM_2, FoM_3 and FoM_4 were 6.9, 7.4, 7.2 and 6.7, respectively. Tulasi *et al*.-, (2020) suggested similar findings during the preparation of instant soup mix using foxtail millet[23] (Figure 4).

Among four mixed millet-based soup mix products, MM_3 showed maximum colour, consistency, flavour, taste and overall acceptability score, i.e., 8, 7.8, 8.1, 7.8 and 7.7, respectively. MM_1 showed minimum colour and flavour score, i.e., 7.2 and 7.4 respectively, whereas MM_4 scored minimum consistency, taste and overall acceptability score, i.e. 7 ,6.9 and 6.9 respectively.

Mean value of overall acceptability of MM_1, MM_2, MM_3 and MM_4 soup mix was 7, 7.4, 7.7 and 6.9, respectively. The sensory analysis indicated that the concentrations of finger millet and foxtail millet flour of 30% each with 40% of corn starch were highest acceptance of sensory attributes, colour, consistency, flavour, taste and overall acceptability. Similar results were also reported by Anita *et al*., (2016) and Pandey *et al*., (2024) [2,15] (Figure 5).

3.3. Mineral composition of accepted products

The data on mineral content of accepted products was given in Table 4. The calcium content of control (Co), FiM_3, FoM_2 and MM_3 were 16.47 mg, 119.07 mg, 22.28 mg and 127.92 mg per 100 g, respectively. The phosphorous content of control (Co), FiM_3, FoM_2 and MM_3 were 164.14 mg, 241.07 mg, 218.78 mg and 327.92 mg per 100 g, respectively. The iron content of control (C_o), FiM_3, FoM_2 and MM_3 was 0.64 mg, 1.64 mg, 1.05 mg and 2.48 mg per 100 g, respectively. The calcium, phosphorus and iron content of MM_3 differed significantly (p<0.05) in comparison with the control and was found to be the highest as compared to other treatments. Similar results were reported by Tiwari *et al*.-, (2017), Nivedita and Raghuvanshi (2018), Jelku *et al.*-, (2019) and Priti and Prameela (2020).[22,14,7,17]

3.4. Microbial analysis of accepted products

The microbial load of accepted products was observed at 30 days intervals of time duration up to 120 days. The data on microbial load of accepted products were illustrated in Table 5.The microbial load of control, FiM_3, FoM_2 and MM_3 in day 1 were 2×10^4 cfu/g, 2.3×10^4cfu/g, 0.8×10^4 cfu/g and 1.8×10^4cfu/g, respectively. The microbial load of control, FiM_3, FoM_2 and MM_3 in day 30 were 2.4×10^4 cfu/g, 2.6×10^4 cfu/g, 1.2×10^4 cfu/g and 2.2×10^4 cfu/g, respectively. The microbial load of control, FiM_3, FoM_2 and MM_3 in day 60 were 3.2×10^4cfu/g, 3.5×10^4cfu/g, 2×10^4 cfu/g and2.4×10^4cfu/g. The microbial load of control, FiM_3, FoM_2 and MM_3 in day 90 were 4×10^4 cfu/g, 4.2×10^4 cfu/g, 3×10^4 cfu/g and 3.4×10^4 cfu/g, respectively. The microbial load of control, FiM_3, FoM_2 and MM_3 in day 120 were 5×10^4 cfu/g, 7×10^4 cfu/g, 4.2×10^4 cfu/g and 5.6×10^4 cfu/g, respectively. FiM_3 got the highest and FoM_2 got the lowest microbial load from day 1 to day 120. Similar results were reported by Rekha *et al*.-, (2008).[19]

3.4. Shelf-life analysis of developed products

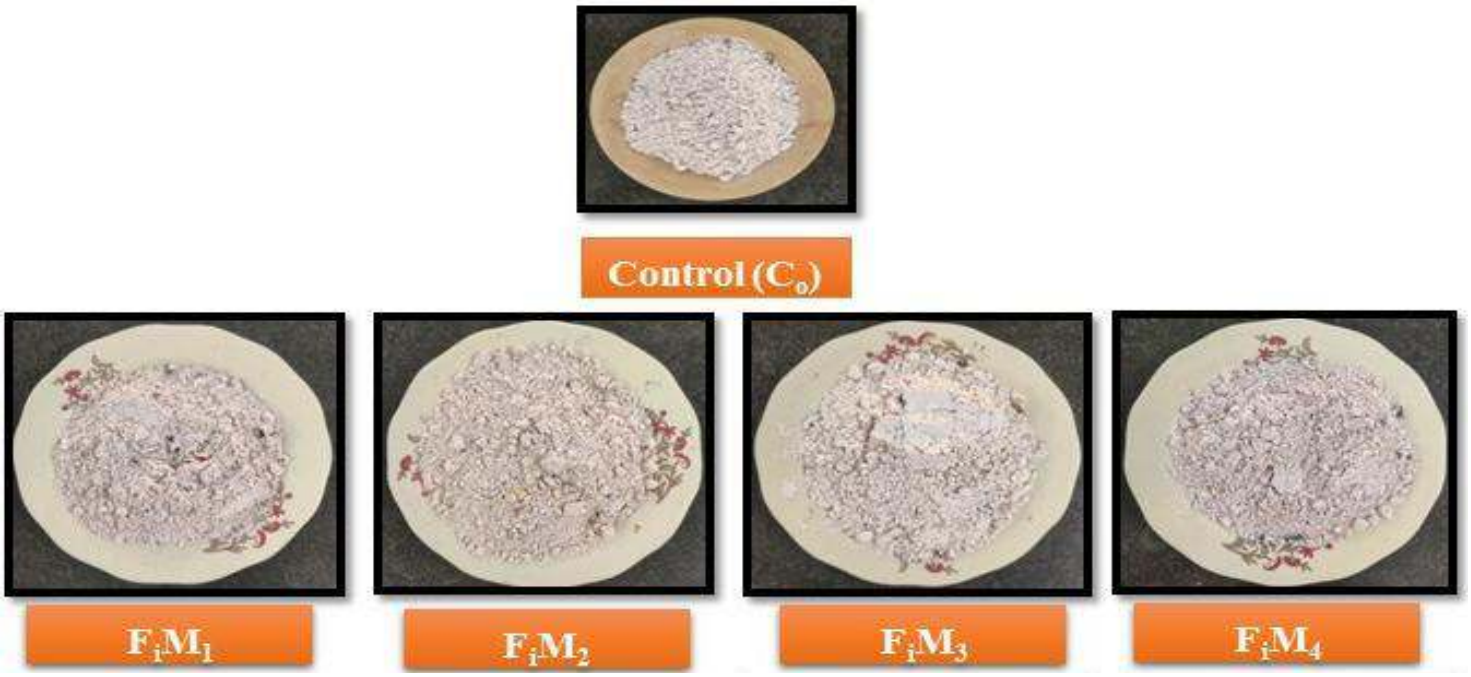
The results of the shelf-life study clarified that there was no significant difference between soup mix products kept in metallised polypropylene pouches and clear stand-up polypropylene zip-lock pouches. The products stored in the clear stand-up polypropylene zip lock pouch showed a greater sensory acceptance than the products stored in the metallised polypropylene pouch, despite the fact that both packaging materials have good shelf-life capacities. The shelf-life of soup-mix products in both packages was up to 2 months within an acceptable range. Similar results were found by Tulasi *et al*.-, (2020) during the development of millet-based instant soup mix.[23]

3.5. Financial estimation of soup mix

The economic estimation of soup mix was carried out on an industrial basis, showing the cost of a product is Rs. 80/- per 50 gm, which could be affordable.

3.6. Awareness programme among SHG (Self-Help Group)

An awareness program was conducted to show the nutritional benefits and its effectiveness among consumers. The participants were the members of the Self-Help group (SHG). They gained an understanding of the methodology and technology utilised in the production of ready-to-cook soup mixes based on millet and the health benefits associated with it. Two programs were held at two distinct locations. The first programme took place at the Central Institute for Women in Agriculture (CIWA) on November 22, 2023, and the second programme took place in the Balianta block of Majhihara village on November 30, 2023. A total of twenty-five to thirty women from various self-help groups came and learned the technology used for the preparation of the product. They have also learned-the cooking method and tasted it to provide insightful feedback. On the basis of sensory evaluation of all 13 formulated products, the most accepted products (F_iM_3, F_oM_2, and MM_3) were demonstrated to them.



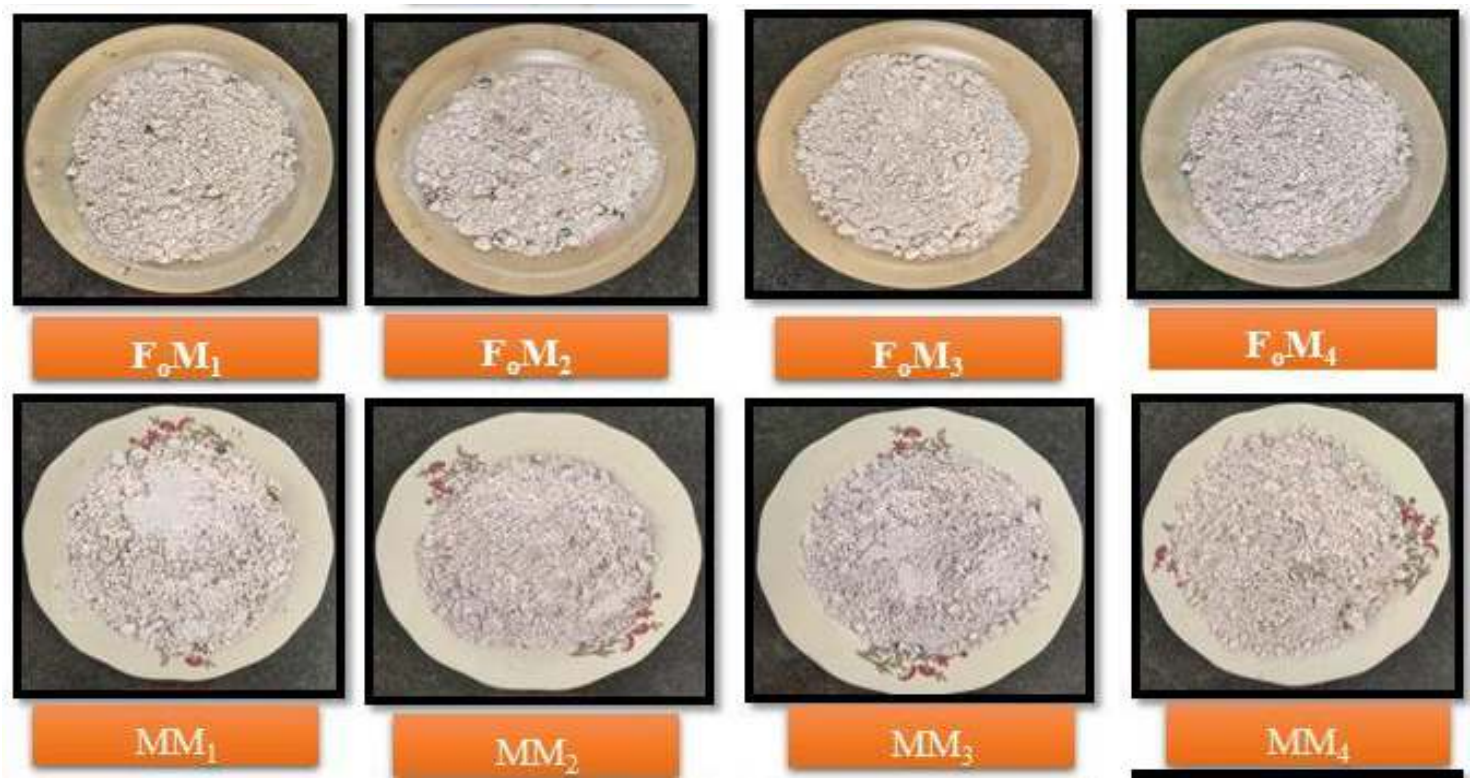


Fig.1. Developed soup mix according to the experimental design

Fig.2. Shelf-life study of soup mix in different packaged conditions

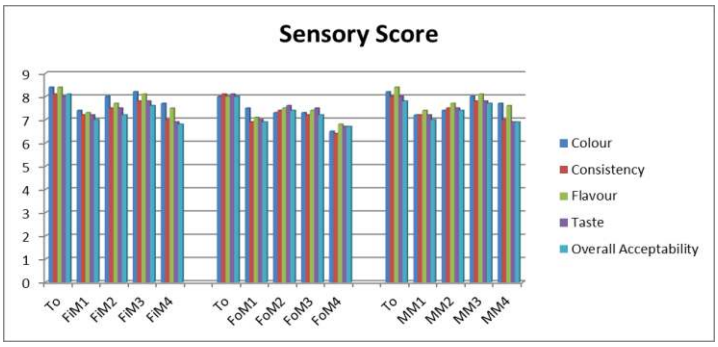


Fig.3. Sensory scores of developed soup mix

Table 2: Composition of spices and vegetables

Name of ingredient	Quantity/100 g soup mix
Coriander powder	10 g
Cumin powder	5 g
Black pepper powder	5 g
Onion powder	10 g
Garlic powder	10 g
Black salt	5 g
Salt	10 g
Dehydrated vegetable mixture	30 g

Table 1: Composition of flours

Composition code	Flour Name	Maize (Corn Starch)
Control (Co)	-	100
Finger millet		
FiM_1	10	90
FiM_2	20	80
FiM_3	30	70
FiM_4	40	60
Foxtail millet		
FoM_1	10	90
FoM_2	20	80
FoM_3	30	70
FoM_4	40	60
Mixed millet (Finger millet:Foxtail millet)		
MM_1	10:10	80
MM_2	20:20	60
MM_3	30:30	40
MM_4	40:40	20

Table 3: Proximate composition of developed soup mix (per 100 g)

Samples	Moisture (g)	Total ash (g)	Crude fat (g)	Crude Fibre (g)	Crude protein (g)	Carbohydrate (g)	Energy (Kcal)
Control (Co)	$3.89^{c} \pm 0.35$	$0.79^{b} \pm 0.19$	$0.28^{d} \pm 0.08$	$1.48^{e} \pm 0.02$	$1.52^{e} \pm 0.37$	$92.02^{a} \pm 0.96$	$376.68^{a} \pm 0.57$
FiM_1	$5.13^{b} \pm 0.09$	$1.08^{b} \pm 0.32$	$0.35^{c} \pm 0.02$	$1.73^{b} \pm 0.56$	$2.24^{c} \pm 0.59$	$89.46^{b} \pm 0.95$	$369.95^{b} \pm 0.66$
FiM_2	$5.15^{b} \pm 0.15$	$1.37^{ab} \pm 0.49$	$0.49^{b} \pm 0.01$	$2.00^{ab} \pm 0.47$	$2.85^{bc} \pm 0.58$	$88.13^{c} \pm 0.88$	$368.33^{c} \pm 0.92$
FiM_3	$5.36^{ab} \pm 0.26$	$1.6^{a} \pm 0.46$	$0.6^{a} \pm 0.02$	$2.28^{a} \pm 0.53$	$3.05^{b} \pm 0.48$	$87.11^{c} \pm 0.29$	$366.04^{c} \pm 0.69$
FiM_4	$5.66^{a} \pm 0.19$	$1.87^{a} \pm 0.54$	$0.72^{a} \pm 0.02$	$2.55^{a} \pm 0.61$	$4.54^{a} \pm 0.41$	$84.65^{d} \pm 0.43$	$363.24^{d} \pm 0.72$
CD@5%	0.35	0.66	0.06	0.76	0.77	1.18	1.21
FoM_1	$4.2^{bc} \pm 0.15$	$1.07^{b} \pm 0.33$	$0.65^{d} \pm 0.1$	$2.17^{d} \pm 0.22$	$2.61^{d} \pm 0.48$	$89.29^{b} \pm 0.78$	$373.45^{b} \pm 0.69$
FoM_2	$4.45^{b} \pm 0.26$	$1.36^{ab} \pm 0.4$	$1.09^{c} \pm 0.15$	$2.81^{c} \pm 0.36$	$3.81^{c} \pm 0.57$	$86.46^{c} \pm 0.94$	$370.89^{c} \pm 0.77$
FoM_3	$4.77^{ab} \pm 0.17$	$1.58^{a} \pm 0.45$	$1.51^{b} \pm 0.13$	$3.52^{b} \pm 0.68$	$5.08^{b} \pm 0.17$	$83.52^{d} \pm 0.73$	$367.99^{d} \pm 0.62$
FoM_4	$5.12^{a} \pm 0.15$	$1.85^{a} \pm 0.56$	$1.95^{a} \pm 0.23$	$4.3^{a} \pm 0.34$	$6.25^{a} \pm 0.62$	$80.52^{e} \pm 1.19$	$364.63^{e} \pm 0.54$
CD@5%	0.36	0.63	0.23	0.6	0.73	1.46	1.52
MM_1	$5.23^{b} \pm 0.03$	$1.35^{bc} \pm 0.45$	$0.78^{d} \pm 0.09$	$2.45^{d} \pm 0.48$	$3.33^{d} \pm 0.48$	$86.84^{b} \pm 1.27$	$376.68^{a} \pm 0.78$
MM_2	$5.35^{ab} \pm 0.1$	$1.83^{b} \pm 0.54$	$1.34^{c} \pm 0.19$	$3.42^{c} \pm 0.69$	$5.33^{c} \pm 0.5$	$82.71^{c} \pm 1.39$	$364.22^{c} \pm 0.64$
MM_3	$5.54^{a} \pm 0.2$	$2.2^{ab} \pm 0.38$	$1.88^{b} \pm 0.45$	$4.35^{b} \pm 0.88$	$7.2^{b} \pm 0.56$	$78.81^{d} \pm 1.08$	$360.96^{d} \pm 0.89$
MM_4	$5.57^{a} \pm 0.15$	$2.6^{a} \pm 0.42$	$2.43^{a} \pm 0.29$	$5.43^{a} \pm 0.39$	$9.08^{a} \pm 0.39$	$74.88^{e} \pm 0.57$	$357.71^{e} \pm 0.73$
CD@5%	0.31	0.65	0.41	0.89	0.73	1.74	1.23

Note: Values are mean ± SE of three independent replications. Mean with same superscript (a, b, c, d, e) in the same column differ significantly (p<0.05) CS- Corn starch MM- Mixed millet F_iM- Finger millet F_oM- Foxtail millet

Table 4: Mineral composition of accepted soup mix (per 100 g)

Treatment	Calcium (mg)	Phosphorous (mg)	Iron (mg)
Control (Co)	$16.47^{d} \pm 0.74$	$164.14^{d} \pm 0.31$	$0.64^{c} \pm 0.26$
FiM_3	$119.07^{b} \pm 0.43$	$241.07^{b} \pm 0.27$	$1.64^{b} \pm 0.42$
FoM_2	$22.28^{c} \pm 0.48$	$218.78^{c} \pm 0.55$	$1.05^{bc} \pm 0.27$
MM_3	$127.92^{a} \pm 0.98$	$327.92^{a} \pm 0.58$	$2.48^{a} \pm 0.77$
CD@5%	4.2	0.93	0.75

Note: Values are mean ± SE of three independent replications. Mean with same superscript (a, b, c, d, e) in the same column differ significantly(p<0.05)

Table 5: Microbial load of highly accepted soup mix products

Treatment	Day 1 (cfu/g)	Day 30	Day 60	Day 90	Day 120
Control	2×10^{4}	2.4×10^{4}	3.2×10^{4}	4×10^{4}	5×10^{4}
FiM_3	2.3×10^{4}	2.6×10^{4}	3.5×10^{4}	4.2×10^{4}	7×10^{4}
FoM_2	0.8×10^{4}	1.2×10^{4}	2×10^{4}	3×10^{4}	4.2×10^{4}
MM_3	1.8×10^{4}	2.2×10^{4}	2.4×10^{4}	3.4×10^{4}	5.6×10^{4}

4. Conclusion

The study concluded that incorporation of finger millet and foxtail millet to develop RTC soup mix significantly enhanced nutritional quality especially increasing protein, fibre, calcium, phosphorous, iron and total ash quantity. Mixed millet (MM_3) provided the highest nutrient density and was well-accepted sensorially. Shelf-life remains a limiting factor, as microbial load increased with time, reducing acceptability. Supplementation of millet flour in different ready-to-eat and ready-to-cook products such as soup, idli, dosa, and dhokla mix can be an effective approach to achieve an optimum health status for all age group consumers as well as to manage various metabolic disorders e.g. diabetes mellitus, CVD, obesity, gluten sensitive enteropathy and vitamin and mineral deficiency diseases like anemia, osteoporosis etc.

5. Acknowledgements

The authors express their sincere gratitude towards the authority of Central Institute for Women in Agriculture (CIWA) for their assistance in guidance during research work and for successfully conducting the awareness programme, and towards the authority of Central Instrumentation Facility (CIF), OUAT, Bhubaneswar, for their assistance in nutrient analysis.

6. Conflict of interest

The authors declare no conflicts of interest.

7. Future Scope of Study

Future research can explore other millet varieties and nutrient-rich ingredients to enhance health benefits, improve shelf-life through advanced preservation.

References

1. Abinayaselvi, R., Santhi, D., Kalaikannan, A., & Nandhini, K. (2018). Effect of incorporation of finger millet (*Eleusine coracana*) as a thickening agent in chicken soup. *Indian Journal of Veterinary and Animal Sciences Research, 47(1)*, 1199-1206.

2. Anita, S., Sameshwari, T., & Kalpana, B. (2016). Formulation and evaluation of instant soup powder using millets. *International Journal of Current Research, 8(08)*, 35668-35673.

3. AOAC. (2007). Official Method of Analysis. (18 Ed.), Association of official analytical chemists. Benjamin Franklin Station Washington, D.C.; USA. Article 4.

4. Bernard, R. W. (1996). Nutritional Methods of Intestinal Regeneration; Health Research Books, Kessinger Publishing: Whitefish, MT.

5. 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 and nutrition, 5(4)*, 911–920. doi:10.1002/fsn3.476

6. Gopalan, C., Rama Sastri, B. V. R., & Balasubramaniam, S. C. (1989). Nutritive value of Indian foods, National Institute of Nutrition (ICMR) Hyderabad, pp, 49.

7. Jelku, D., Sangma, J. W., Jessie, S., Anila, K., & Suneetha, D. K. B. (2019). Standardisation and evaluation of foxtail millet based malt mix. *International Research Journal of Pure and Applied Chemistry, 19(2)*, 1-9. doi:10.9734/irjpac/2019/v19i230104

8. Karuna, T., & Nazni, P. (2018). Formulation, texture and sensory characteristics of little millet based RTC (Ready-to-cook) soup mix. *International Journal of Food Science and Nutrition, 3(2)*, 187-191.

9. Neeharika, B., & Suneetha W, Jessie. (2024). Formulation and evaluation of ready-to-reconstitute smoothie mix with little millet. *Journal of Scientific & Industrial Research*, *83*, 473-482. doi:10.56042/jsir.v83i5.6721

10. Mathangi, S., Geethanjali, S., & Visalachi, A. (2017). Development and formulation of instant soup mix from Sprouted horse gram and radish leaves. *International Journal of Home Science, 3(1)*, 346-349.

11. Girhepunje, C. J., & Gadhe, K., Bhosle, P. B., & Ghatge, P. (2024). Standardisation of instant soup mix powder using horse gram malt, quinoa malt, and roselle (leaves and calyces). *International Journal of Advanced Biochemistry Research*, *8(10)*, 180-184. doi:10.33545/26174693.2024.v8.i10c.2437

12. Muthamilarasan, M., Dhaka, A., Yadav, R., & Prasad, M. (2016). Exploration of millet models for developing nutrient rich graminaceous crops. *Plant Sci., 242*, 89–97. doi: 10.1016/j.plantsci.2015.08.023

13. Niththiya, N., Vasantharuba, S., Subajini, M., & Srivijeindran, S. (2014). Formulation of instant soup mix powder using uncooked palmyrah (*Borassus flabellifer*) tuber flour and locally available vegetables. Proceedings of Jaffna University International Research Conference (JUICE 2014), 198-206.

14. Nivedita, & Raghuvanshi, R. S. (2018). Optimization and quality evaluation of nutritious soup mix. *Food Sci. Res. J., 9(2)*, 336-340. doi:10.15740/HAS/FSRJ/9.2/336-340.

15. Pandey, M., Bhandari, Y., & Peerkhan, N. (2024). Formulation of prebiotic, low glycemic index millet soups using foxtail, barnyard and kodo millet. *Discover Food., 4*, 62. doi:10.1007/s44187-024-00138-z.

16. Peryam, D. R., & Girradot, N. F. (1957). Advanced taste test method. Food Engineering. 24, 58-61.

17. Priti, & Prameela, K. (2020). Formulation, nutritional, sensory, antioxidant activity and shelf life studies of instant soup mix. *Int J Pharm Sci & Res., 11(12)*, 6114-6123. doi: 10.13040/IJPSR.0975-8232.11(12).6114-23

18. Rao, B. D., Bhandari, R., & Tonapi, V. A. K. (2021). "The White Paper on Millets – A Policy Note on Mainstreaming Millets for Nutrition Security". ICAR-Indian Institute of Millets Research (IIMR), Rajendranagar, Hyderabad-500030.

19. Rekha, M., Yadav, R., Dharmesh, S., Chauhan, A., & Ramteke, R. (2008). Evaluation of antioxidant properties of dry soup mix extracts containing dill (*Anethum sowa* L.) leaf. *Food and Bioprocess Technology, 3*, 441-449. doi:10.1007/s11947-008-0123-5.

20. Saleh, A. S., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet grains: nutritional quality, processing and potential health benefits. *Comprehensive reviews in Food Science and Food Safety, 12(3)*, 281-295. doi:10.1111/1541-4337.12012

21. Shanmugam, S., & Malleshi, N. (2007). Preparation and functional properties of decorticated finger millet (*Eleusine coracana*). *Journal of Food Engineering, 79*, 529-538. doi:10.1016/j.jfoodeng.2006.01.076.

22. Tiwari, R., Kumar, S., & Kohli, D. (2017). Production and evaluation of instant herbal mix soup. *International Journal of Agricultural Science and Research, 7(3)*, 37-42.

23. Tulasi, G., Deepika, U., Venkateshwarlu, P., Santhosh, V., & Srilatha, P. (2020). Development of millet based instant soup mix and Pulav mix. *International Journal of Chemical Studies, 8*, 832-835. doi:10.22271/chemi.2020.v8.i5l.10400.

24. Yang, X. S., Wang, L. L., Zhou, X. R., Shuang, S. M., Zhu, Z. H., Li, N., Li, Y., Liu, F., Liu, S. C., Lu, P., & Ren, G. X. (2013). Determination of protein, fat, starch, and amino acids in foxtail millet [*Setaria italica* (L.) Beauv.] by Fourier transform near-infrared reflectance spectroscopy. *Food Sci. Biotechnol., 22(6)*, 1495–1500. doi:10.1007/s10068-013-0243-1

25. Zeenath, B., Somraj, A., Geetha, A., Khan, A., Srinu, B., Vamshi, J., Karunakar, J., & Pidigam, S. (2024). A comprehensive review of biochemical, functional and dietary implications of Gluten. *Ann. Phytomed., 13(1)*,196-208. doi:10.54085/ap.2024.13.1.19

26. Zhang, A., Liu, X., Wang, G., Wang, H., Liu, J., Zhao, W., & Zhang, Y. (2015). Crude fat content and fatty acid profile and their correlations in foxtail millet. *Cereal Chem., 92(5)*, 455–459. doi:10.1094/CCHEM-12-14-0252-R