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Preparation And Nutritional Enhancement Of Instanttomato Soup Mix With Addition Of Kale

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Abstract

Tomatoes are often processed into shelf-stable products and used for direct consumption in various culinary around the world. Changing life style patterns, consumer awareness towards nutrition, high demand of ready to eat products have motivated food technologist to come up with hassle free processed food recipes. Instant soup mix is one of such food products with high demand around the globe as it is easy to digest, provide essential nutrition and consumed by all age groups. In this study, a model instant tomato soup mix was prepared with addition of kale leave powder to enhance the nutritive quality of the soup. Various proximate parameters, vitamin C content, protein and fiber content of the soup mixes were analyzed. Thermal treatment had a negative impact on the vitamin C content and fiber content of the powdered form of the kale. However, no significant impact on these attributes was noticed for tomato powder. The 40:60 ratio of kale and tomato showed highest solubility of kale leave powder into the soup mix. Sensory evaluation of the instant soup mixes suggested 40:60 ratio of kale and tomatoformulation has the highest overall acceptability.

1.Introduction

Tomato (Lycopersicon esculentum) is an important member of the Solanaceae family with high nutritive values. Reportedly, tomatoes are considered as good source of potassium, folate, vitamins A, C, and E, and a superior source of alpha-tocopherol (Canene-Adams et al., 2005). Furthermore, tomatoes also contain valuable non-nutritive phytochemicals, including carotenoids (lycopene, β-carotene) and colourless carotenoids (phytoene, and phytofluene), high flavonol(flavonoids, flavanones, and flavones) up to 98% (as the conjugated forms of quercetin and kaempferol) (Chaudhary et al., 2018; Stewart et al., 2000; Tonucci et al., 1995).

Tomato is among the most cultivated produce with clamming 5.2 million hectares of globally cultivated land area (Njume et al., 2020). Every year 177,118,248 tonnes of tomato are produced worldwide and India is the largest producer after China with 18399000 tonnes/yr production (https://www.atlasbig.com/en-in/countries-by-tomato-production). High production and poor post-harvest management (mishandling, non-adaptive or poor logistic facilities, storage conditions, inefficient and non-timely transportation) leads to qualitative as well as quantitative loss of the commodity. Worldwide, tomato consumption as fresh fruit and salad is a very common practice however; various ready to cook/eat processed food items are also in high demand among consumers worldwide. Interestingly, it is estimated that 5% growth in 2021 to 2026 (https://www.imarcgroup.com/indian-tomato-processing-market) would be expected in Indian tomato processing market with the products including ketchup, tomato puree,beverage, chutney, soup, pickles, juice, pasta and salsa souses and many more. Among all the tomato soup either fresh or ready to eat (as instant soup mix) is one of the most liked and highly consumed processed products around the globe, including India. Tomato soup is one product that is recommended to all age groups including diseased persons for its nutritive values. As per USDA Nutrient Data Bank (tomato soup: 06359) tomato soup is a rich source of many microvitamins, nutrients, potassium, folate and antioxidants (Table 1).

Table 1. Nutrient and phenolic content of fresh tomato and tomato soup

<table>
<tr><th>S.No.</th><th colspan="3">Nutrient composition (per 100 g)</th><th>Reference</th></tr>
<tr><td></td><td></td><td>Tomatoes</td><td>Tomato soup</td><td rowspan="13">USDA Nutrient Data Bank numbers: raw tomatoes, 11529; tomato soup, 06359 and (Tonucci et al., 1995)</td></tr>
<tr><td>1</td><td>Potassium, mg</td><td>237</td><td>181</td></tr>
<tr><td>2</td><td>α-tocopherol, mg</td><td>0.54</td><td>0.50</td></tr>
<tr><td>3</td><td>Vitamin A, IU</td><td>833</td><td>193</td></tr>
<tr><td>4</td><td>Vitamin C, mg</td><td>12.7</td><td>27.3</td></tr>
<tr><td>5</td><td>Total folate, µg</td><td>15</td><td>7</td></tr>
<tr><td colspan="4">Carotenoid content (mcg/100 g)</td></tr>
<tr><td>1</td><td>β-carotene</td><td>449</td><td>75</td></tr>
<tr><td>2</td><td>α-carotene</td><td>101</td><td>0</td></tr>
<tr><td>3</td><td>Lycopene</td><td>2573</td><td>5084</td></tr>
<tr><td>4</td><td>Lutein + zeaxanthin</td><td>123</td><td>1</td></tr>
<tr><td>5</td><td>Phytoene</td><td>1860</td><td>1720</td></tr>
<tr><td>6</td><td>Phytofluene</td><td>820</td><td>720</td></tr>
</table>

In addition to it, changing life style and food habits, consumer awareness towards nutritive aspects of the foods, high demand of ready to eat processed products has emerging. This gives food technologies a chance for value addition of the soup with respect to its health benefits. Since it is always not possible to consume the fruit and vegetables a fresh food processing has emerged as the best solution to provide healthy, nutritive food on the go to the consumers and it also a sustainable solution for limit the post harvest losses.

Kale (Brassica oleracea var. acephala), a leafy vegetable belongs to cruciferae family considered as 'superfood' and listed as the healthiest vegetable (Šamec et al., 2019). Kale having plants species Brassica oleracea L., varieties acephala (collards, tree kale, borecole), medullosa Thellg. (marrow stem kale), sabellica L. (curly kale) and ramosa DC. (thousand-head kale)(Luštinec, 1988). As per the United States Department of Agriculture (USA), some cruciferous vegetables such as kale is counted as 'dark green vegetables' with collards and broccoli while cabbage and cauliflowers listed in 'other vegetables' group (Young et al., 2017). Reportedly, single serving of kale can provide >100% of the recommended daily intake (RDI) of vitamin A and more than 40% of the RDI of vitamin C (Becerra-

Moreno et al., 2014). Kale considered as "powerhouse" nutritional vegetable cant provides ≥10% of the recommended daily allowance of 17 essential nutrients (Reda et al., 2021). Also, it is suggested that kale is the best source of vitamins (A, B1, B2, B6, C and E), folic acid and niacin, fatty acids, and essentials minerals (especially K, Ca, Mg, Fe and Cu) among crucifers (Thavarajah et al., 2016; Westwood et al., 2014). Also, kale powder was found to have a high flavonoid content of 65.2 quercetin/g on dry weight basis(Lotti et al., 2018).Dragović-Uzelac et al. (2009) also reported highest concentration of total polyphenols in kale (1039 mg GAE/kg fresh weight) when compared with broccoli flower, broccoli steam, leek leaf, leek root and cauliflower. Kale also contains glucosinolates, a secondary plant metabolites having anticarcinogenic properties (Reda et al., 2021).

Kale is also a source of prebiotic carbohydrates and single serving of kale (100 g) has only 49 calories that help fight obesity (Thavarajah et al., 2016). Being a low-calorie food, kale is particularly relevant to the new generation processed food market more attentive towards calories with respect to obesity and overweighting.

Effortless cultivation, and highlytolerant to adverse climatic conditions, kale has emerged as a cheap yet highly nutritious source of many minerals and vitamins including Ca, folate, riboflavin, vitamin C, K and A (Šamec et al., 2019). It is evident scientifically that kale if included in human diet can positively affect health and well-being. However, being rich in moisture, this super food has very less shelf life naturally. Similar is the case with tomato as well. Processing specifically drying of kale leavesand tomato and store them in powder form can help to improvise their shelf lives. Addition of these two nutrient rich foodsin daily life intakes can give additional health benefits. With an additional advantage of limiting enzymatic, oxidative, mechanical and biological damage dried soup powders are high in demand. Besides it, they are easy to reconstitute in very short span of time with stable flavors (6–12 months). In powdered form, the transportation process also gets hassle free due to increased shelf life and light weight being not dependent on seasonal availability. Working families, hotels, hospitals, restaurants and institutional organisations are the first line consumers for such instant mixes and it can also be used for military rations.

Keeping into consideration of almost daily intake of tomato soup among larger population of the world, addition of health benefits of kale was done to enhance the nutritive quality of the product. An instant tomato soup mix was prepared with additional goodness of kale considering the high demand of ready to consume food products.

2. Materials and methods

Fresh Kale,Brassica oleracea leaves and well ripened healthy tomatoes with firm and sound texture were purchased from local markets of Agra, Uttar Pradesh, India. All the reagents used in this study for chemical analysis are of analytical grade. The ingredients used to prepare soup mix are of food-grade and procured from local market only.Tomato powder, garlic powder, onion powder, coriander powder, salt, black pepper, xanthan gum and starch are the ingredients used to prepare the soup mix. Proximate analysis (moisture and ash content), vitamin C content analysis, protein and fiber analysis of major ingredients i.e., kale leaves and tomato and their powders were performed in order to access the nutritional potential of the ingredients after drying treatment. A comparative nutritional analysis of the prepared soup was also carried out. Different ratios of all the ingredients were testes and most appropriate one was selected on the basis of various parameters and overallorganolaptic acceptability.

2.1. Preparation of ingredients for soup mix

All the raw materials were washed properly to remove any dust and dirt followed by trimming and sliced by clean non-rusted stainless-steel knife. Tomato slices and kale leaves were dried into a tray drier oven at 60±5°C for 24 h and 6 h respectively. Onion slices, garlic cloves and coriander leaves were dried using a cabinet dryer at 60±5°C for 24 h, 18 h and 4 h, respectively. After cooling, each ingredient was separately grounded using a mixer grinder to obtain a fine powder. Onion powder and kale leave powder were sieved through 40 mm mesh sized sieve to get uniform particle size.

2.2. Preparation of instant soup mix (ISM)

Instant tomato soup mix powder incorporated with kale (ISM) was prepared by mixing all the ingredients in the pre-determined ratios summarized in Table 1.The ISM was prepared by varying the concentration of kale and tomato powder while the concentration of all other ingredients was remained constant.

Table 2. Formulation ratios of the instant soup mix

Sample		Control sample	S1	S2	S3	S4	S5
Kale powder	(g)	0	20	40	60	80	100
Tomato powder	(g)	100	80	60	40	20	0
Garlic powder	(g)	2	2	2	2	2	2
Onion powder	(g)	5	5	5	5	5	5
Coriander powder	(g)	2	2	2	2	2	2
Salt	(g)	10	10	10	10	10	10
Red chili powder	(g)	3	3	3	3	3	3
Black pepper	(g)	2	2	2	2	2	2
Xanthan gum	(g)	0.02	0.02	0.02	0.02	0.02	0.02
Starch	(g)	0.02	0.02	0.02	0.02	0.02	0.02
Citric acid	(g)	1	1	1	1	1	1
Edible oil	(ml)	2	2	2	2	2	2

2.3. Physiochemical analysis of the dried product & soup mix

Total soluble solids (TSS) of ISM powder were determined by refractometer. Moisture content (MC)of fresh tomato and kale leaves as well as their powdered forms was estimated by drying the pre-weighted samples in muffle furnace by considering the weight loss after 24 h.Acidity and ascorbic acid were determined by the methods described by Ranganna (1977). The organoleptic evaluation of all the prepared soup mixes in reconstituted soup form were evaluated using 9 point Hedonic scale on the basis of colour, consistency, taste, flavour and overall acceptability. A five-member sensory panel of trained faculty members and PG students of RBS Engineering College (Agra) were employed for sensory evaluation throughout the entire period of storage of soup mix.

2.4. Sensory analysis and statistical analysis

All the statistical analysis was performed in suitable statistical tools. For plotting the data in graphs including sensory evaluation, Microsoft excel was used. To test the impacts of variations of ingredients on the quality parameters of the prepared soup mixes, analysis of variance (ANOVA) was performed in GraphPad Prism 5.0 and Tucky's test was performed to compare the variance. All the results of ANOVA are presented in tabular form andvalues are expressed as mean (n = 3). Values with different superscripts (a, b, c, d, e) in the same row are significantly different ($p \leq 0.05$).

3. Results and discussions

3.1. Physicochemical analysis of fresh tomato and kale leaves and their powders

The physicochemical parameters analyzed for fresh tomato and kale leaves and their powders are enlisted in Table 2 and presented as Fig. 1. A significant loss in moisture content was noticed when the tomato slices and kale leaves were subjected to thermal/heat treatment. For both the powders, the MC was found to be less than 10% which reduces the chance of oxidative, microbial, and enzymatic decomposition of the commodity(Araújo et al., 2017).However, the MC of tomato powder was found to higher than the suggested MC value by USDA (3.9 mg/100g) (https://www.nal.usda.gov/fnic/usda-nutrient-data-laboratory).The MC of fresh kale leaves was found be in the same range of 81.38%-82.92% as reported earlier (Sikora & Bodziarczyk, 2012). A significant increase in ash content in the powdered form of the tomato and kale was noticed. This indicates heat treatment affected the mineral constituents of the commodity. Heat treatment might have condensed the mineral content in both the commodities leading to increased ash content in their powdered form. A significant dip in the vitamin C content of the kale leave powder was noticed as compared to fresh leaves. This supports the fact of heat liable nature of vitamin C (Lee et al., 2017). Also, irreversible oxidative due to drying process could also be a reason behind loss of vitamin C content in powder form (Araújo et al., 2017; Di Scala et al., 2011). In tomato powder, the vitamin C content was found to be 125 mg/100g which is higher to the values reported by USDA (116 mg/100g) for tomato powder (Srivastava & Kulshrestha, 2013Srivastava & Kulshrestha, 2013). A significant decrease in the protein content in kale powder was observed suggesting, negative impact of hot air (tray-drying) at elevated temperature. Different advanced drying methods such as microwave drying could be helpful to reduce this protein loss. However, no loss in the protein content of tomato powder was noticed despite the fact that both the commodities were subjected to the same drying treatment (tray-drying). It suggested that inclusion of tomato with kale powder for the preparation of soup mix is a better option as the added tomato powder would make up the protein requirement that was lost in case of kale powder. The fiber content of the powdered form of both the commodities was found to be nearly similar, suggesting not much influence of drying treatment on fiber content of the kale and tomato.

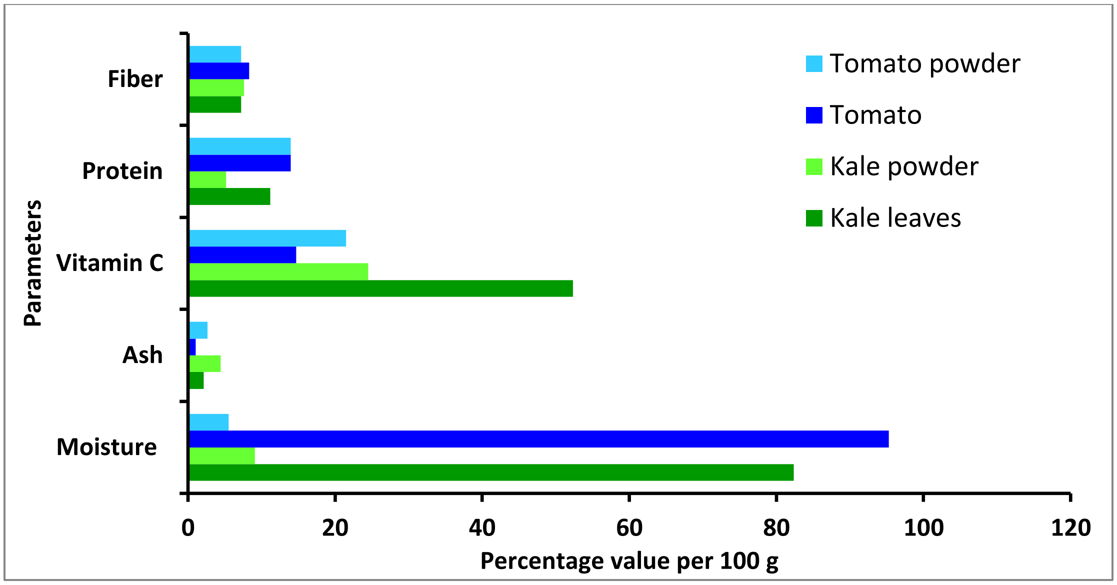

Fig. 1. Physicochemical analysis of fresh and powdered form of tomato and kale leaves

Table 2. Physicochemical analysis of kale and tomato (Fresh and powder)

Characteristics	Kale leaves(100g)	Kale powder(100g)	Tomato(100 g)	Tomato powder(100g)
Moisture content	82.38	9.07	95.29	5.51
Ash content	2.11	4.43	1.06	2.65
Vitamin C	52.34	24.5	14.7	21.5
Protein	11.16	5.16	13.98	13.98
Fiber	7.23	7.6	8.3	7.21

3.2. Physicochemical analysis of Tomato-kale instant soup mix powder (ISM)

Total 5 instant soup mixes (ISMs) were prepared as per the ratios mentioned in Table 1. All the 5 ISMs were analyzed for various physicochemical properties. Difference in the ratio of tomato and kale powder addition has shown an impact of the physicochemical parameters of the ISMs. The 40:60 ratio of kale and tomato showed highest solubility of kale leave powder into the ISM (S2). Solubility has become an important parameter when it comes to palatability and flavor. However, vitamin C content was found to be more in case of S5 where 100% kale powder was added. Low vitamin C content in other ISMs despite the fact having a considerable amount of tomato powder added suggested degradation of vitamin C during the storage time.

Table 3. Physicochemical analysis of kale –tomato instant soup mix powder

ISM powder	Moisture content	Ash	Vitamin C	Protein	Fiber	TSS(BRIX)	Kale leaves powder

samples							**solubility**
S1	6.32	0.24	63.48	7.48	11.67	80.52	66.6
S2	4.81	0.53	66.39^{a}	12.05^{a}	8.65^{a}	80.56	69.71^{a}
S3	5.09	0.78	56.48^{b,e}	13.12^{b}	11.66^{e}	80.60	67.24^{e}
S4	5.41	0.41	68.33^{c,f,h}	12.86^{c}	12.01^{f}	80.62	68.9^{c,h}
S5	7.82	0.8	72.90^{d,g,I,j}	13.23^{d}	12.58^{g}	80.66	66.34^{g,j}

All the values are mean value of at least three readings.

- a, b, c, d signify significant difference between S1 vs S2, S1 vs S3, S1 vs S4, S1 vs S5
- e, f, g signify significant difference between S2 vs S3, S2 vs S4, S2 vs S5
- h, I signify significant difference between S3 vs S4, S3 vs S5
- j signify significant difference between S4 vs S5

Values with different superscripts in the same row are significantly different ($p \leq 0.05$)

3.3. Sensory evaluation of the instant soup mixes

All the five instant soup mixes prepared in this study were subjected for sensory evaluation by trained panelists at 9-point Hedonic scale. A famous market soup Knorr was taken as the control to compare the prepared instant soup mixes for all the parameters. The market soup was reconstituted fresh as the prepared ISMs were reconstituted. The results of sensory evaluation werelisted in Table 4and presented as Fig. 2. As can be seen from Fig. 2, reconstituted ISM S2 was found be most accepted formulation in sensory evaluation.

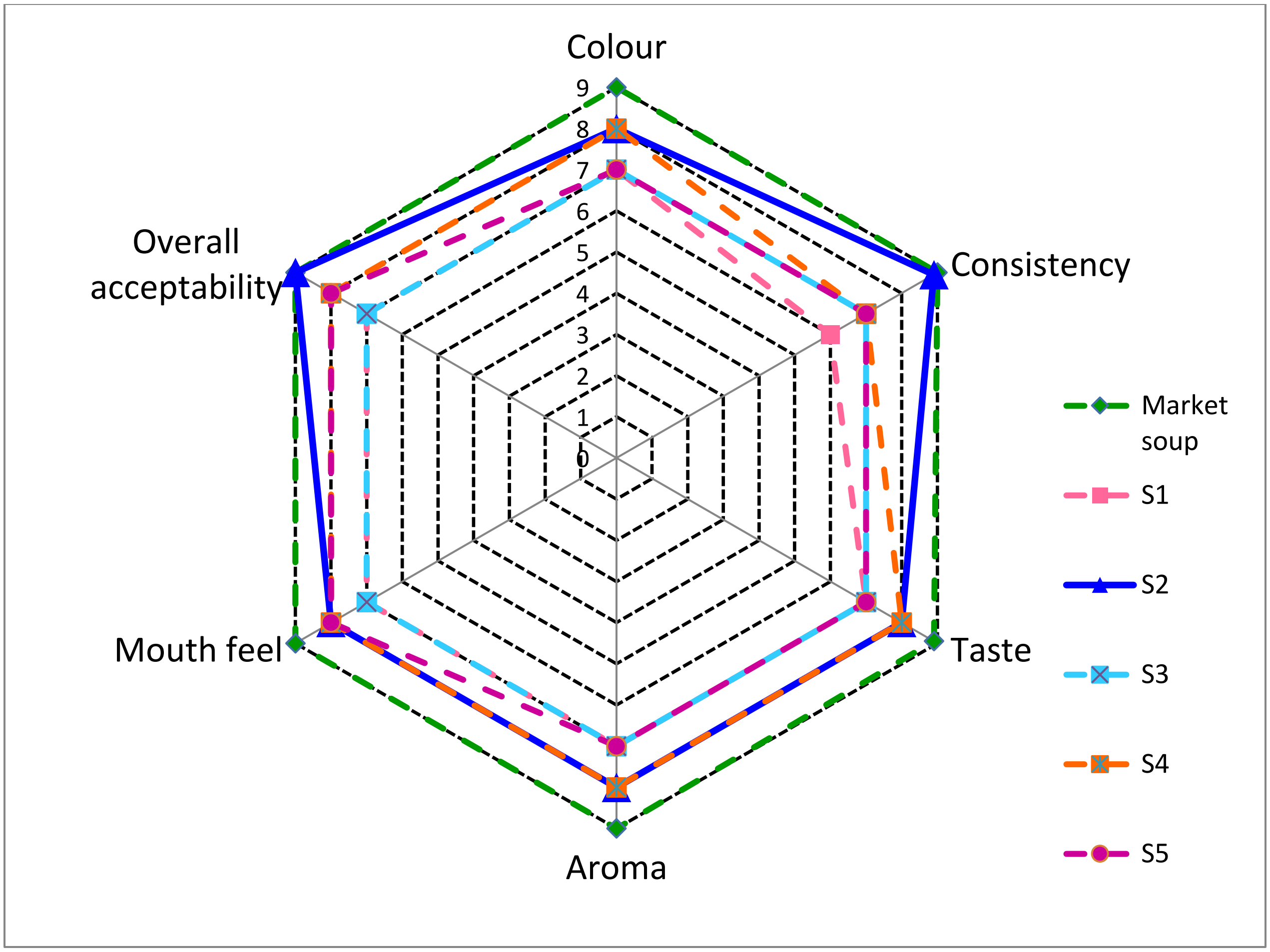

Fig. 2. Sensory evaluation of the five instant soup mixes compared with market soup

Table 4. Sensory parameters (9 scale hedonic scale)

Sample	Colour	Consistency	Taste	Aroma	Mouth feel	Overall acceptability
Market soup	9	9	8.9	9	9	9
S1	7	6	7	7	7	7
S2	8	8.9	8	8	9	9
S3	7	7	7	7	7	7
S4	8	7	8	8	8	8
S5	7	7	7	7	8	8

4. Conclusion

Kale (Brassica oleracea var. acephala) has become a part of daily diet due to its antioxidant and anticancerogenic potential and nutritive values. Similarly, tomatoes also posses' nutritional health benefits with phytochemicals that contribute to reduce the risk of cardiovascular disease and prostate cancer. Without doubt, dietary intake of these two vegetables can provide variety of compounds with health benefits. Changing consumer food habits and addressing the post-harvest losses of these two highly moisture contained perishable commodities their processing in value added food product is a combinable approach. With this motivation, instant tomato soup mix with added health benefits of kale was prepared and subjected to various physicochemical analyses. The 40:60 kale: tomato powder ratio soup mix was found to most acceptable in sensory evaluation with closest flavor, feel, consistency similar to reconstituted market soup.

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