

Acceptability Profile of Tomato Soup Prepared Using Flavor Potentiator and Spices

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Abstract

Flavor enhancer is widely used in various cuisines to enhance the original flavor or taste in a food system. The most commonly used flavor enhancers in Asian cuisine are the glutamate related compounds such as monosodium glutamate (MSG), monopotassium glutamate and ribonucleotide based compounds. The present study was planned with an objective of evaluating the flavor potentiating effect of monosodium glutamate on tomato soup. Five soup formulations were prepared using spice powders (*Capsicum annum L.*, *Capsicum frutescens L.*, *Syzygium aromaticum L.*, *Cinnamomum verum, C.* and *Piper nigrum L.*), employing three different levels of MSG (50, 100 or 150mg/100g). Products without MSG served as control. The products were evaluated by trained panelists (n=10) using a score card comprising a maximum score of 20. The results revealed that there was a gradual increase in the scores being awarded for each increasing level of MSG incorporation. Statistical analysis indicated a significant difference in taste, mouth feel and aroma quality of the formulated products. This implies that MSG with spices would tend to have a synergistic effect which in turn contributes for the enhanced liking of the product.

Keywords: Sensory Attributes; Monosodium Glutamate; Spices; Sensory Scoring; Free Choice Profiling.

Introduction

Flavor is considered as one of the most important sensory attribute. Flavor enhancers are the ingredients which by its unique synergistic property would tend to intensify the flavor profile of a product. One of the most common ingredients that have been used as a flavor enhancer since time immemorial is the monosodium glutamate (MSG). It has been identified as the source of *umami* taste for obtaining pleasant savoury taste (Ikeda 2002). Another major advantage of addition of MSG to dishes is that it would serve to reduce sodium content without drastically affecting taste and pleasantness of foods when they are used alone or in combination with Inosine 5' monophosphate (IMP) (Carter et al 2011a; Okiyama and Beauchamp 1998; Roininen et al 1996). There is a common notion that the umami rich foods

are usually regarded as satiating. For instance, sweet taste would exert influence signaling for high energy sources, while that of umami substances might have profound influence on amino acids and proteins (Chawdhari and Roper 2010). Findings from Marsh et al (2007) indicated that, the taste sensitivity to MSG has been thought to be linked with an increased demand for dietary protein.

Several researchers have also reported that, MSG is likely to interact with protein, and can influence gastric emptying leading to subsequent altered appetite and energy intake (Marsh et al 2009; Masic and Yeomans 2013; Zai et al 2009). MSG is also known to have greater impact on satiety which is mainly due to the presence of umami taste receptors and its signaling molecules and their expression in gastro intestinal enteroendocrine cells (Nakamura et al 2010; Gabriel et al 2007). Incorporation of glutamate has been estimated to stimulate these cells, consequently promoting the release of satiety related hormone such as cholecystokinin and glucagon like peptide both in rodents as well as in humans (Daly et al 2013; Hosaka et al 2012). The synergistic interactions of free glutamate and 5'-ribonucleotides are known to be the major determinants of intensity of umami taste in any product. A significant enhancement in umami taste

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could be brought about by 5'ribonucleotides. This unique taste property is termed as taste synergism (Zhang et al 2008). Investigations of Marcus (2005) and Peralta et al (2005) have indicated that, most of the processed savoury foods have been reported to contain umami substances which are mainly released during various processing steps such as ripening, drying, curing, aging and or fermentation. The objective of the present investigation was to examine the flavor potentiating effect of MSG in tomato soups prepared with different spices.

Methodology

For the preparation of soups the materials such as full ripe tomato (*Lycopersicon esculentum*), corn flour (*zea mays*), milk, salt and five different spices namely; two varieties of chillies- chilli CA (*Capsicum annum* L), chilli CF (*Capsicum frutescens* L), pepper (*Piper nigrum* L), cloves (*Syzygium aromaticum* L) and cinnamon (*Cinnamomum verum* C) were procured from local market. These spices were ground into desired particle size prior to incorporating into soups. The two different varieties of chillis used in soup formulation are known to have varied level of pungency. Chilli CF is known to impart a bright appealing color with an appetizing delicate aroma, while chilli CA has higher pungency. Hence, they contribute for the different flavor profile to whatever dishes they may be added. MSG was obtained from Ajinomoto company, Japan.

Preparation of the Soup

Fresh full ripe tomatoes were washed, blanched and the skin was removed. The pulp was ground into a fine paste and was strained. This pulp was used for the preparation of soup. The basic soup recipe was developed by using 75g of ground tomato pulp, 0.5g corn flour and 25ml milk. The level of addition of spice powders, namely chilli CA, chilli CF, pepper, cinnamon and cloves was standardized individually to give the soup a pleasant flavour. Each of the selected spice powders were added at the level of 0.2, 0.4, 0.2 0.05 and 0.1g respectively per 100g of the prepared soup samples. The soups were standardized with three different levels of MSG (100, 150 and 200mg) and the one without MSG served as control sample. For each sample 1g salt was added. A white sauce was prepared by adding corn flour to boiled and cooled milk. To this mixture tomato pulp was added and was cooked on medium flame for 5 min with constant stirring. Towards the end of cooking, spice

powders and desired level of salt and MSG were added, mixed well.

Sensory Evaluation

The prepared soup samples were subjected to sensory evaluation by a total of 10 trained panelists. The sensory panelists were recruited by various sensory screening tests and were selected based on their ability to perceive and detect the flavor of MSG when the samples were presented in a solution comprising various basic tastes. Multiple training sessions were completed using taste solutions of all basic tastes for intensity scaling. The concentration of salt solutions used for testing were 0.05, 0.1, 0.15 0.2, 0.25 and 0.3% and for sour solution [represented by citric acid] were 0.01, 0.03, 0.05, 0.07, 0.09 and 0.11%. The grading scale used was : 0- none or taste of pure water, ?-different from water but taste quality not identifiable, X-very weak taste, 1- very weak taste, 2-medium, 3- strong, 4- very strong, 5- extremely strong. Tests were conducted pre- and post MSG to bring out the flavor potentiating effect of MSG on basic taste.

For soup samples, a maximum score of 20 was assigned for the various sensory attributes such as appearance, taste, mouth feel, aroma and overall acceptability. The grading scale was defined as follows; 1-4 fair, 5-8 satisfactory, 9-12 good, 13-16 very good, 17-20 excellent. An additional score card was also used to evaluate the free choice profiling of the soup samples. The characteristic attributes of the sample was evaluated in a descriptive manner.

Statistical Analysis

The results obtained through sensory evaluation were subjected to statistical tests to derive mean and SD. The scores of sensory attributes were subjected to analysis of variance (ANOVA) to determine statistical significance at $p = 0.05\%$ using data analysis tool pack.

Results and Discussion

The results of the study are compiled in Figures 1-2 and Tables 1-2.

Flavour Potentiating Effect of MSG on Basic Tastes

Since, MSG is known to have flavor enhancing effect, results of sensory threshold testing for salt and sour taste were selected for inclusion as they have

a direct relation with the flavour attributes of tomato soup. Data pertaining to cumulative responses for threshold tests for salt is presented in Figure 1. Majority of the panel members were able to identify the taste quality at different intensities as weak, medium and strong. For very few panel members the perception was found to be towards very strong. The responses were found to be nil for the intensity scale indicating extremely strong taste of the given solution. The results of after effect of MSG on the perception of salt taste (salt post MSG) showed that MSG did not exert a masking effect on the perception of basic taste quality which was evident from the compiled results. A very small number of panel members were still able

to perceive the basic taste quality as being different from water [5] and a perception of very weak threshold [8]. For considerably higher number of panel members the taste intensity was found to be in the range of weak to very strong. According to the responses of 3 panel members it was opined to have extremely strong taste. Similarly the responses obtained for mixed solution i.e. MSG +salt showed that the taste perception was better in the presence of MSG because it exerts synergism with salt. Here, a proportionately higher number [20] of panel members were found to be more sensitive to salty taste and thus the responses obtained were shown to be towards

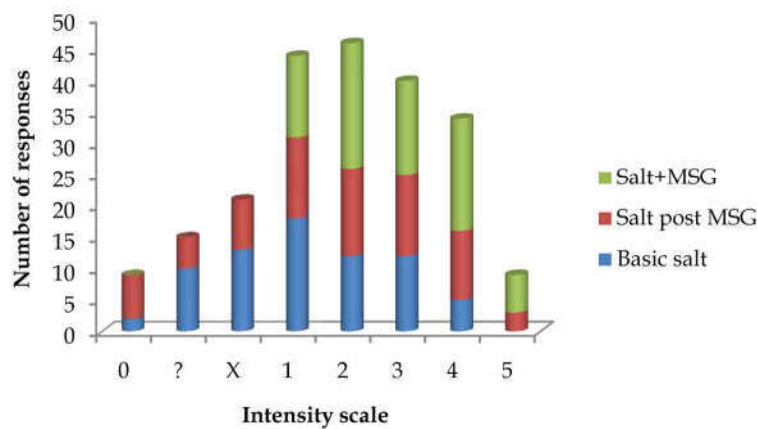


Fig. 1: Cumulative responses for threshold tests for salt

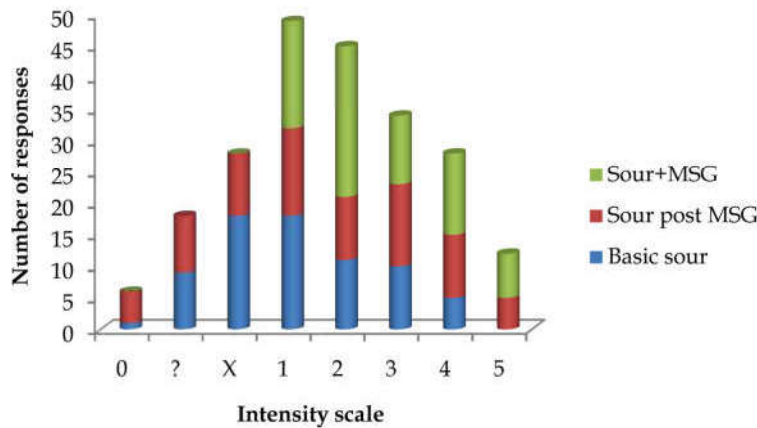


Fig. 2: Cumulative responses for threshold tests for sour

the higher category of intensity scaling.

Grading scale: 0- none or taste of pure water, ?- different from water but taste quality not identifiable, X-very weak taste, 1- very weak taste, 2-medium, 3-strong, 4- very strong, 5- extremely strong.

Citric acid was used to prepare the solution

representing the sour taste. The threshold responses for basic sour taste and sour post MSG are presented in Figure 2. For the basic sour taste majority of the respondents identified the taste as either bland or to be very weak. The observed responses were found to be spread over a wide range of intensity scaling ranging from unrecognizable level to extremely strong

taste. The compilation of the responses implied that there was a gradual progress in the recognition of the given taste which showed an increase from being weaker to stronger category.

A similar trend was observed in taste perception of sour solution which was tasted after MSG solution. According to the responses it can be said that there was no carry over/taste masking effect. Here a proportionately higher number of panel members were able to recognize the taste quality. This shows that sour taste could be very easily recognized in comparison to salt even at a lower intensity scale. This could be due to the characteristic sharp tangy taste of the citric acid to which most humans are found to be sensitive and can be recognized very easily. In this case also the results were found to be widely distributed throughout the entire intensity scaling ranging from very weak to extremely strong. A slightly higher number of responses were found to be distributed in the intensity scale of ? and X.

The results of mixed solution of MSG and sour taste indicated that majority of the responses were found as having a medium taste perception (24), followed

by weak (17), strong (11), very strong (14) and extremely strong taste (7). This indicates that even after mixing with MSG the basic sour taste was able to maintain its characteristic taste and flavor. All the recorded responses were towards the progressive higher range of intensity scaling.

Effect of MSG Addition on Sensory Quality of Tomato Soup

The mean sensory scores of tomato soup prepared with chilli CA and chilli CF, pepper, cinnamon and cloves are presented in Table 1. The mean scores for the quality of appearance were found to be similar for various samples with two different varieties of chillies. For chilli CA the score was 14.8 ± 1.33 and for soup with chilli CF 12.5 ± 1.43 . Statistical analysis indicated p-value greater than 0.05 implying that the appearance of soup samples was not affected due to the addition of MSG. The mean scores for all the other attributes of control sample were found to be comparatively lesser than that of samples prepared by incorporating MSG. The taste quality of sample with chilli CA was indicated to have obtained gradually increasing level of scores which ranged between 10.1 ± 1.3 – 13.2 ± 1.23 respectively. Statistical

Table 1: Sensory scores [Mean \pm standard deviation] for tomato soup

Appearance	Chili CA	Chili CF	Pepper	Cinnamon	Clove	ANOVA
Control	12.5 \pm 1.43	14.8 \pm 1.33	13.3 \pm 1.73	11.6 \pm 1.56	11.2 \pm 1.33	3.61 ^{NS}
100	12.5 \pm 1.43	14.8 \pm 1.33	13.3 \pm 1.73	11.6 \pm 1.56	11.2 \pm 1.33	3.61 ^{NS}
150	12.5 \pm 1.43	14.8 \pm 1.33	13.3 \pm 1.73	11.6 \pm 1.56	11.2 \pm 1.33	3.61 ^{NS}
200	12.5 \pm 1.43	14.8 \pm 1.33	13.3 \pm 1.73	11.6 \pm 1.56	11.2 \pm 1.33	3.61 ^{NS}
p-value	1.000	1.000	1.000	1.000	1.000	
Taste						
Control	10.65 \pm 1.58	10.1 \pm 1.3	12.6 \pm 1.43	11.4 \pm 1.56	11.5 \pm 1.43	0.01*
100	11.5 \pm 1.43	11.3 \pm 1.36	13.35 \pm 1.42	12.45 \pm 1.59	12.6 \pm 1.28	0.02*
150	12.4 \pm 1.02	12.15 \pm 1.34	14.6 \pm 1.34	13.35 \pm 1.55	13.45 \pm 1.11	0.001**
200	13.3 \pm 1.10	13.2 \pm 1.23	15.4 \pm 1.43	14.5 \pm 1.36	14.3 \pm 1.19	0.003**
p-value	0.00085	0.00013	0.0006	0.0009	0.0002	
Mouth feel						
Control	11.75 \pm 1.29	10.65 \pm 1.45	11.5 \pm 1.28	11.6 \pm 5 1.42	11.2 \pm 1.6	0.48 ^{NS}
100	12.78 \pm 1.38	11.8 \pm 1.31	12.55 \pm 1.31	12.7 \pm 1.23	12.35 \pm 1.69	0.58 ^{NS}
150	13.8 \pm 1.33	12.75 \pm 1.19	13.6 \pm 1.26	13.55 \pm 1.31	13.1 \pm 1.58	0.46 ^{NS}
200	14.4 \pm 1.56	13.55 \pm 1.15	14.3 \pm 1.19	14.4 \pm 1.28	13.9 \pm 1.3	0.56 ^{NS}
p-value	0.0013	0.00019	0.00021	0.0006	0.005	
Aroma						
Control	12.3 \pm 1.35	10.7 \pm 1.62	11.3 \pm 1.28	12.25 \pm 1.36	10.8 \pm 1.33	0.03*
100	13.25 \pm 1.36	11.75 \pm 1.44	12.35 \pm 1.10	13.2 \pm 1.33	11.9 \pm 1.39	0.05*
150	14.23 \pm 1.37	12.65 \pm 1.45	13.15 \pm 1.10	14.15 \pm 1.34	12.7 \pm 1.40	0.02*
200	15.3 \pm 1.35	13.8 \pm 1.40	13.7 \pm 0.81	15.05 \pm 1.31	13.3 \pm 1.36	0.004**
p-value	0.00029	0.00068	0.0017	0.0005	0.0029	
Overall acceptability						
Control	11.2 \pm 1.33	11.65 \pm 1.18	11.65 \pm 1.18	11.95 \pm 1.31	11.9 \pm 1.45	0.10 ^{NS}
100	12.3 \pm 1.27	12.6 \pm 1.11	12.6 \pm 1.11	13.0 \pm 1.26	13.05 \pm 1.27	0.12 ^{NS}
150	13.3 \pm 1.17	13.4 \pm 1.20	13.4 \pm 1.20	13.9 \pm 1.30	14 \pm 1.26	0.16 ^{NS}
200	13.95 \pm 0.93	14.2 \pm 1.25	14.2 \pm 1.25	14.9 \pm 1.30	14.8 \pm 1.33	0.19 ^{NS}
p-value	0.0001	0.00045	0.00045	0.0002	0.0003	

Note: P value indicates effect of MSG on taste attribute of samples whereas ANOVA indicates comparison between different spices

analysis revealed highly significant differences ($p=0.00013$). A similar trend in the pattern of score being given for other attributes was observed. The differences were found to be statistically highly significant. Chilli CA was known to impart a delicate pungent aroma to the soup samples which was reported to enhance the aroma characteristics. The incorporation of MSG resulted in a synergistic effect and a gradually increasing level of score was awarded for the various soup samples.

For soups prepared with chilli CF, samples with 200mg of MSG was found to be given the highest score (13.3 ± 1.10). For the quality of aroma the scores given were in the range of 12.3 - 15.3. Statistically highly significant differences were noted for the attributes like taste ($p=0.00085$), aroma ($p=0.00029$) and overall quality ($p=0.00011$). While mouth feel was evaluated to have only a mild significant differences ($p=0.0013$). A similar trend in the pattern of score being given for other attributes was observed. The differences were found to be highly significant. Chilli CA was known to impart a delicate pungency to the soup samples which was reported to enhance the aroma characteristics. The incorporation of MSG resulted in a synergistic effect with a consequent gradual increase in the scores of the soup samples with different levels of MSG.

For soups prepared with chilli CF, sample with 200mg of MSG was found to be given the highest score (13.2 ± 1.23) for its taste quality. For the quality of aroma the scores given were in the range of 10.7 ± 1.62 - 13.8 ± 1.40 respectively. Statistically significant differences were noted with respect to attributes like; taste ($p=0.00013$), Mouth feel ($p=0.00019$), aroma ($p=0.00068$) and overall acceptability ($p=0.00037$).

As can be seen from the table, the soups prepared with pepper powder was found to have obtained highest scores for the quality of taste (15.4 ± 1.43) in comparison to soups prepared with cinnamon (14.5 ± 1.36) and cloves (14.3 ± 1.19). Appearance quality was shown to have statistically non significant difference for all the three different set of samples. For aroma quality of pepper soup, cinnamon and cloves the scores given were in the range of 11.3-13.7, 12.25-15.05 and 10.8 - 13.3 respectively. Among all the soup samples soup with cloves was found to have scored proportionately lower scores. The control samples from all the three sets were found to have been awarded comparatively lower scores. Within each set, the control product was found to have scored much lower scores for its overall acceptability in comparison to products with MSG. Considerable variations were observed within each set of samples for the attributes of taste, mouth feel, aroma and overall

acceptability. A similar trend in the scoring pattern was observed for all the 3 set of products, i.e, as the level of MSG increased the scores were also found to be given in an increasing trend. This is suggestive of the fact that, MSG incorporation along with different spice powders was shown to exert flavor synergism with a consequent increase in the perceived level of palatability. Statistically highly significant differences were noted for all the attributes of three different set of products.

The analysis of variance was performed in order to determine whether there exists any inter sample differences when compared with different levels of MSG and with spices. The inter sample comparison indicated that the difference was not significant for the appearance quality ($p=3.61$) of all the samples with different levels of MSG and spices. With respect to taste quality all the formulated soup samples were exhibited to have mild to moderate level of differences. Control sample and sample with 100mg MSG were found to have very mild significant differences ($p=0.01$ and 0.02). While for product with 150 and 200mg MSG it was indicated to have moderate differences with the probability value of 0.001 and 0.003 respectively. With the available data it can be inferred that with increasing the concentration of MSG the product would acquire better taste quality in comparison to those made without incorporating MSG. The quality of mouth feel was shown to have no significant differences for all the soup samples with different levels of MSG and spices. For the quality of aroma the statistical analysis indicated significant differences. For control sample ($p=0.03$), and sample with 100 and 150mg MSG ($p=0.05$, 0.02). The differences were observed to be quite large ($p=0.004$) for product with 200mg MSG. This data implies that MSG incorporation tended to enhance the aroma characteristic. The analysis of overall acceptability data showed no significant differences between all the developed soup samples. From the above observations it can be concluded that certainly there was a significant improvement in taste and aroma characteristics. This could be because MSG is basically known as an excellent flavor potentiator and its role has been clearly demonstrated in the present investigation via enhancement in taste and aroma quality.

A study was conducted by Kang et al (2007) to evaluate the sensory interactions of organic acids and various flavours in ramen soup systems. There are basically three types of ramen soup bases namely; beef, sea food and kimchi flavours that are considered as most popular flavor bases for ramen soup in South Korea. These were selected as model food system for

evaluating the potential of organic acids such as malic, citric and lactic acid as flavor enhancers. The results of the sensory characteristics of 'beef' ramen soup showed that the intensity of all the attributes except for fat and MSG taste indicated to have significant differences. In 'seafood' ramen soup system the intensity of hot, sweet taste, salty, MSG taste, dried shrimp, mussel dried seaweed were indicated to have no significant differences. The addition of acid tended to increase the sourness but was shown to have least effect on other flavor attributes. The addition of organic acid to kimchi soup resulted in an increase in astringent, hot, sour taste and metallic taste. But, tended to decrease sweet taste, MSG taste, artificial beef flavor and mushroom flavor. In this particular formulation the flavor attributes generally known to have congruency with sourness such as astringency and metallic tastes which were seem to be enhanced with the addition of organic acids. On the other hand, the attributes not exerting congruency such as sweet, MSG, artificial beef and mushroom flavor were shown to be suppressed. The authors concluded that, the sour flavor intensification was thought to be largely dependent on the congruency of the pair in each of the specific food systems.

Kawai et al (2012) investigated the glutamate concentration in miso soup served in hospitals and nursing homes for the elderly in Japan. This traditional savoury soup is very popular in Japan which is served at least once a day in such institutions. It is generally prepared by boiling ingredients such as vegetables in soup stock (dashi) and then seasoning the stock with fermented soybean paste (miso). The collected soup samples were analyzed for glutamate concentration, Disodium inosine 5' monophosphate (IMP) and Disodium-5'-guanosine monophosphate (GMP) and sodium content. The results showed that the glutamate concentration in samples ranged from 36 ± 4.0 to 98 ± 7.0 mg/100ml. The variation in glutamate concentration within each institution was noted to be relatively small. The estimated concentration of IMP was 8.8 ± 8.5 mg/100ml, while, that of GMP was 1.6 ± 3.1 mg/100ml. These two substances are known to exert synergistic effect especially when mixed with glutamate. The sodium concentration was observed to fall within a narrow range of 142 and 596 mg/100g. A significant positive correlation was noted between the glutamate and sodium concentration. Miso is known to contain high glutamate and sodium since it is prepared with salted and fermented soybeans. Readymade dashi contains higher concentration of glutamate and sodium as it comprises sodium chloride and umami compounds

Table 2: Free choice profiling of tomato soup prepared using different spices

Sensory Attributes	Chili CA			Chili CF			Pepper			Cinnamon			Clove			
	Level of MSG (mg/100g) Con.	100	150	200	Level of MSG (mg/100g) Con.	100	150	200	Level of MSG (mg/100g) Con.	100	150	200	Level of MSG (mg/100g) Con.	100	150	200
Appearance																
Appealing	7	6	8	6	7	6	6	8	9	9	9	9	10	10	10	10
Attractive	3	4	2	4	3	4	4	2	1	1	1	1	-	-	-	-
Taste																
Appetizing	4	8	7	5	8	9	8	7	6	8	8	8	6	7	7	7
Pleasant	6	2	3	5	2	1	2	3	4	2	2	2	4	2	3	3
Aroma																
Delightful	8	9	7	6	8	7	9	6	8	7	5	6	8	9	7	9
Very mild	2	1	3	4	2	3	1	4	2	3	5	4	2	1	4	3
Consistency																
Smooth	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Overall acceptability																
Delicious	3	6	5	8	6	7	9	8	6	7	8	8	9	7	8	8
Appetizing	7	4	5	2	4	3	1	2	4	3	2	2	1	3	2	2

Con.: Concentration.

as major ingredients. The positive correlation between the concentration of glutamate and sodium in miso soup could be due to the wide variety of associated aspects of miso soup.

The information pertaining to responses for descriptive quality attributes given under free choice profiling of soups prepared with Chilli CA and Chilli CF, pepper, cinnamon and cloves is indicated in Table 2. As can be observed from the table, all the products were rated to be 'appealing' and 'attractive' for the quality of appearance. Taste profile showed that all the products were perceived as 'appetizing and pleasant'. For the quality of aroma highest number of response was obtained for 'delightful' followed by very few responses stating as 'very mild' perception. Similarly for soup with chilli CA obtained higher responses for the appearance attribute under appealing and a few responses reporting as 'attractive'. Consistency was rated as 'smooth' and overall acceptability as delicious and appetizing.

In general the overall responses obtained for the soups were as follows: majority of the responses indicated the soup to be appealing followed by 'attractive'. Taste was reported to be appetizing by majority of the panelists. While, a small number of responses were also recorded as pleasant. Aroma quality was regarded as delightful by most of the panelists and very few reported it to be as very mild for all the three set of soups. Considerably higher number of subjects responded as the soup was delicious and appetizing. From the compilation of above responses it can be inferred that the spices would interact with the taste and aroma characteristics with a consequent impact on enhancing the flavor profile of formulated soup samples. Thus it could be said that to have maximum acceptability, spices and MSG combination could be regarded as a better option for achieving consumer acceptability.

Conclusion

The study indicated that the soups formulated with different spice combination with the incorporation of MSG exhibited maximum acceptability as evident with sensory scores. Hence MSG could be used as an additive to bring about enhanced flavor effect along with spice combination, since it is known to exert flavor synergism.

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