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Technology Development for Preparation of Tomato Soup Powder with Incorporation of Partially Hydrolyzed Guar Gum

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ABSTRACT: The aim of this research project to develop dehydrated tomato soup powder as a functional food by utilizing partially hydrolyzed guar gum (PHGG) as a highly soluble dietary fibre enhancer, and also to improve the consistency, solving viscosity problem of prepared tomato soup. High viscosity nature of guar gum cannot be utilized as a dietary fibre for this reason guar gum was hydrolyzed partially by an enzymatic method (cellulase), PHGG can be used >1% in tomato soup when compared to guar gum. The technology was developed to standardize the process for preparation of tomato soup powder incorporated with partially hydrolyzed guar gum (PHGG) to achieve the desirable characteristics along with increase in soluble dietary fibre. Good quality of raw materials such as ginger powder, onion powder, tomato powder and garlic powder was prepared by using cabinet tray dryer at 60°C temperature. Prepared tomato powder contains good source of lycopene, β-carotene and vitamin C. Tomato soup powder was prepared from tomato powder, onion powder, ginger powder, garlic powder, chilli powder, salt, with different level incorporation of partially hydrolyzed guar gum (5%, 10%, 15%, 20%). The overall acceptability scores of prepared tomato soup revealed that 15% incorporation of partially hydrolyzed guar gum was found most acceptable among other combinations and also consistency score was increased. Prepared and selected tomato soup powder was found to contain 4.89±0.03% moisture, 9.8±0.02% ash, 1.37±0.03% fat, 8.68±0.1% protein, 51.81±0.3% carbohydrate, 23.43±1.35% total dietary fibre and 20.9±1.1% soluble dietary fibre. Tomato soup powder with incorporation of partially hydrolyzed guar gum having good source of soluble dietary fibre.

Keywords: PHGG, Tomato soup powder, Sensory, Chemical composition.

INTRODUCTION

Increasing health-consciousness has resulted in the creation of functional foods with health related benefits. Dehydrated soup powder can be prepared as a functional meals through the fortification of active substances such as soluble dietary fibre and bioactive components. Tomatoes (*Lycopersicon esculentum)* are belong to the family of Solanaceae (Farooq *et al.*, 2020). Tomatoes are good source of antioxidants such as phenolics, carotenes, lycopene (natural colorant) and vitamin C (ascorbic acid) (Aderibigbe *et al.*, 2018) and its products contain lycopene as carotenoid, it is an antioxidant and decreases risk of cardiovascular and cancer diseases, these are forms of chronic diseases (Agarwal and Venketeshwer 2000), vitamin C is a natural antioxidant prevent the scurvy diseases and capable of eliminating the degenerative diseases, vitamin A formed by conversion of β-carotene, which helps in prevention of infection, controlling immune function and skin health and also ability to cure the night vision (Hedges and Lister, 2005). Tomatoes are good source minerals such as calcium, magnesium and potassium and also contain appreciable amount of dietary fibre. Minerals helps in decrease level of blood pressure, normal growth and improvement in health condition of human possible by presence of potassium in diet (Hedges and Lister, 2005). Nutrient percent of tomatoes increases by removal of water content from it and enhance the nutrition in processed food products. With these nutritional facts in mind, dried tomato powder was prepared by drying method, it is a low cost food preservation, can be used for processing of tomatoes (Farooq *et al.,* 2020). While knowing health benefits and nutrients in tomatoes and tomato powder used as raw material for preparation of soups, ketchups, preparation of pasta, juices, sauce and canned foods, with combination of other vegetables (Hedges and Lister, 2005).

Soup is a warm and liquid food consisting of flavours and nutrients and served as hot before lunch, dinner or meal (Juana *et al.*, 2020). Soup improves the gastrointestinal response by giving nourishment quickly and stimulating appetite and also given as starter and also helps to improve the weight loss, reduces energy consumption (Cecil *et al.*, 1999) and also accelerates saliva production and stomach peristalsis, increases satiety in humans (Clegg *et al.,* 2013). Consumers prefers dry soup mix than other soups (Chavan *et al.,* 2015; Niththiya *et al.,* 2014). Dry soup mix can be prepared by spray drying of prepared soup or slurry, mixing of thickeners and formulated dry ingredients. Rice flour, corn flour and rice bran used as thickeners in preparation of soups (Chavan *et al.,* 2015).

Guar gum has unique property such as gel forming and viscosity property, based on these properties it is used as a natural thickener and stabilizer in various food products such as ketchup, icecream and juices (Barak and Mudgil, 2020). Guar gum is permitted upto 0.8% in soups and soup mixes (CFR, 1974), due to its high viscous nature 5900±100 cps (Mudgil *et al.,* 2014), it cannot be utilized as a dietary fibre in food products (Mudgil *et al.,* 2017) and also it is use-full 0.5-1% in foods, >1% negatively affects the food products by enhancing viscosity in liquid foods. To solve this problem guar gum hydrolyzed partially by an enzymatic method (Mudgil, 2018). Partially hydrolyzed guar gum (PHGG) low viscous nature (10 mPa.s), it can be used >1 percent in various food products (beverages) as a source of soluble dietary fibre (generally recognized as safe) without affecting the sensory attributes such as taste, color, odour of food products (Yoon *et al.,* 2008). PHGG has ability to cure irritable bowel syndrome (IBS) disease such as constipation and diarrhea (Giannini *et al.,* 2006), enhance the growth of bacterial cells in colon (Takahashi *et al.,* 1994), reduces lipolytic acitivity by undergoing depletion flocculation mechanism restricts bile salts emulsification (Minekus *et al.,* 2005). PHGG helps in improvement of glycemic response, improvement of atrophy of terminal ileum villi, enhancement of mineral absorption (during deficiency), prebiotic effect, hypolipidemic and hypocholesterolemic effect (Yoon *et al.,* 2008).

In view of the functional characteristics and nutritional health benefits of PHGG (partially hydrolyzed guar gum), an efforts have been under taken to utilize PHGG in tomato soup powder to enhance its consistency and imparts health benefits specially soluble dietary fibre in prepared dehydrated tomato soup powder and also tomato powder taken as major raw material in preparation of tomato soup powder.

MATERIALS AND METHODOLOGY

The present investigation was carried out in Department of Food Engineering collaboration with Department of Food Chemistry and Nutrition in College of Food Technology, VNMKV, Parbhani during year 2020-21.

Materials: The raw materials such as vaishali variety of tomatoes, red onion, garlic, ginger, salt, chilli powder were purchased from local market parbhani district, Maharashtra state. Guar gum, glass wares and chemicals required for research work was available in the Department of Food engineering and Department of Food chemistry and nutrition parbhani district of Maharashtra.

METHODOLOGY

A. Preparation of partially hydrolyzed guar gum (PHGG)”

Adjust distilled water pH 5.6 by using citric acid and addition of cellulase enzyme at concentration 0.19 mg/g of guar gum. 4 g of guar gum was dissolved in 396 ml of distilled water without formation of lumps and completely mixed and agitated the guar gum solution at 800 rpm. Transfer flask containing guar gum solution to BOD incubator and maintaining 50ºC for 4 hours, simultaneously agitated at 100 rpm. Guar gum solution forms low viscous and sterilized at 90ºC for 15 minutes for inactivation of enzyme (cellulase), filtering and freeze-drying (lyophilization) was carried out. Finally partially hydrolyzed guar gum was extracted as per method given by (Barak and Mudgil, 2020; Mudgil *et al.,* 2014).

(i) Preparation of tomato powder: Tomatoes were visually sorted based on colour, absence of physical damage and spoiled. Tomatoes were washed by using clean water to removal of soil and dirts. Cut tomatoes into 3mm thickness slices and transferred to cabinet tray dryer, further drying at 60°C temperature for 14 hours, each and every 2 hours rotate tomato slices (to avoid sticking on the trays). Dried tomato slices are grind cum mixer and packed in polythene bags.

(ii) Preparation of onion powder: Good quality of red onions was brought from the market, peeling of onions was carried out by using knife, cut into slices and transferred to cabinet tray dryer and drying at 60°C temperature for 12 hours, dried onions slices grind into fine powder by using mixer.

(iii) Preparation of ginger powder: The ginger was visually sorted based on physical damage and spoiled ginger. Ginger was washed by using clean water, cleaned ginger was taken to peeling by using stainless steel knife, cut into small pieces and transferred into cabinet tray dryer and drying at 60°C temperature for 4 hours 30 minutes, dried ginger was grind into fine powder by using mixer and allowed to cool.

(iv) Preparation of garlic powder: Garlic was visually sorted by observing physically damaged and spoiled colour patches on the garlic. Peeling of garlic was carried out by using hand, later cut into small pieces by using knife, then transferred into cabinet tray dryer and maintaining 60°C temperature for 13 hours. Dried garlic grind into fine powder and allowed to cool.

(v) Formulation of tomato soup powder: The tomato soup powder was prepared with composition of ingredients such as tomato powder, onion powder, garlic powder, chilli powder, ginger powder, salt, partially hydrolyzed guar gum and guar gum. The formulation for the five samples of tomato soup powder was prepared and presented in Table 1.

Table 1 revealed that, an efforts was under taken to develop tomato soup powder by standardization method. Onion powder (10%), ginger powder (5%), garlic powder (5%), chilli powder (2.5%) and salt (5%) were utilized same proportion in each and every sample. Tomato powder (71.5%) and guar gum (1%) utilized in T_0 (control), whereas $T_{1,}$ $T_{2,}$ $T_{3,}$ T_4 incorporated with (5, 10, 15 and 20%) PHGG and (67.5, 62.5, 57.5 and 52.5%) of tomato powder was utilized.

Table 1: Formulation of tomato soup powder with addition of PHGG

Ingredients (%)	Samples				
	T_0	T_1	T_2	T_3	T_4
Tomato powder	71.5	67.5	62.5	57.5	52.5
Onion powder	10	10	10	10	10
Garlic powder	5	5	5	5	5
Ginger powder	5	5	5	5	5
Chilli powder	2.5	2.5	2.5	2.5	2.5
Salt	5	5	5	5	5
PHGG	-	5	10	15	20
Guar gum	1	—	—	—	—

Reconstitution of the formulated tomato soup powder: Preliminary trials was evaluated for reconstitution of formulated tomato soup powder. Initially 10g of tomato soup powder was reconstituted in hot water, tomato peeling flavor was not observed based on sensory for this reason, 10g of prepared tomato soup powder was reconstituted in 100 ml, 75 ml and 60 ml of water separately and boil for 6-8 minutes. The consistency and flavour was judged by panel members. Amount of water required for reconstitution of tomato soup powder was evaluated by panelists. Finally panelist decided that 75 ml of water suitable for reconstitution of 10 g of tomato soup powder

Preparation of tomato soup with addition of partially hydrolyzed guar gum: Addition of (57.5%) tomato powder as a major ingredient , (10%) onion powder utilized as a taste improver, (5%) ginger powder, (5%) garlic powder, (2.5%) chilli powder used as a spices, (5%) salt, (1%) guar gum used as thickener in control (T_0) and (15%) PHGG utilized as a consistency improver in (T_3). All these ingredients are mixed in mixer cum grinder for the preparation of tomato soup powder. 10 g of tomato soup powder was reconstituted in 75 ml of water and boil for 6-8 min and served as a hot.

Organoleptic evaluation of prepared tomato soup: Organoleptic evaluation of PHGG (partially hydrolyzed guar gum) incorporated tomato soup was carried out by using a 9 point headonic scale with the help of trained panel members, teaching staff, post graduate students, non-teaching staff of College of Food Technology, VNMKV, Parbhani, for the purpose of knowing the sensory score, consumer wants and marketability of the product. Sensory was evaluated for initially prepared tomato soup based on color, appearance, consistency, taste, flavour. The scoring was done using 9-point Headonic scale developed by Quarter Master Food and Container Institute, USA (Gupta, 1976).

Proximate analysis: All samples were analyzed for moisture, crude fat, total ash and total carbohydrate contents to their respective standard methods as described in (AOAC, 2000), soluble and insoluble dietary fibre was estimated as per method given by (Asp *et al.*, 1983).

Computation of energy: Energy content was computated by multiplying 4, 9 and 4 for obtained values of protein, fat and carbohydrate from the analysis, and expressed in Kcal/100g this method given by Gopalan *et al.*, (1991).

Bioactive components of tomato powder

(a) Determination of Lycopene content in tomato powder: Estimation of lycopene given by (Obadina *et al.*, 2018) 1g of tomato powder was placed in 125 ml Erlenmeyer flask, the ratio 2:1:1 of hexane: ethanol: acetone (50 ml hexane: 25 ml ethanol: 25 ml acetone) totally 100 ml was added in Erlenmeyer flask. Then flask was sealed with the help of rubber stopper and kept extraction for 30 minutes. Lycopene in supernatant was measured at 503 nm absorbance by using spectrophotometer.

$$\text{Lycopene}\left(\frac{\text{mg}}{\text{kg}}\right)=\frac{A_{503}\times 171.7}{W}$$

A_{503} = Absorbance at 503 nm, W = Weight of sample

(b) Determination of β-carotene content in tomato powder: The β-carotene content (mg/100 g) was determined as per the modified method given by (Farooq *et al.*, 2020). 5 g of powder was extracted in beaker containing 10-15 ml of acetone with addition of anhydrous sodium sulfite. The sample was re-extracted until it becomes colorless. The mixture poured in separating funnel and 10-15 ml petroleum ether was added to separating funnel and a mixture was washed. The mixture was mixed thoroughly and kept for some time and formation of two phases. The upper phase was organic phase transferred to volumetric flask and volume made upto 100 ml by using petroleum ether. Petroleum ether used as blank and absorbance determined at 452 nm by using UV-spectrophotometer. β-carotene was estimated by using formula given by below.

$$\beta-\text{carotene}\left(\frac{\text{mg}}{100\text{ g}}\right)=\frac{\Delta A}{\in L}\times\frac{V}{G}\times MW\times D$$

Where, ΔA = absorbance at 452nm, ∈ = β-carotene molar extinction coefficient (2590)

L = cell path length (1cm), MW = (536.8) was molecular weight of β-carotene, D = dilution factor, V = final volume (mL), G = Weight of sample (g)

(c) Determination of ascorbic acid (Vitamin C) content in tomato powder: Vitamin C (ascorbic acid) was determined as per the modified method given by (Farooq *et al.*, 2020). Preparation of 2,6-dichlorophenol indophenols dye solution – was done 0.050 g of 2,6-dichlorophenol indophenol dye dissolved in 150 ml of hot distilled water containing 0.042 g of sodium bicarbonate. Then cooled and diluted with distilled water upto 200 ml. 10 g of tomato powder was transferred to beaker containing 100 ml of 3 percent meta-phosphoric acid and extracted for three times. The each extract was filtered by using Whatman filter paper No. 42. Then (2-10 ml) filtered (aliquot) sample was taken and titrated against 2, 6-dichlorophenol indophenols dye solution until pink color was absorbed. Dye factor = 0.5

$$\text{Ascorbic acid}\left(\frac{\text{mg}}{100\text{ g}}\right) = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made} \times 100}{\text{Aliquot taken} \times \text{Weight of sample}}$$

Quality characteristics of tomato powder analysis: Water solubility index and wettability was estimated by method of (Kumar *et al.,* 2017), water solubility index and water absorption index formula given by (Gandhi *et al.,* 2018). Colour analysis was determined by Hunter Lab Colorimeter, which is given in (Kumar *et al.,* 2017) and lightness, redness and yellowness ranged values given by Pankaj *et al.,* (2013).

Estimation of pH and Titratable acidity:

pH - pH was determined with help of digital pH meter which was firstly calibrated 4, 7 and 10 pH buffers, then by dissolving 10 g of powder in 100 ml of distilled water in beaker, then pH probe was inserted in beaker, readings were visually observed in digital pH meter .

Titratable acidity: 0.5 g of powder was accurately weighed and transferred to 20 ml of distilled water. The mixture was filtered and the supernatant was collected and titrated against 0.1N NaOH until a stable brownish pink colouration obtained. This method mentioned by (Megha, 2015). Milli equivalent of citric acid = 0.064

$$\text{Acidity (\%)} = \frac{0.064 \times \text{Titre value} \times \text{N of NaOH} \times 100}{\text{Weight of sample}}$$

Viscosity: Viscosity of guar gum, partially hydrolyzed guar gum and prepared tomato soup was measured by using (Brookfeild viscometer, U.S.A). Spindle number (S64) used for measuring viscosity of guar gum. Spindle number (S1) used for measuring viscosity of partially hydrolyzed guar gum. Spindle number (S61) used for measuring viscosity of prepared tomato soup. 1 percent aqueous solution was prepared from dissolving 1g of guar gum in 100 ml of water in a beaker, similarly 1g of partially hydrolyzed guar gum dissolved in 100ml of water. Similarly 10g of tomato soup powder reconstituted in 75 ml of water, spindle no 63 used for viscosity measurement of tomato soup. Firstly viscometer was auto zeroing was done by fixing specific spindle number (64 or 1 or 63). Spindle was inserted in beaker at 20 rpm and measured the viscosity (cPs) of different samples separately (Barak and Mudgil, 2020).

Yield: Yield was calculated by obtained weight of material after drying divided by raw material weight.

Statistical analysis: The data obtained was analyzed statically by completely Randomized design (CRD) as per the procedure given by Panse and Sukhatme, (1967). The analysis of variance revealed at significance of $P<0.05$ level, S.E, and CD. at 5% level is mentioned wherever required.

RESULTS AND DISCUSSION

Yield, percent yield and particle size of prepared powders: Tomato, garlic, onion and ginger powder was prepared by using cabinet tray dryer at 60ºC temperature. The results for yield, percent yield and sieving size (µm) of powders are presented in Table 2.

Table 2: Yield, percent yield and particle size of prepared powders.

Raw materials taken before drying (1 kg)	Yield (g/kg of raw materials)	Percent yield	Sieving size (µm)
Tomatoes	45±1.10	4.5±0.11	250
Garlic	300±1.65	30±0.16	250
Onion	130±1.51	13±0.15	250
Ginger	136.8±1.1	13.68±0.11	250

*Each value is an average of three determinations

Table 2 narrated that yield and percent yield of tomato powder was 45±1.10 g/kg and 4.5±0.11 percent respectively. Similarly yield value for tomato powder was in agreement with (Sarker *et al.,* 2014). Yield and percent yield of garlic powder was about 300±1.65 g/kg and 30±0.16 percent, onion powder was 130±1.51 g/kg and 13±0.15 percent and ginger powder was 136.8±1.1 g/kg and 13.68±0.11 percent respectively. Lowest yield and percent yield was observed in tomato powder, it may be due to high level of moisture content present in tomatoes. Particle size is important for formulation of food powder mixtures and also to known the flowability, mouth feelingness, ability of powders to dissolve in the solvent and formation of solution. A physical property of food powders mainly depends on its particle size reported by Dodds, *et al.,* (2013). Particle size of all prepared powders was kept constant (250 µm mesh size**)** to retain desirable characteristics in a reconstituted soup and also prevent the appearance of larger particles in prepared soup and maintaining soup uniformity.

Chemical composition of guar gum and PHGG: The data pertaining to chemical composition of guar gum and PHGG was recorded and presented in Table 3.

Table 3 revealed that pH of guar gum and PHGG was about 6.8 and 6.4 respectively. pH value decreased in PHGG due to addition of citric acid during hydrolysis of guar gum. PHGG showed lower moisture content (7.54±0.19%), than guar gum (9.73±0.2%), this is due to freeze drying or lyophilization process involved in preparation of PHGG. While ash content was 2.10±0.01 percent and 0.62±0.01 percent for PHGG and guar gum respectively Increasing ash content in PHGG, this may be due to addition of citric acid for maintaining pH value of enzymatic hydrolysis reported by (Mudgil *et al.*, 2018b). Total fat content was found to be higher in PHGG (1.2±0.03%) as compared to guar gum (0.76±0.025%). PHGG showed lower protein content (2.08±0.01%) than of guar gum (4.72 ± 0.02%), it is due to insoluble network of protein, after enzymatic hydrolysis of guar gum protein get separated from water soluble hydrolyzed guar gum portion during filtration step.

Table 3: Chemical composition of guar gum and partially hydrolyzed guar gum (PHGG).

Chemical composition (%)	Value	
	Guar gum	PHGG
pH	6.8	6.4
Moisture	9.73±0.2	7.54±0.19
Ash	0.62±0.01	2.10±0.01
Fat	0.76±0.025	1.2±0.03
Protein	4.72±0.02	2.08±0.01
Crude fibre	1.63±0.02	—
Carbohydrate	83.76±0.04	—
Galactomannan content	**83.64±0.02**	—
Viscosity (cPs)	3600±15	17±2
Total dietary fibre	—	81.30±1.34
Soluble dietary fibre	—	**79.00±1.15**
Insoluble dietary fibre	—	2.30±0.25

*Each value is an average of three determinations

Similarly reported by Mudgil *et al.,* (2018b). The crude fibre and carbohydrate content of guar gum was found to be 1.63 ± 0.02 percent and 83.76 ± 0.04 percent respectively. The obtained guar gum results are similar to values reported by Eldirany *et al.,* (2015); Mudgil *et al.,* (2014). Galactomannan is a carbohydrate (mannose and galactose) mainly present in guar gum and it is soluble in water and unable to digest in human intestinal track, hence it is known to be functional dietary fibre. Guar gum cannot be utilized as a dietary fibre due to its high viscous nature (Mudgil *et al.,* 2017). For this reason guar gum was hydrolyzed partially. PHGG showed lower viscosity (17±2 cPs) when compared to guar gum (3600±15 cPs). Lower viscosity of PHGG was attributed to guar gum that under goes partially hydrolysis by enzymatic method, guar gum consists of heteropolysaccharide that break down into oligosaccharide by an hydrolysis (Sun *et al.,* 2013) and also (Yoon *et al.,* 2008) reported that endo-β-D-mannanase breaks the mannan backbone-chain of galactomannan by an hydrolysis. Total dietary fibre content of PHGG was 81.30±1.34 percent, about 79.00±1.15 percent soluble dietary fibre in PHGG, while insoluble dietary fibre was about 2.30±0.25 percent respectively. It can be concluded that PHGG as a good source of soluble dietary fibre and it can be used as fibre fortification in foods, due to its low viscosity nature. The data pertaining to chemical composition of PHGG, results are similar to findings of (Barak and Mudgil, 2020; Yoon *et al.,* 2008).

Chemical composition of tomato powder prepared by cabinet drying at 60°C: Chemical composition of tomato powder such as total fat, carbohydrate, ash content, pH, protein, titratable acidity was determined and results obtained are presented in Table 4.

The data presented in Table 4 indicates that moisture and ash content for tomato powder was about 5.61±0.01 percent and 7.3±0.05 percent respectively. Similar findings were reported by Srivastava and Kulshreshtha, (2013). pH was 4.12±0.05 and titratable acidity was 4.1±0.1 percent respectively. The results were close with (Obadina *et al.,* 2018). Protein is found to be 12.1±0.02 percent while total fat contain was about 1.9±0.1 percent. The value for titratable acidity, protein and fat content of tomato powder agreement with values reported by Sarker *et al.,* (2014). Tomato powder contain 56.68 ± 1 percent of carbohydrate and 8.6±0.03 percent of crude fibre, these values are in agreement with findings of Narsing *et al.,* (2011).

Table 4: Chemical composition of tomato powder prepared by cabinet drying at 60°C.

Chemical parameters	Mean value
Moisture (%)	5.61±0.01
Ash (%)	7.3±0.05
Total fat (%)	1.9±0.1
Total protein (%)	12.1±0.02
Total carbohydrate (%)	56.68±1
Crude fibre (%)	8.6±0.03
pH	4.12±0.05
Titratable acidity (citric acid) %	4.1±0.1
Lycopene (mg/100g)	23.76±0.2
β-carotene (mg/100g)	20.4±0.1
Vitamin C (ascorbic acid) (mg/100g)	110.2±0.9

*Each value is an average of three determinations

Lycopene contain was about 23.76±0.2 mg/100g of tomato powder, lycopene responsible for deep-red color in tomatoes and its products and also exhibits antioxidant properties based on elimination of free radicals in the body, the obtained result of lycopene was similar with findings of (Obadina *et al.,* 2018) and higher than values reported by Sarker *et al.,* (2014), vitamin C was 110±0.1 mg/100g of tomato powder. As increasing temperature decreases the vitamin C content in tomato powder reported by Obadina *et al.,* (2018), the result of vitamin-C value close to results mentioned by Srivastava and Kulshreshtha, (2013) and β-carotene was 20.4±0.1 mg/100g of tomato powder, β-carotene is a precursor of vitamin A, revealed value of β-carotene was higher than findings reported by Farooq *et al.,* (2020), it may be due to method followed for drying and varieties of tomatoes. Cabinet tray dried tomato powder at 60°C temperature contains good source nutraceuticals with respect to lycopene, vitamin C and β-carotene and also source of protein, crude fibre and ash.

Quality characteristics of tomato powder prepared by cabinet drying method: Quality characteristics of tomato powder prepared by cabinet drying were determined by considering properties such as water solubility index, wettability and color index. Similarly considered by Kumar *et al.,* (2017). Color index measured by using hunter lab colorimeter, it indicates the lightness, redness and yellowness of tomato powder. L* indicates lightness, L*= 0 indicates black color, L*= 100 pure whiteness, a* positive (+) indicates red colour and a* (–) negative indicates green colour. b* positive (+) indicates yellow colour, b* (–) negative indicates blue colour. C* chroma, h* Hue angle, all these values are narrated by Pankaj *et al.,* (2013).

Table 5: Quality characteristics of tomato powder prepared by cabinet drying method.

Quality Parameters	Values
Water absorption index (g/g)	2.81±0.01
Water solubility index (%)	45.36±0.05
Wettability (g/min)	10±0.05
Colour	
L*	44.18±0.01
a*	29.03±0.02
b*	35.94±0.01
a*/b*	0.8±0.03
C*	46.18±0.01
h*	51.06±0.02

*Each value is an average of three determinations

The results for quality characteristics of tomato powder were summarized in Table 5, 1g of tomato powder absorbs 2.81±0.01g of water. Water solubility index of tomato powder was 45.36±0.05 percent respectively. These results are higher than findings reported by Kumar *et al.,* (2017), it may be due to method of drying and variety of tomatoes. Wettability defined to be 10±0.05 g of tomato powder pass into 100 ml of water surface in 1 min. similar findings was revealed by Kumar *et al.,* (2017). Color was most important quality attribute of tomato powder. Positive a* indicates redness of tomato powder was found to be 29.03±0.02, based on redness tomato powder used as natural colorant in food products, positive b* indicates yellowness 35.94±0.01 and positive L* indicates lightness 44.18±0.01 respectively. All these color values higher than the findings revealed by Obadina *et al.,* (2018) and a*/b* indicates ratio of redness to yellowness was found to be 0.8±0.03. Chroma (C*) was 46.18±0.01 and (h*) hue was 51.06±0.02. These values are in agreement with results reported by Kumar *et al.,* (2017). Good quality of tomato powder was prepared from cabinet tray dryer at 60°C.

Sensory evaluation of prepared tomato soup with addition of PHGG at varying concentration: The sensory evaluation of tomato soup was carried out with the help of trained and semi trained panel members. Sensory score were based on appearance, colour, taste, flavour, consistency and overall acceptability of prepared tomato soup samples. The sensory attributes was scored based on 9 point headonic scale readings was 9 for like extremely, 1 for dislike extremely. Sensory score compared with control sample (T_0) and PHGG incorporated samples (T_1, T_2, T_3, T_4).

Table 6: Sensory evaluation of prepared tomato soup developed with addition of PHGG at varying concentration.

Samples	Appearance	Colour	Taste	Flavour	Consistency	Overall Acceptability
T_0	7.9	8.5	7.0	7.0	7.7	7.5
T_1	8.0	8.3	7.0	8.5	8.0	8.0
T_2	8.0	8.3	7.5	8.4	8.3	8.1
T_3	**8.5**	**8.2**	**8.0**	**8.5**	**8.6**	**8.6**
T_4	7.9	8.1	7.9	7.5	8.5	7.8
SE ±	0.07621	0.2233	0.2481	0.05657	0.05604	0.04807
CD@5%	0.22352	0.6551	0.7279	0.16592	0.16438	0.141

*Each value is an average of three determinations

T_0 (control) - 1% guar gum and 71.5% of tomato powder, T_1 - 5% PHGG and 67.5% of tomato powder, T_2 - 10% PHGG and 62.5% of tomato powder, T_3 - 15% PHGG and 57.5% of tomato powder and T_4 - 20% PHGG and 52.5% of tomato powder

Sensory evaluation of the prepared tomato soup has been represented in Table 6. T_3 received maximum consistency score (8.6) followed by T_4 (8.5), T_2 (8.3), T_1 (8.0) and lowest consistency score received by T_0 (7.7). All samples received good colour score, not much variations are observed in colour attribute of developed soup samples. The colour score ranged from 8.1 to 8.5 respectively. Among the all samples T_3 (15% addition of PHGG) showed the highest score for all the sensory attributes *viz.,* appearance 8.5, colour 8.2, taste 8.0, flavour 8.5, consistency 8.6 and overall acceptability 8.6. It was observed that T_3 was liked most, followed by T_2, T_1 and T_4. By considering the sensory attributes, the tomato soup formulation T_3 was found to be statistically significant over all samples (T_0, T_1, T_2 and T_4). Therefore T_3 (addition of 15% PHGG) of tomato soup was selected for further study to prepare tomato soup powder. At finally decided that addition of 15 percent PHGG in tomato soup consistency score was increased in PHGG incorporated samples when compared to control sample.

Chemical composition of tomato soup powder with addition of PHGG: Chemical composition of such as moisture, protein, fat, carbohydrate, titratable acidity, soluble, insoluble dietary fibre was estimated and results mentioned Table 7.

Table 7: Chemical composition of tomato soup powder with addition of PHGG.

Parameters (%)	Control (T_0)	(T_3)
Moisture	4.75±0.02	4.89±0.03
Ash	10.59±0.14	9.8±0.02
Fat	1.55±0.02	1.37±0.03
Protein	10.55±0.15	8.68±0.1
Carbohydrate	58.57±0.4	51.81±0.3
Titratable acidity (citric acid)	3.11±0.05	2.74±0.04
Total dietary fibre	11.74±1.45	23.43±1.35
Soluble dietary fibre	7.15±1.2	**20.9±1.1**
Insoluble dietary fibre	4.59±0.25	2.53±0.22
Total energy value (Kcal)	290.68±0.14	251±0.35
Viscosity (cPs)	47.4	34

*Each value is an average of three determinations

T_0 (control) - 1% guar gum and 71.5% of tomato powder, T_3 - 15% PHGG and 57.5% of tomato powder

Table 7 analyzed the moisture content of control (T_0) and T_3 sample was found to be 4.75±0.02 percent and 4.89±0.03 percent respectively. The result of moisture content was agreement with FSSAI specification mentioned by Chavan, (2015). (Chavan, 2015) mentioned that moisture content (m/m) of soup powder should not more than 5 percent. Shelf life, microbial growth, maillard type of browning reactions depends on moisture content in dried products, for these reasons moisture content should be less than 5 percent in soup powder reported by Pandey, (2006). However, T_0 (control) sample showed higher ash content (10.59±0.14%), than T_3 sample (9.8±0.02%). Protein content was significantly higher in T_0 (control) sample (10.55±0.15%) than T_3 sample (8.68±0.1%). The value of carbohydrate content in T_3 was 51.81±0.1 percent and T_0 (control) sample was found to be 58.57±0.4 percent. T_3 sample showed significantly lower fat content (1.37±0.03%), than T_0 (control) sample (1.55±0.02%). Titratable acidity for T_3 sample was 2.74±0.04 percent, which was lower than control sample. Titratable acidity of T_3 sample was similar to findings reported by Megha, (2015).

Fat, protein, carbohydrate, titratable acidity, ash content was higher in control sample when compare to T_3 sample, it is due to addition of higher percent of tomato powder in control sample than T_3 sample and also protein, fat, ash content and carbohydrate was lower in PHGG, when compared to tomato powder, which was presented in Table 3 and 4. The result showed that total dietary fibre content was 23.43±1.35 percent and 11.74±1.45 percent and soluble dietary fibre content was 20.9±1.1 percent and 7.15±1.2 percent for T_3 and T_0 tomato soup powder samples. However, insoluble dietary fibre content was significantly lower in T_3 sample (2.53±0.22%) than T_0 (4.59±0.25%) sample, it is due to crude fibre percent was higher in tomato powder when compare to PHGG. Total energy value of control T_0 and T_3 was found to be 290.68±0.14 Kcal and 251±0.35 Kcal. Table 7 results are agreement with values reported by Verma and Morga, (2017). Addition of 15 percent PHGG (partially hydrolyzed guar gum) increases the soluble dietary fibre content for T_3 when compared to control sample (T_o). Similarly addition of PHGG increases the soluble dietary fibre content in both food products such as noodles reported by Mudgil *et al.,* (2018a) and also in bread revealed by Mudgil *et al.,* (2016a). It is clear that viscosity was lower in T_3 sample (34 cPs) than control sample (47.4 cPs). It is due to addition 15 percent PHGG in T_3 sample. (Mudgil *et al.,* 2016b) reported that increasing level of PHGG decreases the viscosity of yoghurt due to increasing percent of PHGG, as increasing level of PHGG decreases the water holding capacity (WHC) of yoghurt, when water holding capacity was decreases, therefore viscosity of yoghurt also decreases. The viscosity result of tomato soup samples are close with findings of Ramana, (2004).

CONCLUSION

It can be concluded that 15 percent incorporation of partially hydrolyzed guar gum improved sensory attributes, acceptability and consistency of prepared tomato soup. Addition of 15 percent PHGG increased the soluble dietary fibre content in T_3 tomato soup powder, and its energy value was found to be 251±0.35 Kcal. Addition of PHGG decreases the viscosity of T_3 sample. Good quality of ginger powder, onion powder, garlic powder and tomato powder was prepared by using cabinet tray dryer at 60°C temperature and also tomato powder contain good source of antioxidants such as lycopene, vitamin C and β-carotene.

Tomato soup powder prepared by incorporation of partially hydrolyzed guar gum and tomato powder is an innovative product in dehydrated soup mix, as a source of highly soluble dietary fibre. It can be recommended for consumers for curing various diseases such as irritable bowel syndrome, constipation, diarrhea and also prebiotic effect.

FUTURE SCOPE

Now-a-days people are conscious towards health, so there is need of functional meals. It can be prepared by combination of (PHGG) soluble dietary fibre and tomato powder (antioxidants) in dehydrate tomato soup powder. In recent days, time required for planning and cooking foods has significantly reduced due to participation of women in work force. Dehydrated tomato soup powder is easy to prepare, available in various packs, easy to transport and also it can be used as a breakfast substitute. In coming days dehydrated tomato soup powder used as nutraceutical food to eliminate degenerative and scurvy diseases, ability to cure irritable bowel syndrome such as constipation, diarrhea and also enhance growth of beneficial bacteria cells in colon.

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