Efficacy of Monosodium Glutamate in Sodium Reduction and Impact on Sensory Profile of Traditional Indian Dishes

Prabhavathi SN and Jamuna Prakash*

Department of Studies in Food Science and Nutrition, University of Mysore, Mysuru, India

*Corresponding author: Jamuna Prakash, Department of Food Science and Nutrition, University of Mysore, Mysuru, India. E-mail: jampr55@hotmail.com

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Abstract

Sodium chloride is one of the most commonly used food additive, because it is low cost and has the ability to increase one likes of foods via bringing about modification in flavor and other functional parameters in a food. It is indispensable in food processing and is normally added to achieve technological properties. The present study aimed to formulate and evaluate sensory profile of low sodium traditional Indian dishes incorporating Monosodium Glutamate (MSG). A total of 12 dishes categorized as flat breads, split legumes based dishes (Sambar and Dhals), sautéed vegetables and gravies were prepared and evaluated for sensory acceptability with 10 trained panel members. All the dishes were also analyzed for sodium content in both control (without MSG and only with salt) and experimental products (salt partially substituted with MSG). The sensory data of rice based flat bread showed that substitution of MSG resulted in a superior taste in contrast to the control sample. The compiled scores for mixed vegetable sambar for the quality of taste indicated low initial scores for product without MSG (7.6±2.36), whereas after substituting MSG, a sharp increase in the score was noticed (11.3±2.54). The amount of sodium contributed by MSG was in the range of 6.15-14.7 mg/100g of the product which is proportionately lower than the amount contributed by table salt. The overall sodium reduction for the developed products was in the range of 30.6% - 43.3%. The results clearly demonstrated that MSG could be considered as a better choice of salt substitute for replacing certain amount of sodium content in the products and a better sensory profile.

Keyword: Flavor enhancer; Low sodium; MSG, Salt substitute; Traditional dishes

Introduction

Sodium chloride is considered as an indispensable ingredient in most of the processed savoury products. The salty taste contributed by sodium chloride is a prototypical stimulus [1]. Sodium is known to improve various sensory properties of food; mainly by increasing saltiness, decreasing bitterness and increasing sweetness in addition to bringing about other congruent flavor effects [2]. However, excessive use of salt has been recognized as a risk factor and associated with adverse health profiles. World Health Organization recommends an overall reduction in sodium intake to less than 2000 mg/day of sodium [3]. It was reported that a modest 15% reduction in sodium intake could prevent cardiovascular disease related deaths all over the world over 10 years [4]. Despite its negative health consequences, humans are still continuing to consume sodium in the form of salt in amounts well above the recommended levels in most of the developed countries. Hence, salt reduction should become the prime priority for public health and wellbeing.

Due to the adverse effect of high sodium consumption on health it has become imperative to use a suitable alternative that can compensate for the salty taste along with maintaining normal sensory attributes. The food processing industries have resorted to use salt substitutes to maintain normal sensory attributes of savoury foods.

One of the most important flavor potentiating agents is Monosodium Glutamate (MSG) which is responsible for contributing umami flavor and has been proven to be a good flavor enhancer especially in low sodium chloride products. MSG is known to contain only 12% of sodium which is comparatively much lower than common table salt. Thus MSG incorporation would help to achieve normal salty taste perception along with maintaining normal sensory attributes without leading to substantial increase in total sodium content of the product [5,6]. It may be noted that MSG is not used in traditional Indian cooking and the taste perception of MSG is a new experience for Indians, though they may have experienced it while consuming...
Materials and Methods

Materials

The ingredients needed for preparation of various dishes such as food grains, vegetables, curry powders, spice mixtures were procured from local market. All the ingredients were thoroughly cleaned and processed according to the standard procedure. MSG was obtained from Ajinomoto company, Japan. The chemicals used for the analysis were all of analytical grade and were procured from SD fine chemicals, India. Glass distilled water was used for all the analysis. All the estimations were carried out in duplicates. This particular study was designed to explore the flavor potentiating effect of MSG in Indian cuisine. About 12 commonly eaten day-to-day dishes [classified into 4 different categories] were selected, standardized and prepared. They were subjected to sensory evaluation and estimation of sodium content. A brief description of various categories of products is as follows:

1. Flat breads (Roti)- These are mainly cereal based preparations.
   Bland in taste and are often eaten with spicy preparations.
2. Split legume based curry (Sambar and Dhal) - Made with a combination of split legumes, spices, vegetable and/or acidulant (tomato/ tamarind) and are accompaniment to cereal based preparations such as flatbreads or rice.
3. Gravies - prepared using whole legume and spice combination and eaten with flat breads.
4. Sautéed vegetables - eaten as a side dish in a meal. These could also be half boiled and seasoned to enhance the flavor profile.

The spice combination employed in these preparations were unique to each dish which helped to impart a rich taste to these products.

Methodology

A total of 12 products were standardized and prepared under the categories such as breakfast items, sautéed vegetables, vegetable stews and gravies. Basic dishes and sodium reduced dishes were prepared and evaluated for sensory profile and sodium content. Basic dish was treated as control to estimate the amount of reduction in sodium. The detailed methodology pertaining to the preparation of dishes is appended in Appendix A.
6. Mixed leafy vegetable sambar

**Ingredients:** Amaranth leaves – 80g, Amaranthus tricolor leaves – 50g, Red gram dhal – 50g, Garlic – 2g, Sambar powder – 3 tsp, Oil – 1 tsp, Mustard – ½ tsp, Curry leaves – 12 in no, Tomato – 100g, Tamarind extract – 2 tsp, Water – 100ml, Salt – 1 g

**Experimental:** MSG- 50 mg, Salt- 0.65 g.

**Method:** The leafy vegetables were cleaned, washed, chopped and kept aside. Red gram dhal, tomato, leafy vegetables and salt were cooked in an open vessel till they became soft. Once the leaves were cooked to its doneness, Sambar powder and tamarind extract was added and boiled for 5 minutes. In a pan oil was heated, mustard seeds, curry leaves and crushed garlic were added and fried for 2 minutes on medium flame. The seasoned mixture was added to the sambar, boiled for 2 minutes and removed from flame.

7. Sautéed cabbage

**Ingredients:** Cabbage – ¾ kg, Coconut gratings – 2 tsp, Green chillies – 2 in no, Black gram dhal – 2 tsp, Oil -15ml, Water-100ml, Turmeric – a pinch, Salt – 1 g

**Experimental:** MSG- 60 mg, Salt- 0.55 g.

**Method:** Cabbage was cleaned and shredded. In a pan, oil was kept for heating. To the heated oil, black gram dhal, turmeric and slit green chillies were added and fried for 2 minutes. The shredded cabbage and salt was also added and fried for about 5 min. Small quantity of water was added and the cabbage was cooked on medium flame with constant stirring until it was done.

8. Sautéed beans

**Ingredients:** Beans – ¼ kg, Split chickpeas – 1 tbsp, Split Black gram – 2 tsp, Oil – 2 tbsp, Mustard – ½ tsp, Onion – 100g, Curry leaves – 20 in no, Asafetida – a pinch, Coconut gratings – 30g, Water – 400ml, Salt – 1 g

**Experimental:** MSG- 50 mg, Salt- 0.55 g.

**Method:** The beans were cleaned, chopped, and pressure cooked with salt. In a pan, oil was heated and mustard seeds were added. To the above seasoning split Black gram and chickpeas were added and fried on low flame till they became golden brown. Finally, onions and curry leaves were added and fried for 3-4 min. To this mixture, pressure cooked beans and coconut gratings were added and mixed well.

9. Plain dhal fry

**Ingredients:** Split Red gram – 100g, Mustard – ½ tsp, Cumin seeds – ½ tsp, Split green chillies – 2 in no, Turmeric – a pinch, Oil – 1 tsp, Water – 300ml, Salt – 1 g

**Experimental:** MSG- 50 mg, Salt- 0.55 g.

**Method:** Red gram was pressure cooked with salt. A pan was heated, oil and cumin seeds were added. When they started to crackle, a pinch of turmeric, asafoetida and green chillies were added and fried for few seconds. The pressure cooked red gram was added to the pan, mixed well and cooked for 4-5 minutes.

10. Spinach dhal

**Ingredients:** Split green gram – 100g, Spinach – 50g, Mustard – ½ tsp, Cumin seeds – ½ tsp, Split green chillies – 2 in no, Turmeric – a pinch, Water – 300ml, Salt – 0.85 g

**Experimental:** MSG- 75 mg, Salt- 0.5 g.

**Method:** Spinach was cleaned, washed and finely chopped. Green gram and spinach were pressure cooked with salt till they became soft. A pan was heated, and seasoning prepared with oil, slit green chillies, cumin seeds and pinch of turmeric. To the above seasoned mixture, pressure cooked dhal and spinach were added, stirred well and was cooked for 5 min on low flame.

11. White chickpea gravy

**Ingredients:** White chickpeas – 150g, Tomato – 100g, Onion – 60g, Mustard – 1 tsp, Coriander seeds – 1 tsp, Chilli powder – 1 tsp, Spice mix – 2 tsp, Ginger garlic paste – 1 tsp, Turmeric – a pinch, Green chillies – 2 in no, Potato – 100g, Fresh coconut gratings – 2 tbsp, Poppy seeds – ½ tsp, Water – 400ml, Salt – 1 g, Oil – 1 tbsp

**Experimental:** MSG- 80 mg, Salt- 0.65 g.

**Method:** Chickpeas and de skinned potatoes were pressure cooked with salt. Amaranth seeds and coriander seeds were roasted and powdered. Coconut gratings and poppy seeds were ground to a fine paste. Oil was heated in a pan, cut onions were added and fried, followed by ginger garlic paste and tomatoes and cooked for 2-3 min. To this mixture, coriander powder, chilli powder, spice mix, turmeric and slit green chillies were added and cooked for 3 minutes. Towards the end coconut and poppy seed paste was added and cooked for another 2 minutes. Boiled chickpeas and potatoes were added to the above mixture and boiled for 10 min.

12. Green gram gravy

**Ingredients:** Green gram – 125g, Onion – 50g, Tomato – 50g, Green chillies – 10g, Cinnamon – 1” piece, Turmeric – a pinch, Coriander leaves 5g, Ginger garlic paste – 1 tsp, Pepper – 3 in no, Poppy seeds – ½ tsp, Oil – 1 tbsp, Mustard – ½ tsp, Water – 300ml, Salt – 1 g

**Experimental:** MSG- 100 mg, Salt- 0.6 g.

**Method:** For the gravy: Cut onions, tomato, cinnamon, turmeric, green chillies, coriander leaves, pepper corns, poppy seed and green chillies were ground to a fine paste in a grinder. Green gram was pressure cooked with salt. In a pan, oil was heated and mustard seeds were added. To this ground paste was added and fried for about 2 min. Pressure cooked green gram was added, mixed and allowed to boil for 10 min.

Appendix A: Recipes of Indian traditional dishes.

MSG was added to the experimental product along with salt as indicated.

Training of the panel members

Volunteers familiar with sensory techniques and prior exposure to oriental cuisine were selected. For the purpose of accustoming the sensory assessors to the unique taste of MSG, all panelists who were a part of the study were trained adequately to obtain objective responses. Each selected panel member underwent a total of 18 training sessions. The panel members were selected based on their ability to correctly identify the various basic taste solutions presented. Initial screening comprised of 9 sessions. Here, due care was taken
Analysis of sodium content in formulated dishes by flame photometer

About 5.0 g of sample was weighed into silica crucibles and heated over flame at low heat until all the organic matter volatilized or till no smoke was observed. The dish was transferred to muffle furnace for ashing. The prepared ash solution was filtered using Whatman No. 41 paper into 100 ml volumetric flask. A standard solution of 10 ppm, 20 ppm, 40 ppm, 60 ppm, and 100 ppm was measured for calibration curve. The aliquot of the ash solution was diluted and was automated into a calibrated flame photometer with the wave length dial set at 589nm [15].

Statistical Analysis

All data were analyzed to obtain mean values and Standard Deviation (SD). These sensory analysis data were subjected to statistical analysis (mean±SD and ANOVA) to determine significant differences in samples using computer software SPSS version 18.0.

Results and Discussion

Impact of salt reduction on sensory attributes of prepared dishes

The results of sensory analysis of all dishes are compiled in table 1 and figure 1. While appearance is a common attribute for all dishes, texture was applicable to flatbreads and sauteed vegetables. For all curry type products such as sambar, dhal and gravies, consistency was evaluated. Aroma was applicable to all, and blend of flavour was specifically judged for products with added spices such as sambar and gravies.

Flatbreads

The mean sensory scores of low sodium wheat, rice and millet based flat breads is presented in table 1. Appearance and texture were not affected by lowering of salt and addition of MSG in any product with similar scores for control and experimental. The attributes of taste, aroma and overall acceptability showed an improvement on incorporation of MSG with significant differences for all products. The mean sensory scores ranged between 8.8 to 10.5 for control and 11.2 to 13.0 for experimental indicating statistically significant differences (p=0.02) between products. From the compiled mean sensory scores of rice based flat bread, it was very clear that substitution of MSG resulted in a superior taste in contrast to the control sample. Considerable improvement in the sensory score for taste was noticed when MSG was added. For instance, while the control product was given a total mean score of 8.4, a further increase of 12.3 was noted for MSG added product.
### Products Appearance Texture/Consistency Taste Aroma/Blend of flavour Overall acceptability

#### Wheat
- **Control (C)**: 11.7±1.58 12.3±1.49 8.8±2.52 8.7±2.05 9.2±2.05
- **Experimental (E)**: 11.7±1.58 12.3±1.49 12.0±1.86 12.4±1.25 12.7±1.57

#### Rice
- **Control (C)**: 12.1±1.22 12.3±1.12 8.4±1.99 9.8±2.00 10.5±1.76
- **Experimental (E)**: 12.1±1.22 12.3±1.12 12.3±1.40 12.5±1.52 13.0±1.59

#### Finger millet
- **Control (C)**: 9.3±1.58 9.9±1.71 9.0±2.16 9.3±1.61 10.0±1.62
- **Experimental (E)**: 9.3±1.58 9.9±1.71 12.0±1.74 11.2±1.40 12.0±1.41

#### Mixed green
- **Control (C)**: 8.6±0.91 8.7±1.00 8.7±2.49 8.5±2.03 9.5±2.52
- **Experimental (E)**: 8.6±0.91 8.7±1.00 11.2±2.08 12.2±1.86 12.5±2.06

#### Fenugreek leaves
- **Control (C)**: 8.3±1.00 8.7±0.68 9.1±2.75 10.1±1.85 10.7±1.78
- **Experimental (E)**: 8.3±1.00 8.7±0.68 12.6±1.84 13.0±0.97 13.2±7.1

#### Mixed vegetables
- **Control (C)**: 12.6±1.52 12.2±1.15 7.6±1.26 8.8±2.55 8.0±2.31
- **Experimental (E)**: 12.6±1.52 12.2±1.15 11.3±2.54 11.8±2.16 10.9±2.27

#### Beans
- **Control (C)**: 9.1±0.94 10.8±1.53 6.9±2.55 9.7±2.57 8.0±2.20
- **Experimental (E)**: 9.1±0.94 10.8±1.53 11.7±1.78 12.6±1.93 11.4±1.80

#### Cabbage
- **Control (C)**: 8.9±1.22 10.9±1.51 9.1±2.41 7.8±2.65 8.9±2.21
- **Experimental (E)**: 8.9±1.22 10.9±1.51 11.8±2.19 11.4±2.32 12.4±1.41

#### Spinach dhal
- **Control (C)**: 10.0±1.04 10.5±1.14 8.5±2.45 9.3±2.12 8.7±2.11
- **Experimental (E)**: 10.0±1.04 10.5±1.14 11.5±1.67 12.1±1.93 11.8±1.74

#### Plain dhal fry
- **Control (C)**: 11.6±1.17 11.2±1.02 9.0±2.65 8.1±2.71 9.5±1.44
- **Experimental (E)**: 11.6±1.17 11.2±1.02 10.8±2.31 10.8±2.31 11.8±1.57

#### White chickpea
- **Control (C)**: 12.8±1.44 12.5±1.14 10.4±1.95 8.9±2.36 8.0±2.16
- **Experimental (E)**: 12.8±1.44 12.5±1.14 13.1±1.45 12.1±1.38 11.5±1.71

#### Whole green gram
- **Control (C)**: 10.8±1.41 10.9±0.85 9.4±1.77 8.2±1.33 8.1±2.35
- **Experimental (E)**: 10.8±1.41 10.9±0.85 11.6±1.65 10.9±2.19 11.1±2.09

**Table 1:** Effect of salt reduction on the sensory attributes of MSG incorporated dishes.

**Footnote:** Mean scores±standard deviation of 10 trained panel members. C: Control, E: Experimental.

*p≤0.05, ** P≤0.01, ***p≤0.001, NS: Not Significant

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**Figure 1:** Level of perception of umami flavor in selected low sodium dishes.
Sambar: Split legume based curry

Sambar is a ubiquitous dish in a South Indian meal platter which is a common accompaniment to rice. It is generally prepared with split red gram, vegetables, spices and an acidulant. The sensory attributes of 3 types of Sambar given in table 1 shows that appearance and consistency were similar in both categories of products though other attributes differed significantly. Taste is the most essential attribute of any food product, and here the observations indicated that the sensory scores for taste improved with the incorporation of MSG. Lower scores were given for the control product, 7.6-9.1, which increased to 11.2-12.6 for experimental products. Aroma and overall acceptability followed similar pattern. The data pertaining to the mean sensory scores of fenugreek leaves sambar implied that the addition of MSG resulted in a greater level of enhancement in the perception of attributes of taste, blend of flavour and overall acceptability. Flavour of food along with its palatability are major determinants of food selection, and eventually of food intake also [16].

Many studies have established the role of flavour enhancers in improving the taste quality of foods and different types of flavour enhancers, both natural and synthetic have been used for the purpose. An experimental investigation on the formulation of flavour enhancer using locally available natural raw materials (mushroom, tomato, potato, garlic and salt) was conducted by Silva and Wansapala [17]. About eight different formulations were developed and tested by 30 untrained sensory panellists in order to obtain the best formula, which was subsequently compared with a commercial flavour enhancer like MSG in a rice preparation. The sensory results of the developed flavour enhancer, which was nutritionally rich, demonstrated a significantly higher preferences for the taste quality. Therefore, the investigators concluded that the product could be considered as a flavour enhancer with nutritional properties since it comprised of essential nutrients at an optimum concentration. In another study by Maheshwari et al. [11], MSG was demonstrated to have a synergistic effect with spices too. MSG added to a spiced fried product could reduce the level of salt as well as enhance flavour exhibiting synergism with the spices.

Sautéed/stir fried vegetable based preparations

As evident from table 1, the appearance and texture of control and experimental sautéed vegetables was similar. The scores given for taste quality showed an enormous improvement on incorporation of MSG with reduced salt, while control counterparts received lesser scores. The differences were shown to be statistically extremely significant (p=0.000). Beans are generally reported to have a slight sweetish taste along with mild characteristic flavour. When the product was prepared only with the addition of salt, the responses were not encouraging, being lower for all the attributes related to taste. But, when MSG was added along with standardized level of salt, a considerable improvement was seen in the assigned sensory qualities. According to the panellists, addition of MSG resulted in an entirely different product which had much better sensory attributes in comparison to the control product. This could be attributed to the MSGs potentiality of enhancing the natural aroma and imparting a savoury taste to the dishes. This was the probable reason for the dishes to acquire a highly appetizing flavour. A study by Kumari et al. [8] demonstrated that MSG could be used very well for partially reducing salt in vegetable based soup with enhanced flavour profile and acceptability. It has been shown that glutamate given with a vegetable with savoury odour contribute towards a high degree of taste satisfaction than when given in isolation [18]. This proves the flavour potentiating effect of MSG in vegetable based dishes.

Dhal: Split legume based preparations

The basic difference between ‘Dhal’ and ‘Sambar’ is use of vegetables, spices and acidulants for the latter. Dhal is comparatively bland with or without vegetables, very little spices and no acidulants, whereas for sambar, use of a characteristic spice mixture is a must. Dhalas are prepared using varieties of split or whole legumes, while sambar is principally based on split red gram. The sensory scores of dhal presented in table 1 showed similar scores for appearance and consistency, as was seen for other dishes. With respect to the taste attribute, scores got better after adding MSG as it potentiated and helps to bring out the hidden taste qualities. Thus, product with partial addition of MSG obtained higher score (11.51±1.67) in comparison to the product made without MSG (8.51±2.45). These differences in the score yielded marginally significant statistical differences (p=0.01). As opined by panelists MSG added product had a mildly sweetish and sour taste. This was found to have imparted a relatively higher degree of appetizing taste to the product and thus scores were observed to have improved with the incorporation of MSG.

Gravies

Gravies or curries are highly aromatic spiced dishes which are used as accompaniment to flatbreads or rice preparations. There are many types of gravies which are prepared with vegetables, legumes or meat and are indispensable to authentic Indian cuisine. The spice combinations used in these vary depending upon the region and ethnic groups. The sensory profile of gravies presented in table 1 followed the trend seen for other dishes. While addition of MSG did not affect appearance or consistency, other qualities were influenced significantly. Taste being the major parameter in deciding the products acceptability, partial substitution of salt with MSG enhanced scores (13.1 and 11.8) in comparison to the control product (10.4 and 9.4). This relative increase in the scores of taste quality might be attributed to the MSGs synergistic interaction with sour ingredients and essential flavour that might be present in spices which were used in the preparation. Significant differences were also observed for aroma, blend of flavour and overall acceptability. These gravy types of curries generally comprise of salty and sour taste imparted from the base ingredients. Here, it could be said that addition of tomato might have resulted in a very delicious taste profile. Tomato is known to contain umami flavour enhancing compounds, which impart savoury taste to the product. Therefore both the products were awarded considerably higher scores.

Perception of Umami flavour is selected dishes

Umami flavour is very characteristic of glutamate compounds and is recognized as one of the basic tastes. The term umami is basically a Japanese concept which means savoury or delicious which is a prototypical stimulus imparted mainly by monosodium glutamate. First discovered in seaweeds and recognized for its flavour
The panel members were asked to identify the presence of umami flavour in selected dishes with the help of a descriptive quality profile and their responses for mixed vegetable sambar, fenugreek leaves sambar, sautéed beans and cabbage are compiled in figure 1. With respect to the perception of umami taste in mixed vegetable sambar, it was evident that a proportionately higher number (6) opined that they could perceive the umami flavour at a moderate level. While the responses for mild level of perception was also comparatively higher. For sautéed beans category, a majority of the panel members were able to very clearly perceive the umami flavour at a higher level (6) in comparison to other two responses such as mild (1) and moderate level (3). Though cabbage is known to possess strong characteristic flavour, it did not interfere with the perception of umami flavour quality, which was detected as high. The overall responses for the perception of umami flavour in fenugreek leaves sambar was similar to beans.

Various scientific investigators through their experimentation have provided substantial evidence regarding the role of MSG in achieving considerable level of sodium reduction in the formulated dishes. The sensory acceptability of a garlic seasoning salt formulation was evaluated by a group of Brazilian investigators. They employed both MSG as well as KCl to replace 25% and 50% of salt respectively. The results clearly demonstrated that the product was highly acceptable since it had all the desirable sensory attributes especially when used with cooked rice [21]. In another study, local spicy soup dishes such as curry chicken and chili chicken which had varying amount of NaCl and MSG were evaluated. The amount of NaCl needed to achieve optimal level of acceptance was 0.8%. With partial replacement of NaCl in a ratio of 0.3% NaCl: 0.7% MSG, the dishes had the same level of palatability [22]. Leong et al. [23] investigated the effect of sodium reduction and flavour enhancer such as MSG on the sensory acceptability of two different types of hawker foods namely; chicken rice and mee soto broth that are known to be commonly consumed in Singapore. In sodium reduced recipes two levels of sodium chloride i.e. 0.48 and 0.55% for chicken rice and 0.76 and 0.86% for mee soto were used. The selected levels were reported to be equivalent to 31 and 22% reduction in sodium. MSG was added at the level of 0.2 and 0.4% to the prepared dishes. The study revealed that an amount of addition of 0.4% MSG lead to a total reduction in sodium by 22%. Quadros et al. [24] evaluated the sensory quality of a fish hamburger formulated with reduced sodium. The concentrations such as 1.5g/100g and 0.75g/100g of NaCl associated with 0.3g/100g of MSG were employed in formulations. The results showed that MSG incorporation contributed for an overall increase in the acceptability scores in products containing 0.75g NaCl/100g, i.e. it resulted in a total reduction of salt by about 50%.

The quality profile of cream cheese was evaluated by Silva et al. [25]. The cheese was formulated using various types of salt substitutes namely; potassium chloride, magnesium and calcium chloride, calcium and potassium lactate, potassium phosphate and MSG. The investigators reported that, potassium chloride contributed the highest salting equivalence in comparison to sodium chloride. While, MSG had the lower salting equivalence. Therefore MSG could be considered to have the maximum flavour potentiating property which could be regarded as beneficial for bringing down the sodium content in any product.

### Analysis of Sodium Content of Prepared Dishes

The prepared dishes were analysed for sodium content to assess the level of reduction in sodium. Table 2 represents the sodium content of the various dishes. The data indicated that all the control samples had comparatively higher sodium levels than those of experimental products that were prepared with a combination of salt and partially substituted MSG. The data demonstrated a huge difference in the amount of sodium content of wheat based flat bread. Control product was shown to contain 407.3 mg sodium/100g of the product. While that of experimental product had only about 29.5 mg/100g.

The sodium content of control chickpea gravy was 416.2 mg/100g, and that of experimental product was only 289.2 mg/100g. Since the basic recipe involves the addition of various types of spice powders, in order to balance the taste, salt needs to be added at slightly higher concentrations. As MSG is known to impart savoury taste due to its synergistic interaction with various spices, it generally boosts up the taste along with bringing out other higher flavour qualities effectively reducing the need of salt.

A perusal of table 2 provides information about the total amount of sodium contributed by table salt, MSG and food ingredients and percent reduction in sodium content of MSG substituted products. The sodium content in all the control products was considerably higher which was in the range of 390-429mg/100g of the product. Whereas for experimental products, the amount of sodium from table salt was comparatively less. The amount of sodium contributed by MSG was in the range of 6.15-14.7mg/100g of the product which is proportionately lower than the amount contributed by table salt. Therefore, it could be said that, by reducing the amount of table salt it is possible to achieve considerable reduction in the total sodium content. In general, the overall sodium reduction was in the range of 30.6% - 43.3%. Among the developed products, wheat based flat bread indicated highest amount of reduction (92.7%) since no salt was added during the preparation, and only 100mg MSG was added. Thus it resulted in a greater level of sodium reduction. MSG not only brings down the sodium content, but also acts as an appetite stimulating agent by enhancing the rate of salivary secretion. This particular property has been reported to be beneficial among certain segments of population like elderly people, where they may have difficulty in swallowing due to lack of salivary secretion. This problem could be overcome by incorporating MSG in the dishes. Similarly for other breakfast items like rice flatbread and finger millet flatbread, the percent reduction in sodium content was computed as 36.5 and 34.7% respectively.
68% sodium reduction. Reduction of sodium in foods especially in fermented foods has been studied mostly since last three decades. Also, the effect of different mineral salts on the fermentation profile, microbial flora, physicochemical, textural, and flavour characteristics of product was investigated in this context. For instance, substitution of NaCl was carried out with KCl, CaCl2, and MgCl2 in sauerkraut, with monosodium glutamate, KCl, and CaCl2 in olives and with KCl in cheese fermentations, which has indicated that they could be used as an alternative choices for sodium reduction in formulated or reformulated preparations [27-30].

**Conclusion**

The study brought out important inferences that it is possible to produce traditional Indian dishes with 30-40% reduced sodium content with the substitution of monosodium glutamate. The products had lower intensities of saltiness and appetizing umami taste with good blend of sensory parameters. Further, substitution of MSG also resulted in enhanced perception of different flavor characteristics, which had a greater impact on the overall palatability of products.

**Author’s Contribution**

Dr. Prabhavathi S.N.: She was responsible for all the bench work, as well as analysis and compilation of data and writing the manuscript. This was a part of her doctoral research work.

Dr. Jamuna Prakash: Senior Professor and research supervisor, responsible for guiding and supervising the entire research work and correction of manuscript.

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**Table 2:** The analysed sodium content of the prepared dishes.

<table>
<thead>
<tr>
<th>Product</th>
<th>Sodium content (mg/100g)</th>
<th>Percent reduction in sodium in Experimental product</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Experimental</td>
</tr>
<tr>
<td>Wheat based flat bread</td>
<td>407.3±1.3</td>
<td>290.5±0.25</td>
</tr>
<tr>
<td>Rice based flat bread</td>
<td>390.5±0.5</td>
<td>248.5±0.5</td>
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<tr>
<td>Millet based flat bread</td>
<td>465.5±0.5</td>
<td>304.5±0.5</td>
</tr>
<tr>
<td>Mixed vegetable sambar</td>
<td>486.5±0.5</td>
<td>338.5±0.5</td>
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<tr>
<td>Mixed leafy vegetable sambar</td>
<td>658.0±0.8</td>
<td>472.1±0.35</td>
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<tr>
<td>Fenugreek leaves sambar</td>
<td>454.8±0.3</td>
<td>288.7±0.15</td>
</tr>
<tr>
<td>Sautéed beans</td>
<td>467.5±0.3</td>
<td>297.7±0.4</td>
</tr>
<tr>
<td>Sautéed cabbage</td>
<td>390.5±0.55</td>
<td>221.4±0.1</td>
</tr>
<tr>
<td>Plain dhal fry</td>
<td>422.8±0.15</td>
<td>252.7±0.05</td>
</tr>
<tr>
<td>Palak dhal fry</td>
<td>450.0±0.4</td>
<td>264.3±0.3</td>
</tr>
<tr>
<td>White chickpea gravy</td>
<td>416.2±0.05</td>
<td>289.2±0.15</td>
</tr>
<tr>
<td>Green gram gravy</td>
<td>438.6±0.2</td>
<td>288.2±0.1</td>
</tr>
</tbody>
</table>

**Foot note:** Mean scores±standard deviation.

**Conflict of Interest**

Authors declare no conflict of interest with the research reported in this study.

**References**


