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## Development of technology for preparation of instant tomato (*Solanum lycopersicum* L.) soup mix powder

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**Abstract**

The present investigation entitled “Development of technology for preparation of instant tomato (*Solanum lycopersicum* L.) soup mix powder” was aimed to evaluate effect of thickening agents on physico – chemical parameters of instant tomato soup mix powder and effect of storage on quality of instant tomato soup mix powder. The experiment was conducted for preparation of instant tomato soup mix powder by combinations of different concentration of thickening agents [Four concentration of xanthan gum – (0.5%, 1.0%, 1.5%, 2.0%), Four concentration of potato starch – (1.0%, 2.0%, 3.0%, 4.0%), Pectin – 0.5% (control)]. The results of present investigation indicate that instant tomato soup mix powder can be prepared by blending tomato powder (50g), onion powder (5g), garlic powder (2g), coriander leaf powder (2g), salt (10g), sugar (23g), red chilli powder (3g), black pepper (2g), citric acid (1g), edible oil (2ml) along with 1.5% xanthan gum and 2.0% potato starch (T<sub>11</sub>). Instant soup mix powder blended with 1.5% xanthan gum + 2.0% potato starch (T<sub>11</sub>) rated best treatment on the basis of higher nutritional as well as sensory qualities.

**Keywords:** ITSMP (Instant tomato soup mix powder), Xanthan gum, Potato starch

**Introduction**

Tomato (*Solanum lycopersicum* L.) is a solanaceous fruit vegetable believed to have its origin in Tropical America. It is grown extensively and marketed throughout the world. It ranks next to potato and sweet potato with respect to world vegetable production. It is widely cultivated in tropical, sub-tropical and temperate climates (Thompson and Kelly, 1957) [23]. 100 g of edible fruit of tomato contains 94.7 g water, 1.0 g protein, 0.1 g fat, 1.6 g fiber, 1.9 g carbohydrates, 0.51 g organic acids, 19.1 mg vitamins and 224.5 mg minerals (Mc Glasson, 1993; Rai *et al.*, 2002) [11, 16]. Tomatoes are using as an ingredient in many dishes as well as processed products *viz*, beverage, chutney, soup, pickles, ketchup, sauce and powder. (Tiwari and Choudhary, 1973) [24]. Dried soup powders have advantages of protection from enzymatic and oxidative spoilage as well as flavor stability at room temperature over long period 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 (El Wakeel, 2007; Osman *et al.*, 1991; Rekha *et al.*, 2010) [7, 15, 19]. Tomato soup is normally consumed for its smooth texture, delicious taste and nutritional value. Instant tomato soup mix powder available in the market is generally manufactured by mixing different ingredients in dried form. Rheological behavior and colour properties of tomato soup are the important parameters which decide its acceptability by the consumers. Flow behavior of tomato soup is usually affected by constituents and the temperature of the soup while, colour is generally affected by the extent of lycopene degradation during processing and binding arrangements with other molecules of soup (Ahmed *et al.*, 2012) [1].

**Materials and Methods**

**Raw material:** The experiment was conducted at the Laboratory of Centre of Excellence on Post Harvest Technology, ASPEE college of Horticulture and Forestry, N.A.U., Navsari. Fully ripened tomatoes were procured from Regional Horticulture Research Station, Navsari Agricultural University, Navsari.

Onion, garlic and coriander leaves, various spices and condiments used for seasoning of tomato soup mix powder were obtained from local market. Xanthan gum and potato starch were collected from commercial suppliers.

**Raw material preparation:** The well ripened, healthy fruits with firm and sound texture and good flavour were selected and washed with water to remove any surface dust and dirt. Then the fruits were trimmed and sliced by stainless steel knife. Tomato slices were spread over stainless steel trays and kept for oven drying at 60-65 °C temperature for 24 hrs. After cooling, these slices were ground to obtain fine powder and sieved through mesh sizes 40 mm to get uniform powder. Onion slices, garlic cloves and coriander leaves were dried in cabinet dryer at the temperature of 60 to 65°C for 24 hrs, 18 hrs and 4 hrs, respectively. After drying and cooling they were ground by means of mixer grinder to obtain fine powder.

**Methodology adopted for product preparation:** Instant tomato soup mix powder (ITSMP) was prepared by mixing all ingredients (Tomato powder-50 g, onion powder-5 g, garlic powder-2 g, coriander leaf powder-2 g, sugar-23 g, salt-10 g, red chilli powder-3 g, black pepper-2 g, citric acid-1 g, edible oil-2 ml) along with thickening agents as per treatments.

**Experimental details:** The experiment was laid out in Completely randomized design with 17 treatments and 3 repetitions. The samples were stored in PEP bags (200 gauge).

**Table 1:** Treatment details

|                       |                                       |
|-----------------------|---------------------------------------|
| <b>T<sub>1</sub></b>  | 0.5% Pectin (control)                 |
| <b>T<sub>2</sub></b>  | 0.5% Xanthan gum + 1.0% Potato starch |
| <b>T<sub>3</sub></b>  | 0.5% Xanthan gum + 2.0% Potato starch |
| <b>T<sub>4</sub></b>  | 0.5% Xanthan gum + 3.0% Potato starch |
| <b>T<sub>5</sub></b>  | 0.5% Xanthan gum + 4.0% Potato starch |
| <b>T<sub>6</sub></b>  | 1.0% Xanthan gum + 1.0% Potato starch |
| <b>T<sub>7</sub></b>  | 1.0% Xanthan gum + 2.0% Potato starch |
| <b>T<sub>8</sub></b>  | 1.0% Xanthan gum + 3.0% Potato starch |
| <b>T<sub>9</sub></b>  | 1.0% Xanthan gum + 4.0% Potato starch |
| <b>T<sub>10</sub></b> | 1.5% Xanthan gum + 1.0% Potato starch |
| <b>T<sub>11</sub></b> | 1.5% Xanthan gum + 2.0% Potato starch |
| <b>T<sub>12</sub></b> | 1.5% Xanthan gum + 3.0% Potato starch |
| <b>T<sub>13</sub></b> | 1.5% Xanthan gum + 4.0% Potato starch |
| <b>T<sub>14</sub></b> | 2.0% Xanthan gum + 1.0% Potato starch |
| <b>T<sub>15</sub></b> | 2.0% Xanthan gum + 2.0% Potato starch |
| <b>T<sub>16</sub></b> | 2.0% Xanthan gum + 3.0% Potato starch |
| <b>T<sub>17</sub></b> | 2.0% Xanthan gum + 4.0% Potato starch |

#### Physical-chemical and sensory analysis of instant tomato soup mix powder

The total soluble solids (TSS) of soup mix powder were determined by Abbe refractometer, moisture content were estimated by drying the weighted samples in hot air oven at 70±2°C to a constant weight (Ranganna, 1997) [17], acidity, ascorbic acid, total sugars, reducing sugars and lycopene were determined by the methods described by Ranganna, 1997 [17]. The samples of reconstituted soup on the basis of colour, Consistency, taste, flavour and overall acceptability using 9 point Hedonic scale according to the method of Amerine *et al.* (1965) [2]. Sensory panelists (7-9 members) comprised of trained faculty members and PG students of ASPEE College of Horticulture and Forestry, NAU, Navsari (Gujarat) were employed for sensory evaluation throughout the entire period of storage.

## Results and Discussion

**Physico-chemical parameters:** The effect of different treatments on physico-chemical parameters of instant tomato soup mix powder during six months of storage has been presented in following heads.

**Total soluble solids (TSS):** The data pertaining to effect of treatments on TSS of ITSMP during 6 months storage has been presented in Table 2. Data revealed that the mean TSS (T) of ITSMP varied significantly from 80.57°Brix to 80.84°Brix, with minimum TSS in T<sub>1</sub> (0.5% pectin) and maximum in T<sub>17</sub> (2.0% xanthan gum + 4.0% potato starch). This was mainly due to addition of thickeners which are polysaccharides in nature. Similar results were reported by Lavanya (2011) [9] in tomato ketchup powder and Sharath (2011) [21] in tomato sauce powder with addition of guar gum. Data depict that storage of ITSMP resulted significant increase in mean TSS (S) from initial value of 80.61°Brix to 80.81°Brix after six months storage. The increase in TSS might be due to conversion of polysaccharides like starch to simple sugars in the presence of organic acids. TSS of ITSMP mixed with different concentration of thickeners significantly increased with minimum increase in T<sub>1</sub> (0.5% pectin) and T<sub>2</sub> (0.5% xanthan gum + 1.0% potato starch), whereas maximum increase in T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch) and T<sub>12</sub> (1.5% xanthan gum + 3.0% potato starch) during six months storage.

**Moisture content:** The data pertaining to effect of treatments on moisture content of ITSMP during 6 months storage has been presented in Table 3. Data revealed that the mean moisture (T) of ITSMP varied significantly from 2.99 per cent to 3.91 per cent, with minimum moisture in T<sub>1</sub> (0.5% pectin) and maximum in T<sub>16</sub> (2.0% xanthan gum + 3.0% potato starch). Similar increase in moisture content of chocolate drink powder with the increasing concentration of thickeners was reported by Kabirian *et al.* (2015) [8]. Data depict that storage of ITSMP resulted significant increase in mean moisture content (S) from initial value of 2.42 per cent to 5.01 per cent after six months storage. These increase in moisture content of ITSMP during storage probably due to high relative humidity in environment and permeability of packaging material. Similar increase in moisture content in dehydrated pumpkin based soup mix and in instant pumpkin halwa mix reported by Dhiman *et al.* (2017) [15]. The moisture content of ITSMP mixed with different concentration of thickeners significantly increased with minimum increase in T<sub>2</sub> (0.5% xanthan gum + 1.0% potato starch) and T<sub>3</sub> (0.5% xanthan gum + 2.0% potato starch), whereas maximum increase in T<sub>10</sub> (1.5% xanthan gum + 1.0% potato starch) and T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch) during six months storage.

**Acidity:** The data pertaining to effect of treatments on acidity of ITSMP during 6 months storage has been presented in Table. Data revealed that the mean acidity (T) of ITSMP varied significantly from 2.85 per cent to 3.04 per cent, with minimum acidity in T<sub>14</sub> (2.0% xanthan gum + 1.0% potato starch), whereas maximum in T<sub>3</sub> (0.5% xanthan gum + 2.0% potato starch) and T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch). Data depict that storage of ITSMP resulted significant increase in mean acidity (S) from initial value of 2.80 per cent to 3.15 per cent after six months storage (Fig. 4.6). The increase in acidity might be due to formation of organic acid by degradation of sugars during storage. Similar results were

reported by Sarker *et al.* (2014) <sup>[20]</sup> in tomato powder. The acidity of ITSMP mixed with different concentration of thickeners significantly increased with the minimum increase in T<sub>2</sub> (0.5% xanthan gum + 1.0% potato starch) followed by T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch), whereas maximum increase in T<sub>14</sub> (2.0% xanthan gum + 1.0% potato starch) during six months storage.

**Ascorbic acid:** The data pertaining to effect of treatments on ascorbic acid of ITSMP during 6 months storage has been presented in Table Data revealed that the mean ascorbic acid (T) of ITSMP varied significantly from 42.19 mg/100 g to 47.26 mg/100 g, with minimum ascorbic acid in T<sub>9</sub> (1.0% xanthan gum + 4.0% potato starch), whereas maximum in T<sub>7</sub> (1.0% xanthan gum + 2.0% potato starch) and T<sub>12</sub> (1.5% xanthan gum + 3.0% potato starch) which was at par with T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch) and T<sub>10</sub> (1.5% xanthan gum + 1.0% potato starch). Similar results were reported by Nwaokoro and Aknabi, (2015) <sup>[13]</sup> in tomato-carrot juice blend with addition of hydrocolloids. Data depict that storage of ITSMP resulted significant decrease in mean ascorbic acid (S) from initial value of 55.94 mg/100 g to 30.20 mg/100 g after six months storage. Ascorbic acid content decreased with the advancement of storage period which may be due to leaching and oxidative degradation. Similar degradation of ascorbic acid in tomato powder with advancement of storage period were reported by Sarker *et al.* (2014) <sup>[20]</sup>. Dhawle (2009) <sup>[4]</sup> noticed decrease in ascorbic acid of tomato powder during storage. The ascorbic acid of ITSMP mixed with different concentration of thickeners significantly decreased with the minimum decrease in T<sub>2</sub> (0.5% xanthan gum + 1.0% potato starch) followed by T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch), whereas maximum decrease in T<sub>15</sub> (2.0% xanthan gum + 2.0% potato starch) during six months storage.

**Total sugars:** The data pertaining to effect of treatments on total sugars of ITSMP during 6 months storage has been presented in Table Data revealed that the mean total sugars (T) of ITSMP varied significantly from 43.84 per cent to 49.25 per cent with minimum total sugars in T<sub>1</sub> (0.5% pectin) and maximum in T<sub>17</sub> (2.0% xanthan gum + 4.0% potato starch). This is mainly due to addition of thickeners increased total sugars of ITSMP. It is probably due to thickeners are polysaccharides in nature. Similar results were reported by Lavanya (2011) <sup>[9]</sup> in tomato ketchup powder and Sharath (2011) <sup>[21]</sup> in tomato sauce powder with addition of guar gum. Kabirian *et al.* (2015) <sup>[8]</sup> showed increasing in total sugars of chocolate drink powder with the increasing in concentration of carrageenan and carboxymethyl cellulose. Data depict that storage of ITSMP resulted significant increase in mean total sugars (S) from initial value of 46.02 per cent to 46.16 per cent after six months storage. The increase in total sugars during storage might be due to breakdown of insoluble polysaccharides into simple sugars. Similar results were reported by Devi (2015) <sup>[3]</sup> in instant pumpkin soup mix and Dhiman *et al.* (2017) <sup>[5]</sup> in instant pumpkin halwa mix. The total sugars of ITSMP mixed with different concentration of thickeners significantly increased with the minimum increase

in T<sub>3</sub> (ITSMP mixed with 0.5% xanthan gum + 2.0% potato starch), whereas maximum increase in T<sub>9</sub> (1.0% xanthan gum + 4.0% potato starch) during six months storage.

**Reducing sugars:** The data pertaining to effect of treatments on reducing sugars of ITSMP during 6 months storage has been presented in Table. Data revealed that the mean reducing sugars (T) of ITSMP varied significantly from 5.70 per cent to 6.56 per cent, with minimum reducing sugars in T<sub>1</sub> (0.5% pectin) and maximum in T<sub>17</sub> (2.0% xanthan gum + 4.0% potato starch). Similar results were reported by Dhiman *et al.* (2017) <sup>[5]</sup> in instant pumpkin soup mix with addition potato starch. Data depict that storage of ITSMP resulted significant increase in mean reducing sugars (S) from initial value of 5.43 per cent to 6.69 per cent after six months storage. The increase in reducing sugars during storage might be attributed to breakdown of polysaccharides into oligosaccharides and monosaccharides. Similar results were reported by Devi (2015) <sup>[3]</sup> in instant pumpkin soup mix and Dhiman *et al.* (2017) <sup>[5]</sup> in instant pumpkin halwa mix. The reducing sugars of ITSMP mixed with different concentration of thickeners significantly increased with the minimum increase in T<sub>5</sub> (0.5% xanthan gum + 4.0% potato starch), whereas maximum increase in T<sub>8</sub> (1.0% xanthan gum + 3.0% potato starch) during six months storage.

**Lycopene:** The data pertaining to effect of treatments on lycopene content of ITSMP during 6 months storage has been presented in Table. Data revealed that the mean lycopene (T) of ITSMP varied significantly from 3.12mg/100 g to 3.27mg/100 g with minimum lycopene in T<sub>8</sub> (1.0% xanthan gum + 3.0% potato starch) and maximum in T<sub>4</sub> (0.5% xanthan gum + 3.0% potato starch) which was at par with T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch) and T<sub>13</sub> (1.5% xanthan gum + 4.0% potato starch). Similar results were reported by Nwaokoro and Aknabi, (2015) <sup>[13]</sup> in tomato-carrot juice blend with addition of hydrocolloids. Data depict that storage of ITSMP resulted significant decrease in mean lycopene content (S) from initial value of 4.80 mg/100 g to 1.55mg/100 g after six months storage. Similar decrease in lycopene content in dehydrated tomato slices during six months storage was reported by Reihaneh and Mehdi (2010) <sup>[18]</sup>. Degradation of lycopene might be due to oxidation and isomerization caused by permeability of packaging material to oxygen and light (Shi *et al.*, 1999 and Olorunda *et al.*, 1990) <sup>[22, 14]</sup>. The lycopene content of ITSMP mixed with different concentration of thickeners significantly decreased with the minimum decrease in T<sub>4</sub> (0.5% xanthan gum + 3.0% potato starch) followed by T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch), whereas maximum decrease in T<sub>17</sub> (2.0% xanthan gum + 4.0% potato starch) during six months storage.

**Sensory parameters:** Effect of treatments on mean sensory scores of reconstituted instant soup mix powder during six months storage has been presented in Table no 9. The mean sensory scores for colour, consistency, taste, flavor and overall acceptability of reconstituted soup were maximum in T<sub>11</sub> (1.5% xanthan gum + 2.0% potato starch).

**Table 2:** Effect of treatments on TSS of instant tomato soup mix powder during 6 months storage

| Treatments (T)  | TSS ( <sup>o</sup> Brix) |         |         |         |         |
|-----------------|--------------------------|---------|---------|---------|---------|
|                 | Storage (S)              |         |         |         | Mean(T) |
|                 | Initial                  | 2 month | 4 month | 6 month |         |
| T <sub>1</sub>  | 80.51                    | 80.51   | 80.61   | 80.66   | 80.57   |
| T <sub>2</sub>  | 80.51                    | 80.61   | 80.62   | 80.66   | 80.58   |
| T <sub>3</sub>  | 80.54                    | 80.55   | 80.62   | 80.70   | 80.60   |
| T <sub>4</sub>  | 80.53                    | 80.58   | 80.64   | 80.70   | 80.61   |
| T <sub>5</sub>  | 80.54                    | 80.58   | 80.64   | 80.71   | 80.62   |
| T <sub>6</sub>  | 80.55                    | 80.55   | 80.66   | 80.75   | 80.63   |
| T <sub>7</sub>  | 80.57                    | 80.60   | 80.65   | 80.78   | 80.65   |
| T <sub>8</sub>  | 80.58                    | 80.60   | 80.68   | 80.80   | 80.67   |
| T <sub>9</sub>  | 80.60                    | 80.64   | 80.70   | 80.83   | 80.69   |
| T <sub>10</sub> | 80.62                    | 80.65   | 80.73   | 80.83   | 80.71   |
| T <sub>11</sub> | 80.62                    | 80.67   | 80.75   | 80.87   | 80.73   |
| T <sub>12</sub> | 80.65                    | 80.68   | 80.75   | 80.90   | 80.75   |
| T <sub>13</sub> | 80.66                    | 80.70   | 80.77   | 80.90   | 80.76   |
| T <sub>14</sub> | 80.70                    | 80.74   | 80.81   | 80.90   | 80.79   |
| T <sub>15</sub> | 80.71                    | 80.75   | 80.82   | 80.92   | 80.80   |
| T <sub>16</sub> | 80.75                    | 80.76   | 80.86   | 80.92   | 80.82   |
| T <sub>17</sub> | 80.75                    | 80.80   | 80.88   | 80.93   | 80.84   |
| Mean(S)         | 80.61                    | 80.64   | 80.72   | 80.81   |         |
|                 | T                        |         | S       |         | T×S     |
| SEm±            | 0.003                    |         | 0.002   |         | 0.006   |
| CD 0.05         | 0.009                    |         | 0.006   |         | 0.018   |
| CV%             | 0.015                    |         | 0.013   |         |         |

**Table 3:** Effect of treatments on moisture content of instant tomato soup mix powder during 6 months storage

| Treatments (T)  | Moisture (%) |         |         |         | Mean(T) |
|-----------------|--------------|---------|---------|---------|---------|
|                 | Storage (S)  |         |         |         |         |
|                 | Initial      | 2 month | 4 month | 6 month |         |
| T <sub>1</sub>  | 2.10         | 2.80    | 3.13    | 3.95    | 2.99    |
| T <sub>2</sub>  | 2.10         | 2.93    | 3.14    | 3.93    | 3.02    |
| T <sub>3</sub>  | 2.32         | 3.03    | 3.67    | 4.15    | 3.29    |
| T <sub>4</sub>  | 2.59         | 3.23    | 4.01    | 4.95    | 3.69    |
| T <sub>5</sub>  | 2.51         | 3.16    | 4.05    | 4.92    | 3.66    |
| T <sub>6</sub>  | 2.36         | 3.28    | 3.95    | 4.66    | 3.56    |
| T <sub>7</sub>  | 2.54         | 3.33    | 4.11    | 5.22    | 3.80    |
| T <sub>8</sub>  | 2.51         | 3.36    | 4.12    | 5.26    | 3.81    |
| T <sub>9</sub>  | 2.33         | 3.26    | 4.24    | 5.27    | 3.77    |
| T <sub>10</sub> | 2.32         | 3.15    | 4.15    | 5.34    | 3.74    |
| T <sub>11</sub> | 2.23         | 3.21    | 4.15    | 5.25    | 3.71    |
| T <sub>12</sub> | 2.43         | 3.27    | 4.27    | 5.30    | 3.81    |
| T <sub>13</sub> | 2.36         | 3.29    | 4.12    | 5.33    | 3.77    |
| T <sub>14</sub> | 2.55         | 3.33    | 4.23    | 5.42    | 3.88    |
| T <sub>15</sub> | 2.62         | 3.36    | 4.18    | 5.43    | 3.89    |
| T <sub>16</sub> | 2.58         | 3.36    | 4.21    | 5.50    | 3.91    |
| T <sub>17</sub> | 2.65         | 3.25    | 4.22    | 5.42    | 3.88    |
| Mean(S)         | 2.42         | 3.21    | 3.99    | 5.01    |         |
|                 | T            |         | S       | T×S     |         |
| SEm±            | 0.021        |         | 0.009   | 0.037   |         |
| CD 0.05         | 0.059        |         | 0.025   | 0.104   |         |
| CV%             | 1.93         |         | 1.77    |         |         |

**Table 4:** Effect of treatments on acidity of instant tomato soup mix powder during 6 months storage

| Treatments (T)  | Acidity (%) |         |         |         | Mean(T) |
|-----------------|-------------|---------|---------|---------|---------|
|                 | Storage (S) |         |         |         |         |
|                 | Initial     | 2 month | 4 month | 6 month |         |
| T <sub>1</sub>  | 2.86        | 2.93    | 2.95    | 3.07    | 2.95    |
| T <sub>2</sub>  | 2.93        | 2.95    | 3.02    | 3.02    | 2.98    |
| T <sub>3</sub>  | 2.77        | 3.07    | 3.07    | 3.23    | 3.04    |
| T <sub>4</sub>  | 2.90        | 2.92    | 2.97    | 3.18    | 3.00    |
| T <sub>5</sub>  | 2.78        | 2.92    | 3.07    | 3.23    | 3.00    |
| T <sub>6</sub>  | 2.62        | 2.86    | 2.97    | 3.12    | 2.89    |
| T <sub>7</sub>  | 2.82        | 2.92    | 3.07    | 3.23    | 3.00    |
| T <sub>8</sub>  | 2.76        | 2.90    | 2.90    | 3.07    | 2.90    |
| T <sub>9</sub>  | 2.78        | 2.92    | 2.97    | 3.12    | 2.95    |
| T <sub>10</sub> | 2.88        | 2.92    | 2.97    | 3.12    | 3.01    |
| T <sub>11</sub> | 2.95        | 2.92    | 3.07    | 3.23    | 3.04    |
| T <sub>12</sub> | 2.86        | 2.90    | 3.02    | 3.18    | 2.99    |
| T <sub>13</sub> | 2.86        | 2.86    | 2.92    | 3.07    | 2.93    |
| T <sub>14</sub> | 2.58        | 2.86    | 2.92    | 3.07    | 2.85    |
| T <sub>15</sub> | 2.86        | 2.92    | 3.07    | 3.23    | 3.02    |
| T <sub>16</sub> | 2.77        | 2.90    | 2.92    | 3.07    | 2.92    |
| T <sub>17</sub> | 2.78        | 2.90    | 3.07    | 3.23    | 3.00    |
| Mean(S)         | 2.80        | 2.92    | 3.00    | 3.15    |         |
|                 | T           |         | S       |         | T×S     |
| SEm±            | 0.031       |         | 0.009   |         | 0.040   |
| CD 0.05         | 0.089       |         | 0.027   |         | 0.120   |
| CV%             | 3.53        |         | 2.32    |         |         |

**Table 5:** Effect of treatments on ascorbic acid of instant tomato soup mix powder during 6 months storage

| Treatments (T)  | Ascorbic acid (mg/100g) |         |         |         |         |
|-----------------|-------------------------|---------|---------|---------|---------|
|                 | Storage (S)             |         |         |         | Mean(T) |
|                 | Initial                 | 2 month | 4 month | 6 month |         |
| T <sub>1</sub>  | 53.84                   | 48.20   | 42.10   | 32.40   | 44.14   |
| T <sub>2</sub>  | 48.71                   | 50.08   | 43.50   | 32.40   | 43.67   |
| T <sub>3</sub>  | 53.84                   | 48.20   | 43.50   | 30.20   | 43.94   |
| T <sub>4</sub>  | 56.39                   | 48.20   | 40.70   | 32.40   | 44.42   |
| T <sub>5</sub>  | 53.84                   | 48.20   | 43.50   | 25.80   | 42.83   |
| T <sub>6</sub>  | 56.39                   | 48.20   | 40.70   | 32.40   | 44.42   |
| T <sub>7</sub>  | 61.50                   | 50.08   | 45.06   | 32.40   | 47.26   |
| T <sub>8</sub>  | 56.39                   | 48.20   | 42.10   | 30.20   | 42.22   |
| T <sub>9</sub>  | 51.28                   | 48.20   | 43.50   | 25.80   | 42.19   |
| T <sub>10</sub> | 58.95                   | 48.20   | 43.50   | 32.40   | 45.76   |
| T <sub>11</sub> | 53.84                   | 50.08   | 43.50   | 32.40   | 46.23   |
| T <sub>12</sub> | 61.50                   | 50.08   | 45.07   | 32.40   | 47.26   |
| T <sub>13</sub> | 53.84                   | 48.20   | 40.70   | 32.40   | 43.78   |
| T <sub>14</sub> | 53.84                   | 48.20   | 43.50   | 25.80   | 42.83   |
| T <sub>15</sub> | 61.50                   | 48.20   | 43.50   | 25.80   | 44.75   |
| T <sub>16</sub> | 56.39                   | 48.20   | 43.50   | 25.80   | 43.47   |
| T <sub>17</sub> | 53.84                   | 48.20   | 43.50   | 32.40   | 44.48   |
| Mean(S)         | 55.94                   | 48.64   | 43.02   | 30.20   |         |
|                 | T                       |         | S       | T×S     |         |
| SEm±            | 0.653                   |         | 0.267   | 1.101   |         |
| CD 0.05         | 1.870                   |         | 0.750   | 3.080   |         |
| CV%             | 5.09                    |         | 4.29    |         |         |



**Table 6:** Effect of treatments on total sugars of instant tomato soup mix powder during 6 months storage

| Treatments (T)  | Total sugars (%) |         |         |         |         |
|-----------------|------------------|---------|---------|---------|---------|
|                 | Storage (S)      |         |         |         | Mean(T) |
|                 | Initial          | 2 month | 4 month | 6 month |         |
| T <sub>1</sub>  | 43.72            | 43.78   | 43.88   | 43.98   | 43.84   |
| T <sub>2</sub>  | 43.75            | 43.81   | 43.92   | 43.98   | 43.87   |
| T <sub>3</sub>  | 43.81            | 43.88   | 43.92   | 43.92   | 43.88   |
| T <sub>4</sub>  | 44.65            | 44.81   | 45.03   | 45.19   | 43.92   |
| T <sub>5</sub>  | 43.81            | 43.92   | 43.92   | 43.95   | 43.90   |
| T <sub>6</sub>  | 43.81            | 43.88   | 43.92   | 44.02   | 43.90   |
| T <sub>7</sub>  | 46.17            | 46.21   | 46.81   | 46.85   | 46.51   |
| T <sub>8</sub>  | 43.81            | 43.92   | 43.92   | 44.02   | 43.92   |
| T <sub>9</sub>  | 46.32            | 46.81   | 47.09   | 47.42   | 46.91   |
| T <sub>10</sub> | 47.12            | 47.20   | 47.24   | 47.42   | 47.24   |
| T <sub>11</sub> | 47.12            | 47.24   | 47.24   | 47.42   | 47.26   |
| T <sub>12</sub> | 47.12            | 47.20   | 47.36   | 47.42   | 47.27   |
| T <sub>13</sub> | 47.72            | 47.82   | 47.97   | 47.97   | 47.87   |
| T <sub>14</sub> | 47.72            | 47.76   | 47.97   | 47.97   | 47.86   |
| T <sub>15</sub> | 47.82            | 47.86   | 48.19   | 48.25   | 48.03   |
| T <sub>16</sub> | 48.82            | 48.86   | 48.86   | 45.64   | 48.05   |
| T <sub>17</sub> | 49.15            | 49.17   | 49.34   | 49.34   | 49.25   |
| Mean(S)         | 46.02            | 46.13   | 46.27   | 46.16   |         |
|                 | T                |         | S       |         | T×S     |
| SEm±            | 0.325            |         | 0.099   |         | 0.409   |
| CD 0.05         | 0.93             |         | 0.28    |         | 1.14    |
| CV%             | 2.44             |         | 1.53    |         |         |

**Table 7:** Effect of treatments on reducing sugars of instant tomato soup mix powder during 6 months storage

| Treatments (T)  | Reducing sugars (%) |         |         |         | Mean(T) |
|-----------------|---------------------|---------|---------|---------|---------|
|                 | Storage (S)         |         |         |         |         |
|                 | Initial             | 2 month | 4 month | 6 month |         |
| T <sub>1</sub>  | 5.20                | 5.27    | 6.10    | 6.25    | 5.70    |
| T <sub>2</sub>  | 5.20                | 5.27    | 6.14    | 6.28    | 5.72    |
| T <sub>3</sub>  | 5.13                | 5.45    | 6.23    | 6.30    | 5.78    |
| T <sub>4</sub>  | 5.27                | 5.45    | 6.10    | 6.33    | 5.78    |
| T <sub>5</sub>  | 5.30                | 5.60    | 6.23    | 6.33    | 5.86    |
| T <sub>6</sub>  | 5.32                | 5.49    | 6.28    | 6.58    | 5.92    |
| T <sub>7</sub>  | 5.32                | 5.49    | 6.28    | 6.58    | 5.96    |
| T <sub>8</sub>  | 5.40                | 5.75    | 6.33    | 7.02    | 6.12    |
| T <sub>9</sub>  | 5.42                | 5.75    | 6.35    | 6.71    | 6.05    |
| T <sub>10</sub> | 5.46                | 5.82    | 6.50    | 6.77    | 6.14    |
| T <sub>11</sub> | 5.55                | 6.00    | 6.58    | 6.75    | 6.22    |
| T <sub>12</sub> | 5.54                | 6.10    | 6.63    | 6.77    | 6.26    |
| T <sub>13</sub> | 5.60                | 6.14    | 6.71    | 6.80    | 6.31    |
| T <sub>14</sub> | 5.60                | 6.23    | 6.75    | 6.94    | 6.28    |
| T <sub>15</sub> | 5.69                | 6.55    | 6.77    | 7.01    | 6.50    |
| T <sub>16</sub> | 5.67                | 6.25    | 6.80    | 7.10    | 6.46    |
| T <sub>17</sub> | 5.73                | 6.55    | 6.82    | 7.15    | 6.56    |
| Mean(S)         | 5.43                | 5.84    | 6.44    | 6.69    |         |
|                 | T                   |         |         | S       | T×S     |
| SEm±            | 0.029               |         |         | 0.013   | 0.052   |
| CD 0.05         | 0.084               |         |         | 0.035   | 0.150   |
| CV%             | 1.64                |         |         | 1.49    |         |

**Table 8:** Effect of treatments on lycopene content of instant tomato soup mix powder during 6 months storage

| Treatments (T)  | Lycopene (mg/100g) |         |         |         | Mean(T) |
|-----------------|--------------------|---------|---------|---------|---------|
|                 | Storage (S)        |         |         |         |         |
|                 | Initial            | 2 month | 4 month | 6 month |         |
| T <sub>1</sub>  | 4.81               | 3.62    | 2.91    | 1.46    | 3.20    |
| T <sub>2</sub>  | 4.81               | 3.62    | 2.91    | 1.49    | 3.20    |
| T <sub>3</sub>  | 4.80               | 3.54    | 2.92    | 1.48    | 3.18    |
| T <sub>4</sub>  | 4.80               | 3.62    | 2.87    | 1.78    | 3.27    |
| T <sub>5</sub>  | 4.81               | 3.62    | 2.88    | 1.46    | 3.19    |
| T <sub>6</sub>  | 4.81               | 3.52    | 2.89    | 1.49    | 3.18    |
| T <sub>7</sub>  | 4.79               | 3.37    | 2.87    | 1.57    | 3.15    |
| T <sub>8</sub>  | 4.80               | 3.37    | 2.87    | 1.44    | 3.12    |
| T <sub>9</sub>  | 4.81               | 3.37    | 2.88    | 1.57    | 3.16    |
| T <sub>10</sub> | 4.81               | 3.51    | 2.91    | 1.57    | 3.20    |
| T <sub>11</sub> | 4.81               | 3.51    | 2.91    | 1.78    | 3.25    |
| T <sub>12</sub> | 4.81               | 3.56    | 2.86    | 1.49    | 3.18    |
| T <sub>13</sub> | 4.80               | 3.51    | 2.91    | 1.78    | 3.25    |
| T <sub>14</sub> | 4.80               | 3.40    | 2.91    | 1.53    | 3.16    |
| T <sub>15</sub> | 4.80               | 3.51    | 2.91    | 1.44    | 3.16    |
| T <sub>16</sub> | 4.81               | 3.51    | 2.88    | 1.57    | 3.19    |
| T <sub>17</sub> | 4.81               | 3.51    | 2.91    | 1.44    | 3.16    |
| Mean(S)         | 4.80               | 3.51    | 2.89    | 1.55    |         |
|                 | T                  |         | S       | T×S     |         |
| SEm±            | 0.011              |         | 0.006   | 0.026   |         |
| CD 0.05         | 0.030              |         | 0.018   | 0.073   |         |
| CV%             | 0.99               |         | 1.42    |         |         |

**Table 9:** Effect of treatments on sensory score of instant tomato soup during 6 months storage

| Treatments (T)  | Sensory parameters (9 point hedonic scale) |             |       |         | Overall acceptability |
|-----------------|--|-------------|-------|---------|-----------------------|
|                 | Colour                                     | Consistency | Taste | Flavour |                       |
| T <sub>1</sub>  | 7.78                                       | 6.19        | 7.32  | 7.28    | 7.14                  |
| T <sub>2</sub>  | 7.71                                       | 6.25        | 7.37  | 7.37    | 7.17                  |
| T <sub>3</sub>  | 7.89                                       | 6.27        | 7.31  | 7.39    | 7.22                  |
| T <sub>4</sub>  | 7.88                                       | 7.20        | 7.27  | 7.42    | 7.44                  |
| T <sub>5</sub>  | 7.84                                       | 7.46        | 7.30  | 7.26    | 7.46                  |
| T <sub>6</sub>  | 7.78                                       | 7.29        | 7.07  | 7.34    | 7.37                  |
| T <sub>7</sub>  | 7.98                                       | 7.46        | 7.29  | 7.35    | 7.52                  |
| T <sub>8</sub>  | 8.03                                       | 7.50        | 7.05  | 7.30    | 7.47                  |
| T <sub>9</sub>  | 8.08                                       | 7.33        | 7.15  | 7.17    | 7.43                  |
| T <sub>10</sub> | 8.12                                       | 8.14        | 7.55  | 7.66    | 7.87                  |
| T <sub>11</sub> | 8.17                                       | 8.45        | 7.58  | 7.70    | 7.98                  |
| T <sub>12</sub> | 8.02                                       | 8.22        | 7.38  | 7.60    | 7.81                  |
| T <sub>13</sub> | 7.80                                       | 7.77        | 7.09  | 7.21    | 7.47                  |
| T <sub>14</sub> | 7.75                                       | 7.50        | 6.98  | 7.14    | 7.34                  |
| T <sub>15</sub> | 8.03                                       | 7.22        | 6.85  | 7.16    | 7.31                  |
| T <sub>16</sub> | 7.89                                       | 7.18        | 6.82  | 7.11    | 7.25                  |
| T <sub>17</sub> | 7.82                                       | 6.88        | 6.67  | 7.11    | 7.12                  |

### Conclusion

The study indicated that instant tomato soup mix can be

developed with acceptable overall sensory attributes by incorporating 50 g tomato powder, 5 g onion powder, 2 g garlic powder, 2 g coriander leaf powder, 23 g sugar, 10 g salt, 3 g chilli powder, 2 g black pepper, 2 g citric acid, 2ml edible oil along with 1.5% xanthan gum and 2.0% potato starch. Tomato soup mix powder can be successfully stored in polypropylene bags without much changes in physico-chemical, sensory and microbial quality up to six months storage.

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