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Sensory Attributes of Fresh Herb Chutneys Prepared Using a Flavor Enhancer

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Abstract

Taste and flavor are considered as the most important sensory attributes in food palatability. The most commonly used flavor and taste enhancer is monosodium glutamate (MSG) to bring about positive palatability changes. The present investigation was designed to evaluate the sensory characteristics of MSG incorporated fresh herb chutneys based on mint (*Mentha spicata*), coriander (*Coriandrum sativum*) and curry leaves (*Murraya koenigii*). The products were standardized by incorporating 3 different levels of MSG viz, 100, 150 and 200 mg/100g of the product. Product without MSG served as control. The products were served with and without the carrier (conventional bread, unleavened flat breads prepared with rice and with whole wheat flour) and were evaluated by a group of 10 trained panelists for the attributes like appearance, taste, mouth feel, aroma and overall quality. A maximum score of 20 was assigned for each attribute. The results showed that both set of products (with and without carrier) were acceptable. The taste quality of curry leaves chutney served without a carrier was given highest score in comparison to other two products and was in the range of 14.7 ± 1 to 16.8 ± 1.08. Aroma quality of curry leaves chutney was highly acceptable and obtained the highest score of 18.1 ± 1.3. Except for the quality of appearance all the remaining attributes were indicated to have significant differences for both the set of products. Hence, it can be concluded that MSG incorporation had a positive impact on the sensory parameters of all the products.

Keywords: *Monosodium Glutamate; Threshold Tests; Free Choice Profiling; Flavor Potentiator*

Introduction

Food consumption is known to be motivated by the self felt need as well as with the associated pleasure referred as hedonic hunger [1]. Palatability is considered as one of the major sensory attribute which plays an essential role in food selection and intake. Flavour of the food is considered as the major determinant of status of food in terms of its edibility [2,3]. Sensory perceptions and the major determinants of food choice largely seem to be influenced by a range of factors and inclusion of specific ingredients would help to make food highly palatable. Glutamate is one such ingredient which has been credited with an unique property of having the flavour potentiating effect. The taste that is imparted by glutamate is termed as umami, the 5th basic taste, which is being employed in a wide variety of food preparation to make food tastier, palatable and to have greater acceptability [4]. The term umami is basically a Japanese concept which means savory or delicious which is a prototypical stimulus imparted mainly by monosodium glutamate (MSG) [5]. Sodium lactate or peptides have also been evaluated and reported to potentially bring out the characteristic umami taste. Cheese, soy sauce and miso are known to contain di- and tri-peptides and hence they are generally used as seasoning ingredients or as condiments [6]. It has been reported that when glutamate was used alone as a taste stimulus, it was observed that, the stimulus was not pleasant and was not shown to exert synergistic effect with other basic tastes. Whereas glutamate when presented with a vegetable having savory odour would help to contribute a very high degree of taste satisfaction mainly resulting due to the convergence effect of taste and olfactory pathways in the orbitofrontal cortex [7].

Taste synergy is mainly characterized by the interaction between MSG, IMP and GMP. It is capable of enhancing the taste quality by nearly 8 times the taste intensity that can be obtained by total of the separate ingredients [8]. Thus, MSG is deliberately added to foods like soups, sauces, savory products, dry mixes etc. Apart from this it is also known to be present in certain foods, like meat, sea foods, vegetables like tomato, potato, green peas are known to contain significant amounts of natural glutamate. And thus, these ingredients would become an integral part of any meal. A wide variety of pastes and sauces made from fish and other sea foods are relatively popular in various countries mainly due to their special taste characteristics; and being salty comprise of aroma compounds that stimulate the appetite [9].

Among these sea foods based products *Belacan* is the most popular traditional condiments prepared from shrimp paste. It is available as several variants; chilli belacan, spicy noodle soup and fried rice [10-12]. These are eaten with main course meals. Similarly, in India a wide variety of condiments/side dishes are also prepared. Either herbs or vegetables could be used as a base ingredient. Their inclusion along with the meals has been reported to increase the food acceptability and imparts appetizing flavour due to the addition of various aromatic herbs and spices. It thus provides a greater palatability to the products. However, data on the use of MSG as flavor potentiator in such products is very scarce. Moreover, traditional Indian cooking does not use MSG; hence it is a new flavor for Indian palate. Hence, in the present investigation an attempt has been made to develop fresh herb chutney/condiments by incorporating MSG at different levels to know their sensory acceptability.

Methodology

The basic ingredients like the fresh herbs, salt, spices, spice mixes etc were procured from the local market. MSG was procured from Ajinomoto Company, Japan. A description of ingredients is given in the table below.

Ingredients used in the formulation of the products

Common name	Botanical name	Common name	Botanical name
Chillies, green or red	*Capsicum annum L*	Fresh coconut	*Cocos nucifera*
Chick pea, Puffed/decorticated	*Cicer arietinum*	Tamarind	*Tamarindus indica*
Cumin seeds	*Cuminum cyminum*	Mint leaves	*Mentha spicata*
Onion	*Allium cepa*	Coriander leaves	*Coriandrum sativum*
Garlic	*Allium sativum*	Curry leaves	*Murraya koenigii*
Ginger	*Zinziber officinale*	Jaggery	*Saccharum offinarum*
Description of spice powders used in the product formulation			
Dry mango powder: It is a spice powder prepared from dried unripe green mangoes (*Mangifera indica*). It is generally used as a souring agent in certain dishes such as in soups, curries, vegetable dishes, etc,			
Chat masala: It is a mix of hot and tangy spice powders. Asafoetida (*Ferrula assa-foetida*), black salt and raw mango powder are the basic ingredients used for the preparation. This contributes sour and salty taste to the dishes. It is normally used as a topping/sprinkler in savoury snacks and fruit/vegetable salads.			

Preparation of fresh herb chutneys

For the preparation of the products, all ingredients were obtained from the local market and washed, cleaned, cut and pre-processed as needed. The method of preparation of each chutney is briefly discussed.

Mint leaves chutney

The basic recipe was formulated using 15g of mint leaves, 5g coriander leaves, 20g onion, 2g garlic, 3.5g ginger, 5g green chillies and 100ml curds. The ingredients were blended in a mixer to obtain a fine paste. To the above mixture spice powders such as dry mango powder (1g), chat masala (1g), cumin seed powder (1g) and 2g salt was added and mixed well.

Coriander leaves chutney

For the basic recipe 5g coriander leaves, 5g green chillies, 20g onion, 25g grated coconut, 10g garlic, 5g tamarind, 25g puffed chick pea were ground in a mixer into a fine paste. The ground mixture was seasoned with oil, mustard, and black gram dhal. Towards the end, 2g salt was added and mixed well.

Curry leaves chutney

The basic recipe was developed using 5g curry leaves, cumin seeds, 15g decorticated chick pea, 10g ginger, 6g red chillies, 15g dry coconut, 10g tamarind and 15g jaggery. Except for jaggery and ginger the remaining ingredients were roasted on a medium flame till a nice aroma was emitted. The roasted ingredients were ground along with jaggery and ginger into a fine paste. About 2g salt was added and mixed well.

For each developed product three different levels of MSG were incorporated (100, 150 and 200 mg/100g of the product) prior to sensory evaluation.

Sensory evaluation

Training of panel members

The sensory panelists (n = 24) were mainly selected by involving them in various sensory screening tests. The decision was made based on their ability to perceive and detect the flavor of MSG when the samples were presented in a solution comprising various basic tastes such as sugar, salt, citric acid, caffeine and umami. Multiple training sessions were conducted using taste solutions of all five basic tastes for evaluating the intensity scaling. Since MSG is known to exert synergistic effect only with salty and sour ingredients the data from sensory training of basic salt and citric acid responses are presented. This particular experiment was designed in 3 stages i.e. (1) testing the threshold of basic salt solution, (2) evaluating mixed solution of salt and MSG and (3) serving salt solution after tasting the MSG solution (post MSG). Similar protocol was followed for the citric acid also. The concentrations of different taste solutions given for testing were as follows, salt solution: 0.05, 0.1, 0.15 0.2, 0.25 and 0.3%; sour solution: 0.01, 0.03, 0.05, 0.07, 0.09 and 0.11% [represented by citric acid] and for MSG: 0.007, 0.009, 0.011, 0.013, 0.015 and 0.017%. For the mixed solution of salt and MSG, the basic salt solutions were mixed with 0.013% MSG. The level of MSG chosen (0.013%) was the most perceptible level by panel members in threshold tests, hence that was considered most appropriate for addition. Similar protocol was followed for citric acid solution, wherein to the basic solutions 0.013% of MSG was added. 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. The tests were conducted in two stages i.e. pre- and post MSG to evaluate the flavor potentiating effect of MSG on the selected basic taste modalities.

Sensory evaluation of the formulated products

All the formulated products were subjected to sensory evaluation by a total of 10 trained panelists. At any point of time only one particular set of product was presented to the panelists for the evaluation purpose in order to prevent the fatigue. The products were standardized by incorporating three different levels of MSG viz., 100, 150 and 200 mg/100g of the product. The formulated products were served with and without the carrier item during sensory evaluation. The products were evaluated in two stages i.e. as a plain adjunct and adjunct served with a carrier food item.

Selection of carrier item

The developed products are generally referred as the meal 'adjuncts' which are always served with an accompanying food item. Hence, in the present investigation the formulated products were served with some selected carrier item in order to determine the acceptability. Here, the carrier items were selected in such a way that they would not mask the basic flavour characteristics of the adjunct which was served. The food items selected were bland in taste and did not have strong flavour characteristics. The food carrier and adjunct combinations that were chosen in this study are as follows;

1. Mint chutney + Sandwich bread (conventional white bread).
2. Coriander leaves chutney + Rice flour flat bread (prepared using rice flour dough, which is rolled, sheeted and cooked on an open pan).
3. Curry leaves chutney + unleavened wheat bread (prepared using whole wheat flour dough, which is rolled, sheeted and roasted on an open pan).

Description of the score card

All samples were presented to panel members with a score card. A maximum score of 20 was assigned for the major 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 [13]. In addition to this the products were also evaluated through the free choice profiling for obtaining information about the characteristic attributes of the sample in a descriptive manner [14].

Statistical analysis

The results obtained through sensory evaluation were subjected to statistical tests to calculate mean and SD. The scores of sensory attributes as well as inter sample data were compiled and subjected to analysis of variance (ANOVA) to determine statistical significance at p = 0.05%. The analysis was performed using data analysis tool pack.

Results and Discussion

Effect of MSG on the perception of basic tastes

The results of threshold tests are shown in Figure 1 and 2. For the basic salt solution majority of panel members (n = 24) reported the taste as weak. A very small number (n = 4) opined that it was very strong. The responses obtained for salt and MSG mixed solution was distinctly different. Since, MSG leads to synergistic effect with salt, a highest number (n = 21) were able to recognize the taste as medium and considerably higher number of panel members reported it as strong sensation. The salty taste perception in case of post MSG did not indicate the masking effect as a large number of panelists were able to perceive the taste in the range of medium to strong.

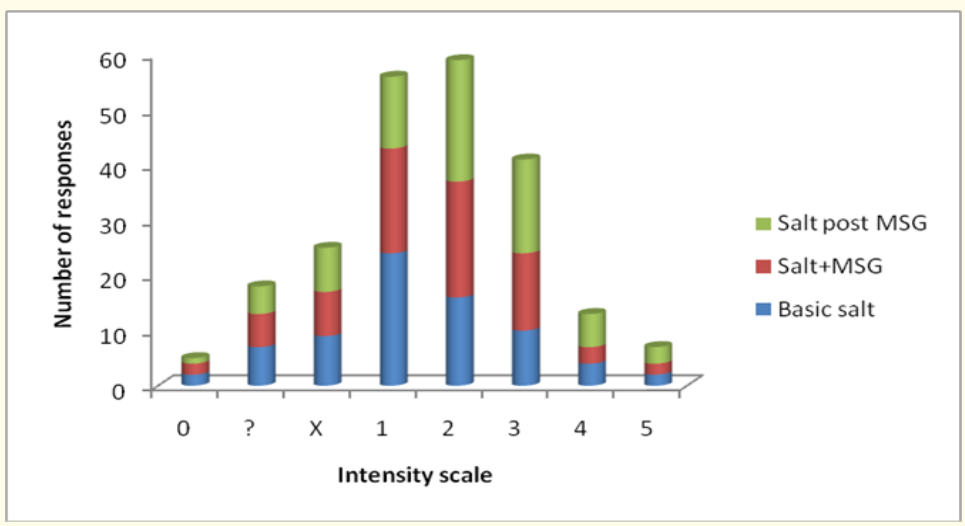

Figure 1: *Cumulative responses for threshold tests for salt*

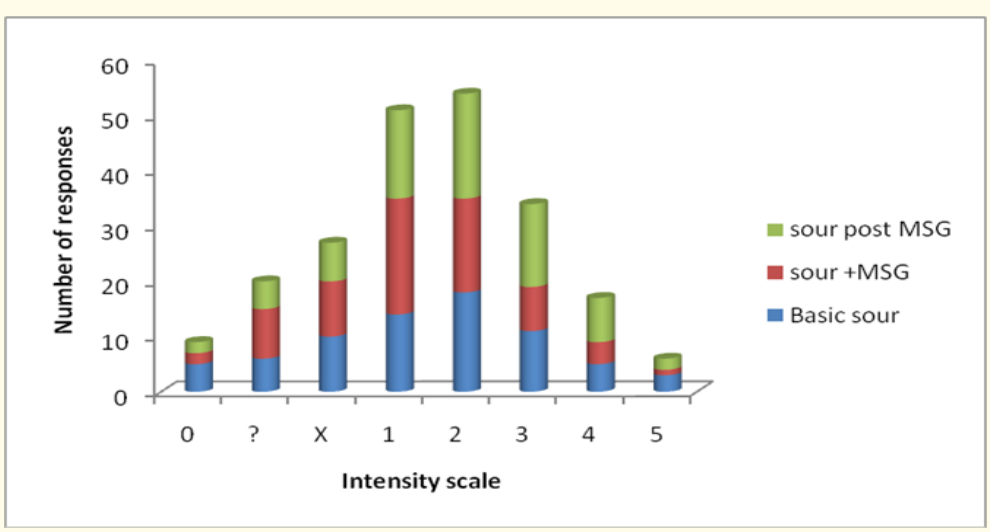

Figure 2: *Cumulative responses for threshold tests for sour taste*

Similarly, the taste sensation of citric acid solution indicated that, at low concentrations a very small number of panel members could recognize the correct taste and it was felt as extremely strong by very few panel members (n = 3). Mixed solution resulted in an intensification of sour taste and thus quiet a large number of panels were able to recognize the taste quality and majority of the responses were obtained for the taste quality as very weak, weak taste and as being medium taste. Data for sour taste post MSG denoted that the solutions were well recognized even after tasting MSG. About 16 of the responses were as "very weak" followed by 19 as "medium" and 15 as "strong". This suggests that there was no masking effect exerted by MSG on the perception of basic taste quality, though it had a synergistic taste enhancing effect on both salt and sour taste.

The influence of MSG on human taste receptors can be monitored through salivary flow as MSG is also known to stimulate the secretion of saliva. Hence, an investigation was conducted to characterize the parotid salivary flow in response to MSG and was compared with the responses of gustatory stimuli produced by other basic tastes. Unilateral saliva was collected from the parotid gland to assess the salivary flow rate from 8 subjects. The solutions used for eliciting the stimuli were made from MSG, sodium chloride, magnesium sulphate, sucrose and citric acid. The results revealed that there was an increase in the flow along with increased concentration of each of the stimulating solutions. The individual mean salivary flow showed occurrence of the highest gradient against each concentration and was noted in response to citric acid and sodium chloride followed by MSG. The authors concluded that the order of relative salivary flow responses from a highest intensity to lowest was in the order of citric > MSG > Nacl > sucrose > magnesium sulphate [15]. In another study Mojet., *et al.* [16] investigated the relationship of pleasantness with threshold sensitivity and supra threshold sensitivity to the intensity of five taste qualities supplied through distilled water and in commercially available products like ice tea, tomato soup, broth, chocolate drink and mayonnaise. Both young and elderly populations were recruited. The overall observations indicated that elderly did not show a preference for higher concentration. All the products were more liked by elderly than by young subjects. The preference for Nacl also did not vary among the two groups. Hence, it could be said that the study did not support the assumption that age related loss of taste sensitivity demands for a taste enhanced foods.

Sensory evaluation of fresh herb chutneys (without carrier)

Information pertaining to the mean sensory scores of chutneys prepared using mint leaves, coriander leaves and curry leaves and served without a carrier is presented in Table 1. The quality of appearance was found to be similar for control and products with three different levels of MSG. With respect to taste quality it was very evident that there was a progressive increase in the total mean scores from control to products with different levels of MSG. For control product, the scores were less (13.10 ± 1.30). A gradual increase in the mean scores being given was noted upon the addition of MSG. The product with 200mg MSG scored highest (15.8 ± 0.98) as against the product with 100 and 150mg MSG. The average mean scores of mouth feel also showed a similar trend. For control product, the scores were less in all cases, while product with MSG showed a greater level of improved mouth feel quality as indicated by the mean sensory scores. Mint leaves by themselves are highly aromatic. The addition of other ingredients along with MSG contributed towards imparting greater degree of aroma. This was very evident from the recorded observations as the products were awarded higher scores which were in an incremental pattern for each different level. As expected the product with MSG scored higher and was in the range of 15.8 to 18.1. The control product scored the least (14.8 ± 1.66). All the products with MSG obtained higher scores in the range of 16.25 - 18.4 and for control it was 15.5 ± 1.28. Statistically significant differences were noted with respect to taste, mouth feel, aroma and overall quality ($p < 0.05$).

Products (MSG, mg/100 g)	Mint leaves	Coriander leaves	Curry leaves	Anova
Appearance				
Control	16.1 ± 1.44	17.1 ± 0.94	15.9 ± 1.14	0.091 ns
100	16.1 ± 1.44	17.1 ± 0.94	15.9 ± 1.14	0.091 ns
150	16.1 ± 1.44	17.1 ± 0.94	15.9 ± 1.14	0.091 ns
200	16.1 ± 1.44	17.1 ± 0.94	15.9 ± 1.14	0.091 ns
p-value	1.000	1.000	1.000	-
Taste				
Control	13.10 ± 1.30	14.1 ± 1.7	14.7 ± 1.00	0.05*
100	14.15 ± 1.27	15.1 ± 1.7	15.6 ± 1.11	0.096 ns
150	14.9 ± 1.04	16.3 ± 1.49	16.3 ± 0.90	0.024*
200	15.8 ± 0.98	17.4 ± 1.43	16.8 ± 1.08	0.025*
p-value	0.0001	0.0005	0.0007	-
Mouth feel				
Control	14.0 ± 2.00	16.2 ± 0.87	15.8 ± 1.25	0.007**
100	15.8 ± 1.72	17.2 ± 0.87	16.1 ± 0.94	0.057*
150	16.7 ± 1.68	17.5 ± 1.12	16.9 ± 0.83	0.386 ns
200	18 ± 1.34	18.3 ± 0.90	18 ± 1.26	0.826 ns
p-value	0.0001	0.0004	0.0005	-
Aroma				
Control	14.8 ± 1.66	16.7 ± 0.90	16.0 ± 1.26	0.016*
100	15.8 ± 1.25	17.1 ± 0.83	16.4 ± 0.92	0.038*
150	16.5 ± 1.5	17.6 ± 0.92	16.9 ± 0.70	0.115 ns
200	18.1 ± 1.34	17.9 ± 1.04	18 ± 1.00	0.931 ns
p-value	0.0002	0.044	0.0008	
Overall acceptability				
Control	15.5 ± 1.28	16.5 ± 1.36	15.9 ± 0.83	0.214 ns
100	16.25 ± 1.47	17.1 ± 1.22	16.6 ± 0.92	0.348 ns
150	17.2 ± 1.40	18.1 ± 0.94	17.2 ± 0.87	0.152 ns
200	18.4 ± 1.20	18.7 ± 1.19	18.1 ± 1.14	0.562 ns
p-value	0.0003	0.001	0.0001	

Table 1: *Mean sensory scores of fresh herb chutney (without carrier).*

Taste is considered as one of the most important sensory attribute in the food acceptability. Here, in the present investigation the 2nd product was prepared using coriander leaves. It was observed that there was a gradual increase in the scores of product prepared with the addition of MSG in comparison to control product which were relatively lesser. It was also observed that the scores exhibited greater variation within each set and between each product having considerable differences which could be mainly attributed to the taste enhancing properties of MSG. With reference to the taste quality the product with 100mg MSG had scored 15.1 and was further observed to have reached to 17.1 with 200mg MSG. The quality of mouth feel was evaluated to be highly desirable and was shown to improve with each level of addition of MSG. Similarly, for aroma and overall acceptability, the pattern of scoring followed a similar trend where all the control products were rated to be slightly inferior in comparison to the products prepared with the incorporation of MSG. The overall acceptability scores were in the range of 17.1 - 18.7. The products indicated highly significant differences for taste (p = 0.0005), mouth feel (p = 0.0004), aroma (p = 0.004) and overall acceptability (p = 0.001). The appearance quality did not show any significant differences.

The compilation of the mean sensory scores of curry leaves chutney indicated that all the products had similar appearance and hence obtained similar scores for all the products with and without MSG. It was also noticed that there was only a marginal increase in the mean scores of taste for the products prepared with and without the addition of MSG. For mouth feel between the products with 100 mg and 150 mg MSG the scores given were found to be almost in the similar range i.e 16.1 and 16.9 respectively. Product with 200 mg MSG obtained the highest maximum score of 18.0. Aroma quality of control product and products with 100 and 150 mg MSG indicated that the addition of MSG did result in relative improvement. The scores given for overall acceptability also followed a similar trend in scoring for each product. The common trend which was observed in this investigation was that as the level of MSG incorporation increased a consequent increase in the scoring pattern was seen. Statistically significant differences were also noted for certain attributes.

All the 3 different types of fresh herb chutneys that were served without a carrier were found to be acceptable. Coriander leaves chutney was found to have scored the highest in comparison to the other two types of chutneys. With the available data, it can be said that incorporation of MSG would definitely help to enhance all the desirable attributes in a product. Especially in a product like chutney or condiments MSG exerts synergistic effect with salt, spices and souring agents that are used. These interactions would in turn help to achieve higher acceptability.

The samples were also subjected to analysis of the variance to determine whether the three different set of products exhibit any inter sample differences. This was performed by comparing the control product and product with different levels of MSG with the 3 different types of fresh herbs used in the formulation of the product. There were no significant differences in the appearance of all products that were served without a carrier in all the sets. With respect to taste all the 4 different sets were indicated to have significant differences. Hence, it could be implied that addition of MSG contributed for additional positive hedonic effect which may be one of the reason for the increasing trend of scores observed between products. This could be attributed to the taste intensifying property of MSG. With reference to mouth feel, the control product and product with 100mg MSG exhibited mild level of significance. While the other two products showed no significant differences. The results of inter sample comparison of aroma was observed to be comparable with the trend of result observed for mouth feel i.e. only control product and product prepared with 100mg MSG had significant differences. For overall acceptability, none of the products were exhibited to have significant differences. The results indicated that between different chutneys, there were differences in taste quality with coriander chutney exhibiting maximum acceptability, however, these differences vanished with higher levels of MSG as there was a uniform increase in flavor of all products.

Rhyu and Kim [17] conducted an investigation to evaluate the umami characteristics of water extract of '*doenjang*' (fermented Korean seasoning) to determine the contribution of peptides and amino acids in imparting delicious taste. It is generally made from fermented soy beans, salt and fermented rice grains and is widely used in Korea as soup base and as a seasoning. Prior to sensory evaluation, the doenjang water extract was dissolved in water at various concentration and was presented to the panelists. The product was subjected to taste profile analysis, difference tests, peptide and amino acid analysis. The taste characteristics indicated that the umami taste scored the highest among the 5 basic tastes at 1% doenjang water extract (DWE) solution. Salty taste was found to have the 2nd highest rating followed by other basic tastes i.e. sour, sweet and bitter. The major amino acid component of DWE is GLU which is present as either free or in bound form. GLU and aspartic acid represented about 38% of the total amino acid content. Whereas for bound type a representative concentration of 46% was found. The peptides with high molar ratio of GLU exhibited MSG like flavor activity and L-GLU and hydrophilic C-terminal residue was found to have umami taste. Thus, the authors concluded that the proteolytic peptides which were present in abundance could be considered as major contributors for obtaining umami taste of DWE.

MSG is being employed as a flavour enhancer in Asian cuisines since very long time for enhancing the sensory properties, in particular, the flavour characteristics. An investigation was conducted on the use of MSG and other condiments that are generally used in the cooking of staple foods in Doula, Cameroon employing about 500 female subjects. The samples of MSG and the most frequently used seasonings and condiments were procured from the retail markets and analyzed for the free glutamate content. The average glutamate content of cube type condiments was 10.7 ± 1.70 (w/w), and 13.87 % (w/w) for magi cube. And these were being used by 80% of the household for preparing staple foods. The study revealed that, the condiments from the retail markets of Cameroon had high amounts of free glutamate. The main ingredients that were being used in the formulation of staple foods were; tomato, herbs, fish, potato, beef slices, dried fish, peanut, etc and all these were reported to contain mixture of organic acids having umami taste characteristics. This served to enhance the flavour characteristics of foods [18].

Sensory evaluation of chutneys served with a carrier

Chutneys are meal adjuncts which are eaten with staple cereal based foods as flat beads prepared with wheat or rice. They are generally very spicy, hence go well with bland cereal based products. Hence, in the present investigation the prepared chutneys were also served with a common carrier (food item) to evaluate the acceptability profile. A perusal of Table 2 provides information about the mean sensory scores of mint leaves, coriander leaves and curry leaves chutney that were served with carrier. For mint chutney, the carrier item used was the white bread. As can be seen from the table it was evident that the mean scores for taste was indicated to have enhanced along with gradual increase in the level of incorporation of MSG, the maximum score being 17.9 for product with 200 mg MSG. Mouth feel was found to have improved in conjunction with the highest level of MSG with maximum score of 18.3. For aroma as well as overall acceptability the pattern of score being awarded was found to be similar i.e. with increase in the amount of incorporation of MSG, a gradually increasing pattern of scores was seen for all 4 set of products. Control product scored the least for all attributes of chutney. All the products were shown to have statistically highly significant differences for taste, mouth feel and overall acceptability, while aroma had marginal differences.

Products (MSG, mg/100 g)	Mint leaves	Coriander leaves	Curry leaves	ANOVA
Taste				
Control	14.7 ± 1.62	14.4 ± 1.62	13 ± 1.34	0.058*
100	15.8 ± 1.54	15.6 ± 1.62	14.2 ± 1.42	0.060 ns
150	17 ± 1.34	16.8 ± 1.54	15.1 ± 1.37	0.017*
200	17.9 ± 1.14	18.2 ± 1.54	16.0 ± 1.34	0.005**
p-value	0.0001	0.0001	0.0003	
Mouth feel				
Control	15.5 ± 1.28	15.2 ± 1.47	14.2 ± 1.47	0.142NS
100	16.5 ± 1.28	16.3 ± 1.4	15.2 ± 1.48	0.107NS
150	17.4 ± 1.11	17.2 ± 1.47	16.3 ± 1.50	0.184NS
200	18.3 ± 1.19	18.4 ± 0.99	17.2 ± 1.17	0.057*
p-value	0.0001	0.0001	0.0004	
Aroma				
Control	14.3 ± 2.10	15.0 ± 1.55	13.8 ± 1.40	0.341 ns
100	15.4 ± 2.06	16.0 ± 1.55	14.9 ± 1.34	0.361 ns
150	16.6 ± 1.74	16.9 ± 1.37	15.9 ± 1.37	0.366 ns
200	17.8 ± 1.66	18.2 ± 0.98	17.0 ± 1.32	0.177 ns
p-value	0.002	0.0001	0.0001	
Overall acceptability				
Control	14.6 ± 1.62	14.95 ± 1.56	13.6 ± 1.56	0.190 ns
100	15.8 ± 1.40	16 ± 1.55	14.6 ± 1.56	0.122 ns
150	16.9 ± 1.37	17.15 ± 1.55	15.9 ± 1.42	0.149 ns
200	18.0 ± 1.34	18.4 ± 1.11	16.8 ± 1.25	0.028*
p-value	0.0001	0.0001	0.0002	

Table 2: *Mean sensory scores of fresh herb chutney (with carrier).*

Coriander leaves chutney was served with flat bread made with rice flour. It was interesting to note that each increasing level of MSG resulted in considerably higher differences in scores of all four products. The responses indicated the products to be much tastier in comparison to those served without a carrier. Taste was rated to have improved to the greatest extent with a score in the range of 14.4 to 18.05. The pattern of scoring was observed to follow the same trend with gradual increment being observed for different levels of MSG that was incorporated. The attributes were shown to have highly significant differences.

The carrier item used for curry leaves chutney was flat bread made with wheat flour called as 'Chapathi'. Chapathi is a common staple food of Indians. It was very surprising to note that even when served with a carrier, the mean sensory score for curry leaves chutney did not improve, on the contrary, it showed a reduction in the scores of mouth feel and aroma quality. Though the addition of MSG indicated to have a progressive increase in the score, it did not make a huge difference in the scores from one product to another that were prepared with different levels of MSG. The maximum score given for taste was 16 ± 1.34. Mouth feel was found to improve as indicated by the mean scores. The scores for aroma quality ranged from 13 - 17. As can be seen from the table it can be said that the scoring pattern followed a common trend of being low for control product and higher for the products made with MSG. Statistical analysis showed highly significant differences.

The overall observation of the mean sensory scores of all the 3 different types of chutneys that were served with a carrier infer that coriander leaves chutney was given higher mean sensory score for aroma and overall acceptability, whereas taste quality scores were almost nearer to that of mint leaves but, were higher when compared with curry leaves chutney. This could be due to the reason that in most of the houses, mint and coriander chutney are commonly prepared and most of the panel members exhibited a greater preference for these two products. The perceived sensory characteristics of curry leaves chutney were not preferred because it has an entirely different aroma property which was not found to be very appetizing. Hence, varied responses were recorded.

An inter sample comparison for the sensory parameters of all three products was also carried out and results compiled in Table 2. The taste quality of product with 150 and 200mg MSG had significant differences whereas for the control and product with 100mg MSG there were no significant differences. The other important aspects of sensory quality i.e. mouth feel and aroma were also noticed to have no significant differences. The inter sample evaluation of overall acceptability inferred that only the last set of product which was prepared by incorporating 200mg MSG was shown to have very marginal significant differences. This suggests that a product should have optimal level of MSG in order for it to be perceived for the objective evaluation of taste differentials that may exist from product to product.

MSG is not just an added chemical it may also be present as a byproduct of hydrolyzed vegetable proteins (HVP). These in turn are deliberately employed as seasoning and flavouring agents in the preparation of wide variety of processed foods like dry mixes, soups and canned foods. In this context, a study was performed by Khairunnisak*., et al.* [19] to quantify the free glutamic acid content in commonly consumed processed foods, prepared dishes and condiments. The study employed a total of 50 types of locally prepared dishes and processed foods, and 26 types of condiments sold in Kualalampur, Malaysia. Among the processed food category each food item was purchased from five different brands and was cooked according to the instruction provided on the label. The samples were subjected to extraction and were analyzed by HPLC. It was evident from the results that among the processed food category, chicken/fish nugget was found to contain highest free glutamic acid (FGA) (4.63 ± 0.41 mg/g) followed by instant noodles (1.79 ± 0.45 mg/g) and canned soup containing 1.70 ± 0.62 mg/g. For cereal based dishes the FGA was in the range of 0.24 ± 0.15 mg/g in roti canai (a puffed bread) to 8.16 ± 1.99 mg/g in dough based casing stuffed with minced meat, sea food and vegetables. As expected the FGA content of condiments were found to be relatively higher. Soup stock had more than 100 mg/g. These observations provide considerable evidences for determining the exposure assessment of population to glutamate.

Descriptive quality is one of the most important factor which helps to clearly define the product characteristics in relation to the respective sensory attributes. It also helps to determine the level of acceptance in case of a newly developed product. Hence, in the present investigation the developed products were subjected for free choice profiling and the results are presented in Table 3. As can be observed from the table for all the products, majority of panelists reported the appearance of all the products as appealing with an appetizing taste. Aroma characteristic was reported as delightful by all the panel members. Blend of flavour was reported to be delightful for majority of the panelists. Hence, with the above observation it could be inferred that all the 3 set of products were well accepted as evidenced from the compiled responses. For almost all the attributes the responses were found to be distributed between both the quality parameters that were assigned for each sensory attribute.

Sensory Attributes	Mint leaves				Coriander leaves				Curry leaves			
	Level of MSG (mg/100g)				Level of MSG (mg/100g)				Level of MSG (mg/100g)			
	Con.	100	150	200	Con.	100	150	200	Con.	100	150	200
Appearance												
Appealing	9	9	9	9	9	9	9	9	6	7	8	9
Attractive	1	1	1	1	1	1	1	1	4	3	2	1
Taste												
Appetizing	5	6	8	9	6	6	7	7	5	6	7	8
Pleasant	5	4	2	1	4	4	3	3	5	4	3	2
Aroma												
Delightful	9	10	7	7	6	6	7	8	6	7	7	8
Very mild	1	0	3	3	4	4	3	2	4	3	3	2
Blend of flavor												
Delightful	6	9	9	10	3	5	8	9	5	6	8	9
Appropriate	4	1	1	0	7	5	3	1	5	4	2	1
Overall acceptability												
Delicious	5	7	8	9	6	6	8	9	7	8	8	9
Appetizing	5	3	2	1	4	4	2	1	3	2	2	1

Table 3: *Free choice profiling of fresh herb chutneys (without carrier).*

Conclusions

The study revealed that, the incorporation of MSG had a greater impact on the various sensory attributes. The products without MSG obtained lower scores in comparison to those prepared with MSG. It was also observed that as the level of incorporation of MSG increased, a consequent increase in the scoring was recorded for each different set of products. Thus, it could be said that MSG has the greatest potentiality of amplifying the flavor profile of the products and could be well utilized in various formulations for achieving enhanced acceptability.

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Volume 10 Issue 1 July 2017