International Journal of Food and Fermentation Technology
Citation: *Int. J. Food Ferment. Technol.*, **16**(01): 165-176, June 2026
DOI: 10.30954/2277-9396.01.2026.11

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

RESEARCH PAPER

Development of Soup Mixes from Spinach and Amaranthus with Jackfruit Seed Starch as Thickener and Study its Qualities

Yogesh Appaso Sargar and Shrikant Baslingappa Swami*

Department of Post-Harvest Engineering, Post-Graduate Institute of Post-Harvest Management, Killa-Roha. Dist: Raigad (Maharashtra State) (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli-Campus Roha), India

*Corresponding author: swami_shrikant1975@yahoo.co.in

Paper No.: 354 **Received:** 09-04-2026 **Revised:** 21-05-2026 **Accepted:** 01-06-2026

ABSTRACT

The study was conducted to develop a healthy leafy vegetables soup mixes supplemented with amaranthus and spinach powder with jackfruit seed starch as a thickner and evaluate its nutritional qualities. Nutritional analysis and sensory evaluation were done by standard method. In this study, moisture, ash, protein, fat, fiber, carbohydrate, and calorific value for soup mixes were ranged from 5.49 to 6.97%, 6.03 to 7.10%, 9.16 to 9.60%, 2.12 to 2.46%, 19.29 to 20.45 %, 54.48 to 56.51% respectively. The sensory evaluation of all soup samples were conducted using 9 point hedonic scale, the treatment T_2 with 6 % amaranthus and 28 % spinach was highly accepted by the panel. On the basis of nutritional analysis and sensory scores of soup mixes the treatment T_2 of leafy vegetable soup mixes was selected as best formulation.

Keywords: Soup, nutritional, sensory

Instant soups are a wide group of dried foods, which play an important role in the nutrition of people as they satisfy the present and future consumer requirements. Vegetable soup is a high water containing food. An easy and convenient way of making a soup is to use a soup base in the form of granule and powder material apart from the cumbersome way of peeling vegetables, cutting, chopping, hot extraction, cooking with thickening agent, seasoning and garnishing further before serving. Soup is often served as the starter, first course or entree before the main meal as it stimulates appetite and provides quick nourishment, which is mainly responsible for the improvement of appetite and gastrointestinal responses (Cecil *et al.* 1999). Also, it may be considered as the best nutrient vehicle for the all sections of the society.

Soup is primarily a liquid heterogeneous food, predominantly served hot, which is prepared using vegetables or meat with stock, juice or water with some thickening agent. Soups are classified into two main groups: clear soup and thick soups. Clear soups are mainly prepared from the use of clear extracts of edible animal or plant parts while cereal or pulse flour, starch; cream or eggs for the thick soup (Singh and Prasad, 2014).

Soup is prepared by blending dried ingredients with thickening agents. Traditionally, soups are classified into two main groups: *clear soups* and *thick soups*. The established French classifications of clear soups are

How to cite this article: Sargar, Y.A. and Swami, S.B. (2026). Effect of Different Drying Methods and Packaging Materials on Quality Parameters of Stored Beetroot Slices. *Int. J. Food Ferment. Technol.*, **16**(01): 165-176.

Source of Support: None; **Conflict of Interest:** None

bouillon and *consomme*. Thick soups are classified depending upon the type of thickening agent used: *purees* are vegetable soups thickened with starch; *bisques* are made from puréed shellfish or vegetables thickened with *cream*; cream soups may be thickened with bechamel sauce; and *veloutes* are thickened with eggs, butter, and cream. Other ingredients commonly used to thicken soups and broths include rice, lentils, flour, and grains; many popular soups also include carrots and potatoes (Chandramouli *et al.* 2012).

People are passing hectic life due to urbanization. They do not have enough time to cook foods and are becoming habituated to consume fast foods. Most of these foods are junk foods due to high sugar, fat, salt content, and low nutrient value in terms of protein, fiber, vitamin, and mineral content (Farzana *et al.* 2016). One of the easy-to-cook foods that are available in our country is dried soup powder which is playing an important role in fulfilling present and future social consumer requirements (Krejcova *et al.* 2007). The nutritional quality could be improved by introducing protein, minerals, and vitamin sources from plant origin that are suitable for all types of people. Generally leafy vegetables have high nutritious values and highly perishability in nature. The spinach and amaranthus could be a good source for making instant soup mix. The utilization of vegetable as protein source continued to attract attention globally because of the presence of affordable nutrients particularly to feed low income populations mainly to combat the protein energy malnutrition problems (Prasad and Singh, 2014). Dried soup powders have an advantage of protection from enzymatic and oxidative spoilage and flavor stability at room temperature over long periods of time (6–12 months). In addition, they are ready for reconstitution in a short time for working families, hotels, hospitals, restaurants, and institutional use as well as to military rations. Moreover, they exert light weight for shipping and availability at all time of the year (Yadav *et al.* 2010).

Among all dehydrated products, Instant mixes gained popularity in the recent years, by way of providing convenience, hygienic, reduce drudgery, extensible shelf life, easy to carry so that it reduces the transportation cost especially to the armed forces and available in various packages and it requires very less time to be taken to prepare food (Premavalli *et al.* 2005). Instant soups are designed for fast and simple preparation. Dry soup mixes are now an established food item in the world food markets. Commercial instant soups mixes are usually dried or dehydrated, canned or treated by freezing.

Various researchers was attempted the instant soup mixes from seaweed based soup powder, barley flaxseed based soup powder, legume and vegetable based soup powder, mushroom whey soup powder, soup using millets (foxtail millet, pearl millet and finger millet), soup mixes supplemented with legume (lentil, green pea and chick pea), soup with soy, mushroom and moringa leaf powder (Jaysinghe *et al*. 2016; Kaur and Das, 2014; Rokhsana *et al*. 2007; Singh *et al*. 2003; Anita *et al.* 2016; Amal *et al.* 2014; Farzana *et al.* 2017), however no attempt has been made so far to develop instant soup mixes using amaranthus and spinach.

In this paper an attempt has been made to develop instant soup mixes using amaranthus, spinach and the thickening agent was used as jackfruit seed starch.

MATERIALS AND METHODS

Preparation of raw material for soup mix

The amaranthus and spinach leaves dried at 45°C for 10.5 and 8.5 hrs respectively. The final moisture content of amaranthus leaves were 5.22 % (db) and spinach leaves were 5.11 % (db). Onion slices and garlic slices was dried at 55°C for 18 hrs and 15.5 hrs to the moisture content 8.46 % (db) and 6.26 % (db) respectively, and make powder to use as seasoning mixture in the soup mixes also carrot cubes were dried at 55°C for 11.5 hrs to 8.00 % (db) moisture content (db) use in mixes. The other seasoning mixture like spices cumin, coriander, black pepper, chilli etc, was collected from local market of Roha.

Formulation of instant soup mixes

Table 1 shows the treatment combination of the dried powders of soup mixes prepared by adding both leafy vegetables at different composition and jackfruit seed starch was used as thickening agent in soup mixes, also different seasoning mixtures cumin powder, coriander powder, black pepper powder, onion powder, garlic powder, chilli powder, citric acid and salt along with carrot cubes in the proportion 0.66, 0.66, 1.33, 2, 1.06, 5, 0.33, 7.33 and 4.66 g/100g making total 23 % were used in the mixes.

Table 1: Treatment combinations of both spinach and amaranthus is added with jackfruit seed starch and other ingredients g/100g

Ingredients	T_1	T_2	T_3	T_4	T_5
Amaranthus	2	6	10	14	18
Spinach	32	28	24	20	16
Jackfruit seed starch	43	43	43	43	43
*Other ingredients	23	23	23	23	23

**Other ingredients- cumin powder, coriander powder, black pepper powder, onion powder, garlic powder, chilli powder, citric acid, salt and carrot cubes.*

Nutritional evaluation of soup mixes

1. Moisture content % (wb)

The moisture content of instant leafy vegetable soup mix with jackfruit seed starch for treatment T_1, T_2, T_3, T_4, and T_5 was determined as per AOAC, 2010. The moisture content was determined by the hot air oven method at 105°C ±1°C for 24 hours. The final weight of instant leafy vegetable soup mixes sample was recorded after 24 hours. The moisture content of the instant leafy vegetable soup mixes was determined by following formula (Chakraverty, 1994). The each observation was recorded three times and average reading was reported.

$$\text{Moisture content (wb)\%} = \frac{W_1 - W_2}{W_1} \times 100 \quad \ldots(1)$$

2. Protein (%)

Protein content in the instant leafy vegetable soup mix with jackfruit seed starch for treatment T_1, T_2, T_3, T_4, and T_5 was determined by a micro-Kjeldahl distillation method (AOAC 2000). The instant leafy vegetable soup mixes powder sample was digested by heating with concentrated sulphuric acid (H_2SO_4) in the presence of digestion mixture, potassium sulphate (K_2SO_4) and copper sulphate ($CuSO_4$). The mixture was then made alkaline with 40% NaOH. Ammonium sulphate thus formed. Released ammonia which was collected in 4% boric acid solution and titrated again with standard HCL. The percent nitrogen content of the sample was calculated by the formula given below. Total protein content was calculated by multiplying the amount of percent nitrogen with appropriate factor (6.25). The observations were recorded three times and average reading was reported.

$$\%N = 104 \times \frac{(mL\ HCL - mL\ blank) \times Conc.\ of\ HCL}{Weight\ of\ sample(g)} \quad \ldots(2)$$

$$\%\ Protein = \%\ N \times Factor\ (6.25)$$

3. Crude fat (%)

Crude fat of instant leafy vegetable soup mix with jackfruit seed starch for treatment T_1, T_2, T_3, T_4, and T_5 was estimated as crude ether extract of the dry material. The dry sample of instant leafy vegetable soup mixes (5g) was weighed accurately into a thimble and plugged with cotton. The thimble was then placed in a soxhlet apparatus and extracted with anhydrous ether for 3 hrs. The ether was then evaporated and the flask with the residue dried in an oven at 80°C to 100°C, cooled in desiccators and weighed. The fat content was expressed as g/100g (AOAC, 1995). The each experiment was repeated three times and average reading was reported.

$$\text{Crude fat content (g/100g)} = \frac{\text{Weight of ether extracted}}{\text{Weight of sample taken}} \times 100 \quad \ldots(3)$$

5. Crude fibre (%)

About 2–5 g of moisture and fat free sample of

instant leafy vegetable soup mix with jackfruit seed starch for treatment T_1, T_2, T_3, T_4, and T_5 available in filter paper from fat extraction method (Ranganna, 1986) was weighed into a 500 ml beaker and a 200 ml of boiling 0.25 N sulphuric acid was added to the mixture and boiled for 30 min keeping the volume constant by addition of water at frequent intervals. The mixture was filtered through a muslin cloth and then transferred to the same beaker and 200 ml of boiling 0.313 N (1.25 %) NaOH was added. After boiling for 30 min, the mixture was filtered through muslin cloth. The residue was washed with hot water till free from alkali, followed by washing with alcohol and ether. It was then transferred to crucible, dried overnight at 80°C to 100°C and weighed. The crucible was heated in muffle furnace at 525°C for 2 to 3 hrs, cooled and weighed again. The difference in the weights represented the weight of crude fibre, Rangana (1986). The each experiment was repeated three times to get the replication. The average reading of crude fibre was reported.

$$\text{Crude Fiber (g/100g)} = \frac{\text{Weight of crucible with ash} - \text{Weight of crucible}}{\text{Weight of sample}} \times 100 \quad \ldots(4)$$

4. Ash (%)

The tare weight of three silica dishes (7-8 cm dia) was noted and 5 g of the instant leafy vegetable soup mix with jackfruit seed starch sample for treatment T_1, T_2, T_3, T_4, and T_5 was weighed into each silica dish. The contents were ignited on a Bunsen burner and the material was ashed at not more than 525°C for 4 to 6 hrs, in a muffle furnace. The dishes were cooled and weighed. The difference in weights represented the total ash content and was expressed as percentage, (Rangana, 1986). The each experiment was repeated three times to get the replication. The average reading of ash content was reported.

$$\text{Ash (\%)} = \frac{\text{Weight of crucible with ash} - \text{Weight of crucible}}{\text{Weight of sample}} \times 100 \quad \ldots(5)$$

6. Carbohydrates (%)

Carbohydrate content of instant leafy vegetable soup mix with jackfruit seed starch for treatment T_1, T_2, T_3, T_4, and T_5 was determined by subtracting the total sum of protein, fiber, ash and fat from the total dry matter (James, 1995). The carbohydrate was calculated by using following equation (6);

$$\text{\% carbohydrate} = 100 - \text{\% protein} + \text{\% fat} + \text{\% fiber} + \text{\% ash} + \text{\%moisture content} \quad \ldots(6)$$

7. Calorific value (kcal/100g)

Calorific value of instant leafy vegetable soup mix with jackfruit seed starch for treatment T_1, T_2, T_3, T_4, and T_5 was determined as follows. Calculation method involved multiplication of percent fat, protein and carbohydrates (excluding dietary fiber) by their physiological energy change coefficients (as full energy of combustion is not available in human body), i.e., 9.0, 4.0 and 4.0 kcal/g, respectively, followed by their subsequent addition (FAO, 2003). Total calories of the dried leafy vegetable soup mixes were calculated by the formula of James as follows:

$$\text{Fat} \times 9 + \text{Protein} \times 4 + \text{Total carbohydrate} \times 4 \quad \ldots(7)$$

8. Colour

Instant soup mixes made from spinach and amaranthus with jackfruit seed starch for treatment T_1, T_2, T_3, T_4, and T_5 was used to measure the colour value by using colorimeter (Konica Minotta, Japan Model-Meter CR-400). The equipment was calibrated against standard white tile and black tile. Around 20 g of instant soup mixes was taken in the glass cup, the cup was placed on the aperture of the instrument. The colour was recorded in terms of L= lightness (100) to darkness (0); a = Redness (+60) to Greenness (-60); b= yellowness (+60) to blueness (-60).

Sensory evaluation of soup samples

The reconstitution of leafy vegetable soup with jackfruit seed starch in to soup for treatment T_1, T_2, T_3, T_4, and T_5 was evaluated by conducting organoleptic evaluation by the method outlined by Dimple and

Rohanie, (2014). Initially, 10 g of all the leafy vegetable soup powder samples T_1 to T_5 of jackfruit seed starch were taken and mixed with 150ml water separately and heated for 3 to 5 minutes for 90°C. The colour, flavor, texture, mouthfeel and overall acceptability of soup were observed by 10 trained panelists. The rating for each characteristic was based on a Nine-point hedonic scale (9 = like extremely; 1 = dislike extremely). The total score for each parameter were obtained from the panelist. The 10 panel members divided in three groups as 4, 3 and 3 members in group and the average score of each group was taken as 3 replication for statistical analysis. Statistical analysis was carried out to test the significance of each score by F test.

Optimum treatment for best product based on nutritional analysis and best sensory score

Optimum product should have better nutritional properties i.e. moisture be less, more protein, lower fat, more ash, more crude fibre and more calorific value and more carbohydrate. Those sensory scores for treatment T_1, T_2, T_3, T_4, and T_5 instant leafy vegetable soup mixes with jackfruit seed starch were correlated with the best sensory scores for treatment T_1, T_2, T_3, T_4, and T_5 and best treatment were obtained.

RESULTS AND DISCUSSION

Nutritional evaluation of leafy vegetable soup mixes

1. Moisture (% wb)

The Fig. 1 shows moisture content, (% wb) of various treatments T_1, T_2, T_3, T_4, and T_5 for leafy vegetable soup mixes using thickening agent jackfruit seed starch.

The moisture content for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 5.49 to 6.97 (% wb), it was 5.88, 6.05, 5.49, 6.70 and 6.97 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest moisture content was observed for treatment T_5 and lowest moisture content was observed at treatment T_3. From Fig. 1 the trend shows that as the concentration of amaranthus was increased using jackfruit seed starch from treatment T_1 to T_5 the moisture content shows slightly increasing trend. Table 2 (a) shows the ANOVA for the effect of treatment combination T_1 to T_5 on the moisture content of soup mixes using jackfruit seed starch. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the moisture content (% wb) of soup mixes for jackfruit seed starch at $p \leq 0.01$.

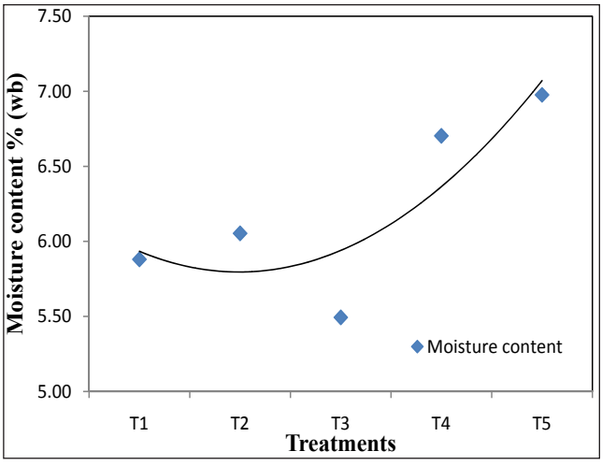


Fig. 1: Moisture content in leafy vegetable soup mixes in treatments (T_1 to T_5)

Water has several effects on food stability, palatability, and overall quality. Moisture can affect the physical properties such as hardening or clotting in powder or powder product. Water as a plasticizer, has an additional effect on the shelf life of low and intermediate moisture foodstuffs (Sunyato and Futiwati, 2012). Amal *et al.* 2014 reported the moisture content of soup mixes supplemented with some legumes was 8.51 to 9.77 %. Farzana *et al.* 2017 reported the moisture content of soup with soy, mushroom and moringa leaf powder was 2.83 to 5.46 %.

2. Protein

The Fig. 2 shows protein content % of various treatments T_1, T_2, T_3, T_4, and T_5 for leafy vegetable soup mixes using thickening agent jackfruit seed starch.

The protein content for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 9.16 to 9.6 %, it was 9.16, 9.27, 9.6, 9.34 and 9.44 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest protein content was observed for treatment T_3 and lowest protein content was observed at treatment T_1. From Fig. 2 the trend shows that as the concentration of amaranthus was increased using jackfruit seed starch from treatment T_1 to T_5 the protein content shows gradual increasing followed by decreasing trend. Table 2 (b) shows the ANOVA for the effect of treatment combination T_1 to T_5 on the protein content of soup mixes using jackfruit seed starch. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the protein content (%) of soup mixes for jackfruit seed starch at $p \leq 0.01$.

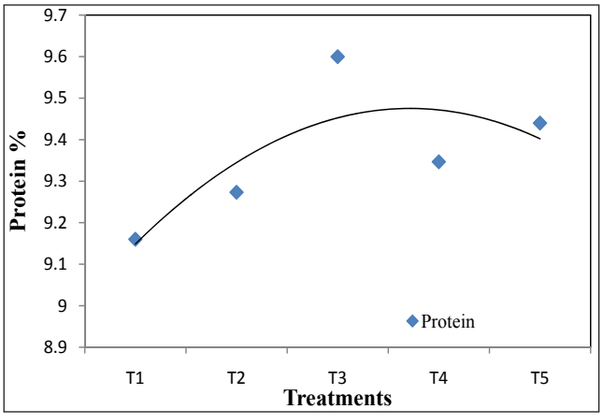


Fig. 2: Protein content in leafy vegetable soup mixes in treatments (T_1 to T_5)

Amal *et al.* 2014 reported the protein content of soup mixes supplemented with some legumes was 7.56 to 15.59 %. Farzana *et al.* 2017 reported the protein content of soup with soy, mushroom and moringa leaf powder was 6.92 to 16.05%. Singh *et al.* 2003 reported protein content of mushroom whey soup 8.35 %. Anita *et al.* 2016 reported protein content for soup of (foxtail, pearl and finger millet) millets was 6.52 to 9.74%.

3. Fat

The Fig. 3 shows fat content % of various treatments T_1, T_2, T_3, T_4, and T_5 for leafy vegetable soup mixes using thickening agent jackfruit seed starch.

The fat content for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 2.12 to 2.46 %, it was 2.35, 2.24, 2.12, 2.42 and 2.46 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest fat content was observed for treatment T_5 and lowest fat content was observed at treatment T_3. From Fig. 3 the trend shows that as the concentration of amaranthus was increased using jackfruit seed starch from treatment T_1 to T_5 the fat content shows gradual decreasing followed by increasing trend. Table 2 (c) shows the ANOVA for the effect of treatment combination T_1 to T_5 on the fat content of soup mixes using jackfruit seed starch. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the fat content (%) of soup mixes for jackfruit seed starch at $p \leq 0.01$.

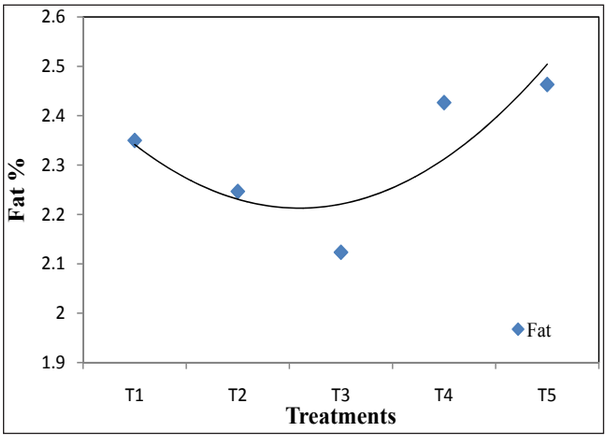


Fig. 3: Fat content in leafy vegetable soup mixes in treatments (T_1 to T_5)

Amal *et al.* 2014 reported the fat content of soup mixes supplemented with some legumes was 2.94 to 5.33 %. Farzana *et al.* 2017 reported the fat content of soup with soy, mushroom and moringa leaf powder was 4.22 to 6.39 %. Anita *et al.* 2016 reported fat content for soup of (foxtail, pearl and finger millet) millets 3.35 to 3.46%.

4. Fibre

The Fig. 4 shows fibre content % of various treatments

T_1, T_2, T_3, T_4, and T_5 for leafy vegetable soup mixes using thickening agent jackfruit seed starch.

The fibre content for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 19.29 to 20.45 (%), it was 20.19, 19.29, 20.45, 19.36 and 19.76 % for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest fibre content was observed for treatment T_3 and lowest fibre content was observed at treatment T_2. From Fig. 4 the trend shows that as the concentration of amaranthus was increased using jackfruit seed starch from treatment T_1 to T_5 the fibre content shows gradual decreasing trend. Table 2 (d) shows the ANOVA for the effect of treatment combination T_1 to T_5 on the fibre content of soup mixes using jackfruit seed starch. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the fibre content (%) of soup mixes for jackfruit seed starch at $p \leq 0.01$.

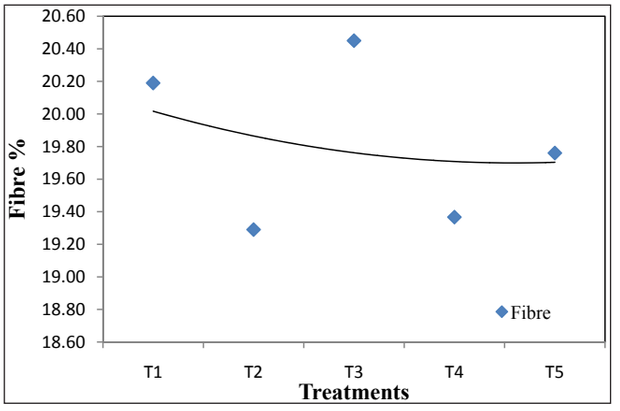


Fig. 4: Fibre content leafy vegetable in soup mixes in treatments (T_1 to T_5)

Amal *et al.* 2014 reported the fibre content of soup mixes supplemented with some legumes was 1.74 to 4.39 %. Farzana *et al.* 2017 reported the fibre content of soup with soy, mushroom and moringa leaf powder was 0.22 to 1.41 %. Kaur and Das, 2014 reported fiber content of barly flaxseed based soup was 4.36%.

5. Ash

The Fig. 5 shows ash content % of various treatments T_1, T_2, T_3, T_4, and T_5 for leafy vegetable soup mixes using thickening agent jackfruit seed starch.

The ash content for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 6.03 to 7.10 (%), it was 6.03, 6.62, 7.10, 6.70 and 6.87 % for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest ash content was observed for treatment T_3 and lowest ash content was observed at treatment T_1. From Fig. 5 the trend shows that as the concentration of amaranthus was increased using jackfruit seed starch from treatment T_1 to T_5 the ash content shows gradual increase followed by constant trend. Table 2 (e) shows the ANOVA for the effect of treatment combination T_1 to T_5 on the ash content of soup mixes using jackfruit seed starch. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the ash content (%) of soup mixes for jackfruit seed starch at $p \leq 0.01$.

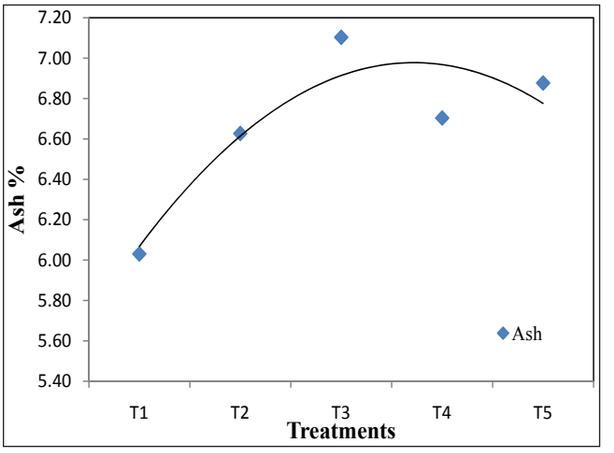


Fig. 5: Ash content in leafy vegetable soup mixes in treatments (T_1 to T_5)

Amal *et al.* 2014 reported the ash content of soup mixes supplemented with some legumes was 6.28 to 6.82 %. Farzana *et al.* 2017 reported the ash content of soup with soy, mushroom and moringa leaf powder was 9.39 to 16.48 %. Jaysinghe *et al.* 2016 reported ash content of seaweed based soup was 9.5 to 9.7 %. Rokhsana *et al.* 2007 reported ash content of legume and vegetable based soup was 4.5 to 5.79%.

6. Carbohydrate

The Fig. 6 shows carbohydrate content % of various treatments T_1, T_2, T_3, T_4, and T_5 for leafy vegetable

soup mixes using thickening agent jackfruit seed starch.

The carbohydrate content for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 54.48 to 56.51 (%), it was 55.31, 56.51, 56.30, 55.45 and 54.48 % for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest carbohydrate content was observed for treatment T_2 and lowest carbohydrate content was observed at treatment T_5. From Fig. 6 the trend shows that as the concentration of amaranthus was increased using jackfruit seed starch from treatment T_1 to T_5 the carbohydrate content shows gradual increasing followed by decreasing trend. Table 2 (f) shows the ANOVA for the effect of treatment combination T_1 to T_5 on the carbohydrate content of soup mixes using jackfruit seed starch. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the carbohydrate content (%) of soup mixes for jackfruit seed starch at $p \leq 0.01$.

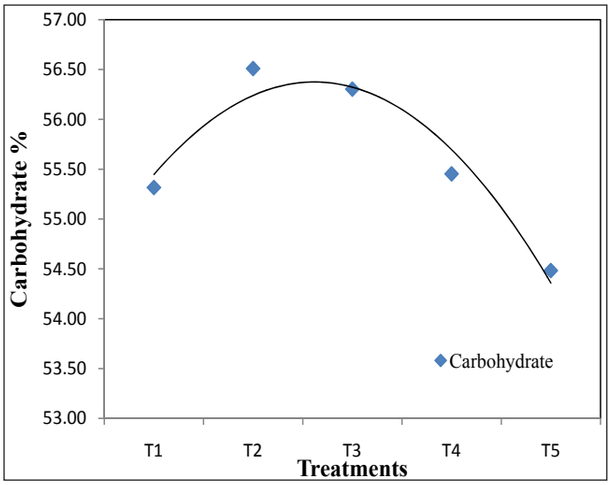


Fig. 6: Carbohydrate content in leafy vegetable soup mixes in treatments (T_1 to T_5)

Farzana *et al.* 2017 reported the carbohydrate content of soup with soy, mushroom and moringa leaf powder was 58.41 to 75.41 %. Jaysinghe *et al.* 2016 reported carbohydrate content of seaweed based soup was 51.32 to 64.54 %. Rokhsana *et al.* 2007 reported carbohydrate content of legume and vegetable based soup was 65.08 to 66.87%.Kaur and Das, 2014 reported carbohydrate content for barly flaxseed based soup was 49.36%.

7. Calorific value

The Fig. 7 shows calorific value (kcal/100g) of various treatments T_1, T_2, T_3, T_4, and T_5 for leafy vegetable soup mixes using thickening agent jackfruit seed starch.

The calorific value for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 277.86 to 283.35 (kcal/100g), it was 279.05, 283.35, 282.72, 281.04 and 277.86 (kcal/100g) for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest calorific value was observed for treatment T_2 and lowest calorific value was observed at treatment T_5. From Fig. 7 the trend shows that as the concentration of amaranthus was increased using jackfruit seed starch from treatment T_1 to T_5 the calorific value shows rapid increasing followed by rapid decreasing trend. Table 2 (g) shows the ANOVA for the effect of treatment combination T_1 to T_5 on the calorific value of soup mixes using jackfruit seed starch. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the calorific value (kcal/100g) of soup mixes for jackfruit seed starch at $p \leq 0.01$.

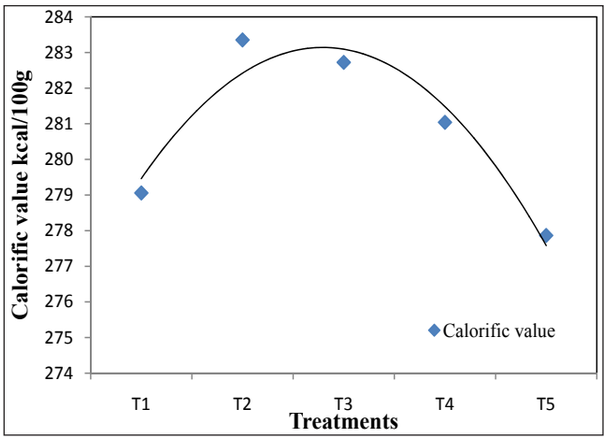


Fig. 7: Calorific value in leafy vegetable soup mixes in treatments (T_1 to T_5)

Farzana *et al.* 2017 reported the calorific value of soup with soy, mushroom and moringa leaf powder

was in range of 337.42 to 386.72 kcal/100 g. Amal *et al.* 2014 reported the calorific value for soup mixes supplemented with some legumes was 387.42 to 401.53 kcal/100 g. Rokhsana *et al.* 2007 reported calorific value for legume and vegetable based soup was 347 to 353 kcal/100g.

8. Colour of soup mixes

Table 2(h) shows colour '*L*' value for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 67.95 to 71.52, it was 68.29, 67.95, 71.52, 69.64 and 70.18 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest colour '*L*' value was observed for treatment T_3 and lowest colour '*L*' value was observed at treatment T_1. The colour values '*L*' was significantly different at p≤0.01.

Table 2(i) shows colour 'a' value for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of -7.20 to -6.18, it was -6.18, -6.34, -6.70, -7.07 and -7.20 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest colour '*a*' value was observed for treatment T_1 and lowest colour '*a*' value was observed at treatment T_5. The colour values '*a*' were significantly different at p≤0.01.

Table 2(j) shows colour '*b*' value for leafy vegetable soup mixes using jackfruit seed starch as a thickening agent was in the range of 23.81 to 25.37, it was 23.81, 24.11, 25.37, 25.15 and 24.86 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest colour '*b*' value was observed for treatment T_3 and lowest colour '*b*' value was observed at treatment T_1. The colour values '*b*' was significantly different at p≤0.01.

Sensory evaluation of prepared soup samples

Sensory quality attributes of the soup with leafy vegetables i.e. amaranthus and spinach with jackfruit seed starch as a thickening agent for treatments T_1, T_2, T_3, T_4, and T_5 are presented in Table 4 respectively.

1. Colour

The Table 3(a) shows sensory colour score for the reconstituted soup for various treatments of soup mixes prepared from amaranthus and spinach with jackfruit seed starch as a thickening agent i.e. treatments T_1, T_2, T_3, T_4, and T_5 respectively. The sensory colour was in the range of 7.76 to 8.05 the colour was highest for treatment T_2 (8.05) and lowest for T_4 (7.76). The control sample had colour score was 7.78. The treatments had significant effect on the colour score at p≤0.01.

2. Flavour

The Table 3(b) shows sensory flavour score for the reconstituted soup for various treatments of soup mixes prepared from amaranthus and spinach with jackfruit seed starch as a thickening agent i.e. treatments T_1, T_2, T_3, T_4, and T_5 respectively. The sensory flavour was in the range of 7.61 to 8.05 the flavour was highest at treatment T_2 (8.05) and lowest for T_5 (7.61). The control sample had flavour score

Table 2: Nutritional composition of soup mixes with jackfruit seed starch

Sl. No.	Treatment		T_1	T_2	T_3	T_4	T_5	SEm(±)	$CD_{at\ 1\%}$
(a)	Moisture % (wb)		5.88± 0.06	6.05± 0.04	5.49 ± 0.13	6.70 ± 0.02	6.97 ±0.19	0.064	0.202
(b)	Protein		9.16± 0.03	9.27± 0.01	9.6± 0.05	9.34 ± 0.04	9.44 ±0.03	0.021	0.670
(c)	Fat		2.35± 0.02	2.24 ± 0.05	2.12± 0.03	2.42 ± 0.04	2.46 ±0.07	0.027	0.870
(d)	Fibre		20.19±0.26	19.29 ± 0.02	20.45 ± 0.02	19.36±0.005	19.76 ± 0.02	0.070	0.220
(e)	Ash		6.03± 0.01	6.62± 0.02	7.10 ± 0.01	6.70 ± 0.02	6.87 ±0.03	0.013	0.041
(f)	Carbohydrate		55.31±0.34	56.51± 0.06	56.30 ± 0.13	55.45±0.11	54.48 ± 0.26	0.121	0.383
(g)	Calorific value		279.05±1.30	283.35±0.48	282.72±0.43	281.04±0.02	277.86 ±0.97	0.452	1.425
(h)	Colour	*L*	68.29±0.095	67.95±0.055	71.52±0.115	69.64±0.085	70.18± 0.03	0.0473	0.149
(i)		*a*	-6.18±0.035	-6.34± 0.011	-6.70± 0.017	-7.07±0.005	-7.20± 0.020	0.011	0.037
(j)		*b*	23.81±0.050	24.11±0.011	25.37± 0.04	25.15±0.032	24.86± 0.015	0.060	0.019

was 7.65. The treatments had significant effect on the flavour score at p≤0.01.

3. Texture

The Table 3(c) shows sensory texture score for the reconstituted soup for various treatments of soup mixes prepared from amaranthus and spinach with jackfruit seed starch as a thickening agent i.e. treatments T_1, T_2, T_3, T_4, and T_5 respectively. The sensory texture was in the range of 7.60 to 8.01 the texture was highest at treatment T_2 (8.01) and lowest for T_4 (7.60). The control sample had texture score was 7.63. The treatments had significant effect on the texture score at p≤0.01.

4. Mouthfeel

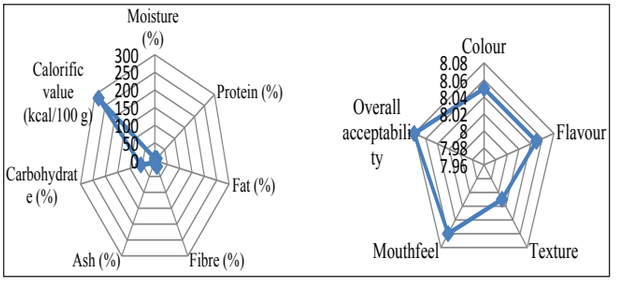
The Table 3(d) shows sensory mouthfeel score for the reconstituted soup for various treatments of soup mixes prepared from amaranthus and spinach with jackfruit seed starch as a thickening agent i.e. treatments T_1, T_2, T_3, T_4, and T_5 respectively. The sensory mouthfeel was in the range of 7.56 to 8.06 the mouthfeel was highest at treatment T_2 (8.06) and lowest for T_4 (7.56). The control sample had mouthfeel score was 7.69. The treatments had significant effect on the mouthfeel score at p≤0.01.

5. Overall acceptability

The Table 3(e) shows sensory overall acceptability score for the reconstituted soup for various treatments of soup mixes prepared from amaranthus and spinach with jackfruit seed starch as a thickening agent i.e. treatments T_1, T_2, T_3, T_4, and T_5 respectively. The sensory overall acceptability was in the range of 7.71 to 8.08 the overall acceptability was highest at treatment T_2 (8.08) and lowest for T_4 (7.71). The control sample had overall acceptability score was 7.77. The treatments had significant effect on the overall acceptability score at p≤0.01.

Based on nutritional and sensory analysis the soup mixes prepared with amaranthus and spinach and jackfruit seed starch as a thickening agent Fig. 8 shows the best treatment score for (a) nutritional and (b) sensory analysis. It indicated that treatment T_2 shows the best treatment which had moisture 6.05 % (wb), protein 9.27 %, 2.24 fat %, 19.29 fibre %, ash 6.62 %, carbohydrate 56.51 %, calorific value 283.35 kcal/100g and sensory score colour 8.05, flavour 8.05, texture 8.01, mouthfeel 8.06 and overall acceptability 8.08.

Best treatment T_2 from treatment T_1 to T_5 of jackfruit seed starch formulation



(a) (b)

Fig. 8: (a) Nutritional analysis of soup with jackfruit seed starch **(b)** Sensory analysis of soup with jackfruit seed starch of treatment T2 of soup

Table 5: Sensory scores of soup mixes with jackfruit seed starch

Sl. No.	Treatment	T_1	T_2	T_3	T_4	T_5	Control	SEm(±)	$CD_{at\ 1\%}$
(a)	Colour	8.02±0.06	8.05±0.35	7.92±0.28	7.76±0.28	7.77±0.32	7.78±0.99	0.163.	0.514
(b)	Flavour	7.84±0.45	8.05±0.69	8.00±0.52	7.64±0.42	7.61±0.43	7.65±1.11	0.296	0.933
(c)	Texture	7.79±0.37	8.01±0.38	7.96±0.20	7.60±0.21	7.65±0.08	7.63±0.92	0.159	0.502
(d)	Mouthfeel	7.77±0.61	8.06±0.40	7.94±0.28	7.56±0.14	7.66±0.12	7.69±0.94	0.209	0.661
(e)	Overall acceptability	7.97±0.49	8.08±0.33	8.02±0.21	7.71±0.27	7.76±0.26	7.77±0.88	0.190	0.600

CONCLUSION

The present research reveals that leafy vegetables (amaranthus and spinach powder) based soup mixes using along with jackfruit seed starch as a thickening agent was found to be superior in quality. Nutritional analysis and sensory evaluation were done by standard method. In this study, moisture, ash, protein, fat, fiber, carbohydrate, and calorific value were ranged from 5.49 to 6.97%, 6.03 to 7.10%, 9.16 to 9.60%, 2.12 to 2.46%, 19.29 to 20.45 %, 54.48 to 56.51% and 277.86 to 283.35 kcal/100 g, respectively for jackfruit seed starch as a thickening agent. Treatment T_2 ranked high in sensory attributes of colour, flavour, texture, mouthfeel and overall acceptability. On the basis of nutritional analysis and sensory scores of soup mixes, the treatment T_2 of leafy vegetable soup mixes with jackfruit seed starch formulation was best.

GENERATIVE AI DECLARATION

The author(s) confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI. The authors developed and verified all scientific content, data analysis, interpretation of results, and conclusions. The authors take full responsibility for the accuracy, integrity, and originality of the work presented, and no AI tool was listed as an author.

REFERENCES

Amal, M., Abdel-Haleem, H and Azza, A.O. 2014. Preparation of dried vegetarian soup supplemented with some legumes. *Food and Nutrition Science,* **5**: 2274-2285.

Anita, S., Sameshwari, T. and Kalpana, B. 2016. "Formulation and evaluation of instant soup powder using millets', *International Journal of Current Research,* **8**(08): 35668-35673

AOAC. 2000. Official methods of analysis of association of official analytical chemistry International 17th ed. Gaithersburg, MD: Association of Analytical Communities.

Cecil, J.E., Francis, J. and Read, N.W. 1999. Comparison of the effects of a high-fat and high-carbohydrate soup delivered orally and intragastrically on gastric emptying, appetite, and eating behaviour. *Physiology and Behavior*, **67**(2): 299-306.

Chakraverty, A. 1994. *Post-harvest technology of cereals, pulses and oilseeds*. New Delhi Oxford and IBH Publishing Co, Third Edition.

Chandramouli, P., Divya, V.S., Bharathi, A., Bharathiraja, B., and Jayamuthunagai, J. Standardisation and nutritional analysis of soup powder prerepared from *Moringa oleifera, Solanum trilobatum, Centella asiatica. International Journal of Future Biotechnology*, **1**(1): 1-16.

Dimple Singh-Ackbarali and Maharaj, R. 2014. Sensory Evaluation as a Tool in Determining Acceptability of Innovative Products Developed by Undergraduate Students in Food Science and Technology at The University of Trinidad and Tobago, *Journal of Curriculum and Teaching,* **3**(1).

FAO, 2003. Food energy-Method of analysis and conversion factors. *In:* FAO Food and Nutrition Paper 77, Rome.

Farzana, T., Mohajan, S., Saha, T., Hossain, M.N. and 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.

James, C.S. 1995. General Food Studies. *In:* Analytical Chemistry of Foods, Blachie Academic and Professional, London, New York, Tokyo, Chapter 6, 135.

Jayasinghe, P.S., Pahalawattaarachchi, V. and Ranaweera, K.K.D.S. 2016. Formulation of Nutritionally Superior and Low Cost Seaweed Based Soup Mix Powder. *J. Food Process Technol.*, **7**: 571.

Kaur, S. and Das, M. 2015. Nutritional and functional characterization of barley flaxseed based functional dry soup mix. *Journal of Food Science and Technology*, **52**(9): 5510-5521.

Krejčová, A., Černohorský, T. and Meixner, D. 2007. Elemental Analysis of Instant Soups and Seasoning Mixtures by ICP-OES. *Food Chemistry*, **105**: 242-247.

Prasad, K. and Singh, Y. 2014. Rice based vegetable supplemented functional instant soup mix: Development and optimization (p. 84). Saarbrücken: Scholar's Press.

Premavalli, K.S., Madhura, C.V. and Kumar, M. 2005. Studies on tradition Indian foods –IV, Development and storage stability of green vegetables based instant mixture. *Indian Food Packer*, **4**: 68-71.

Ranganna, S. 1986. *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education.

Rekha, M.N., Yadav, A.R., Dharmesh, S., Chauhan, A.S. and Ramteke, R.S. 2010. Evaluation of antioxidant properties of dry soup mix extracts containing dill (*Anethum sowa L.*) leaf. *Food and Bioprocess Technology*, **3**: 441–449.

Rokhsana, F., Yeasmin, R. and Nahar, A. 2007. Studies on the development and storage stability of legume and vegetable based soup powder. *Bangladesh J. Agric. Res.*, **32**(3): 451–459.

Singh, S., Ghosh, S. and Patil, G.R. 2003. Development of a mushroom-whey soup powder. *Int. J. Food Sci. Technol.*, **38**: 217–224

Singh, Y. and Prasad, K. 2015. Sorption isotherms modeling approach of rice-based instant soup mix stored under controlled temperature and humidity. *Cogent Food and Agriculture*, **1**(1): 1103683.

Sunyoto, M. and Futiawati, R. 2012. The Influence of Full Cream Milk Powder Concentration on the Characteristics of "*Rasi*" Instant Cream Soup. *Journal of Agricultural Science and Technology*, **2**: 1218-1231.