MSG usage in the ethnic food catering industry

We have a choice

be safe be healthy be well

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Executive Summary

In the EU, the flavour enhancer monosodium glutamate (MSG), like other permitted food additives, must appear on the label if used as a deliberate ingredient and has been ascribed the E number 621. Current legal requirements for using glutamate-based food additives, including MSG, in the catering industry recommend not exceeding 10 grams (g) per kg of food10 g/kg either individually or in combination. A number of studies have confirmed the liberal use of MSG exceeding this maximum allowed level, especially in ethnic dishes. This research also recognised that the problem may be caused by a lack of awareness of the MSG already included as an ingredient in commercially–available products used in the preparation of dishes to which further MSG might be added. To date no such survey has been conducted on an island of Ireland basis and consequently we do not know how liberally MSG is used in ethnic cuisine here. This survey, funded by ***safe***food, was designed and executed with three aims in mind: (1) to investigate the use of MSG in the ethnic food catering industry by measuring the free glutamate content in a range of Oriental take-away dishes, (2) to assess the awareness and knowledge of the staff in these premises with respect to the use of MSG in their cuisine and (3) to determine if a customer can obtain an MSG-free dish on request. The results of this survey may provide the basis for future guidance in the ethnic catering sector.

The MSG analyses of 100 food samples purchased in Chinese, Indian and Thai restaurants and take-away outlets in Cork and Belfast were carried out at the Southern Region Public Analyst's Laboratory in Cork. Approximately half of the samples were standard dishes of food typically expected to contain added MSG and the other half were purchased as MSG-free dishes (or MSG-free options of the same dish when available). The sampling officers also completed questionnaires in each of the 50 ethnic food premises visited in the survey. The questionnaires contained information on the knowledge and awareness of staff in ethnic food premises concerning the use of MSG in food for sale at their premises.

The standard dishes almost invariably had a higher content of free glutamate compared to the MSG-free options and the difference was often substantial. This ranged from 0 to 20 g/kg. By contrast, the free glutamate content of the MSG-free dishes varied from 0 to 2.7 g/kg which was probably due to free glutamate from sources including MSG already in the ingredients. Most (94%) of the all the dishes sampled in ethnic food premises contained less than 10 g free glutamate per kg. A smaller proportion (6%) of the dishes – all standard dishes – exceeded statutory limits and contained between 10 and 20 g free glutamate per kg. Chinese dishes, especially those that were sauce based, contained

the highest concentrations of free glutamate while Indian and Thai dishes had much lower concentrations. Almost 1 in 5 of the Chinese standard dishes exceeded statutory limits. This was due to liberal use of MSG during cooking.

The maximum amount of MSG added during cooking of Chinese, Thai and Indian standard dishes was estimated at 19.8, 1.5 and 1.3 g/kg, respectively. Added MSG was detected in 88 %, 71 % and 50 % of Chinese, Thai and Indian premises, respectively. In the case of Chinese premises, these findings are corroborated by the high number of staff who reported using MSG in most of their dishes. The levels of MSG estimated in Thai and Indian dishes were substantially lower than in Chinese dishes and there was a considerable overlap between standard and MSG-free samples. So if MSG was deliberately added in these cuisines, it was at very low levels similar to normal background free glutamate levels.

Staff knowledge of MSG and why it is used in cooking was rather low at 56%. This varied depending on the type of premises with most Chinese staff showing some degree of awareness compared to Thai and Indian staff. However, it may not be as important in the latter ethnic premises as the level of free glutamate detected in these cuisines was relative low overall. Staff were not always aware that some of the ingredients they use during cooking may already contain MSG or naturally occurring free glutamate.

Overall, 76 % of all ethnic food premises (especially Chinese) can offer MSG-free options if requested to do so. Therefore, the majority of staff appear willing to accommodate their customers. These premises routinely receive requests for MSG-free food from customers, especially in Chinese and Thai establishments. It would appear that consumers associate Thai, but not Indian, cuisine with MSG usage similar to Chinese cuisine. However, free glutamate was detected in cuisine from all ethnic establishments so it is in their interests to advise customers that (a) they don't add MSG to their dishes or, where it is added, this step can be omitted, and (b) their dishes may contain free glutamate from other ingredients.

1 Introduction

The basis for the survey

The lifestyle and eating habits of many people on the island of Ireland have changed in many ways compared with those of the general population from one or two generations ago. There are now many convenience food outlets that produce large quantities and varieties of 'take-away' foods. Many of these are associated with ethnic cuisine from the Chinese, Thai and Indian traditions. Thus, Irish people today have a much greater choice of food ranging from traditional Fish and Chips to exotic oriental dishes. This ***safe***food-commissioned research project was designed to find out more information about the use of MSG in Oriental cuisine, the food purveyor's awareness and knowledge concerning the use of MSG, and the choice consumers have with respect to the MSG content when purchasing meals prepared in ethnic food restaurants and take-aways.

Many people are concerned about the possible health impacts of MSG in their diet, a widely used and safe food additive that is also a naturally occurring amino acid. This report explains what MSG is, where it comes from, what food products it is used in, and discusses the reported effects on susceptible individuals. The key findings of an MSG survey of a range of ethnic take-away dishes is presented along with a series of recommendations that serve to better inform staff and customers about the use of MSG in foods and its possible impact on the health of the consumer.

What is MSG?

Monosodium glutamate is the sodium salt of the amino acid, L-glutamic acid (Figure 1.1). Dissolved in water, the sodium and glutamate ions freely separate in solution. Glutamic acid is the most common amino acid found in the human body and a major constituent of virtually every dietary protein. It occurs mostly bound up in enzymes and other proteins although free or unbound glutamate is also found in many foods including meat, fish, poultry, human breast milk and vegetables (Table 1.1)[1]. Fermented soy products, Parmesan cheese and tomato juice also contain large amounts of free glutamate[2]. Food processing which involves aging, drying, roasting, fermentation, toasting or ripening of foods liberates free glutamate from the breakdown of protein causing the deliciousness in foods known as the *umami* taste. There are other substances which contribute to the *umami* taste and include complex sugar phosphates such as inosine 5'-monophosphate (IMP), guanosine mono

phosphate (GMP) and their derivatives. These substances are also found in meat, fish, vegetables and mushrooms.

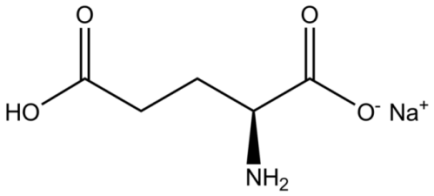


Figure 1.1: Chemical structure of monosodium glutamate. It consists of a simple carbon backbone, amino group (-NH_2), carboxylic acid (-COOH) and sodium ions (Na^+). It does not contain multiple ring type structures that are often associated with more reactive or hazardous chemicals.

Table 1.1: The natural glutamate content of foods

Foods	Bound glutamate (mg/ 100g)	Free glutamate (mg/ 100g)
Milk/dairy products		
Cow's milk	819	2
Human milk	229	22
Parmesan cheese	9847	1200
Poultry products		
Eggs	1583	23
Chicken	3309	44
Duck	3636	69
Meat		
Beef	2846	33

Pork	2325	23
Fish		
Cod	2101	9
Mackerel	2383	36
Salmon	2216	20
Vegetables		
Peas	5583	200
Corn	1765	130
Beets	256	30
Carrots	218	33
Onions	208	18
Spinach	289	39
Tomatoes	238	140
Green Peppers	120	32

Taken from *Loliger,* (2000)[1]. Foods that are particularly high in free glutamate include Parmesan cheese, peas and tomatoes. Bound glutamate is essentially glutamate that is a component of protein. Free glutamate is that found freely soluble in the food.

Flavourings play an important nutritional role, particularly in foods that are bland in taste, by making them more appealing to eat. Foods and ingredients high in free amino acids have been used in cooking for many centuries and in many cultures in order to enhance the flavour qualities of various dishes[3]. In its free form, glutamate has a flavour enhancing effect[4]. When glutamate is part of a protein, it does not have this effect. Because of its flavour enhancing effect, free glutamate is often deliberately added to foods or indirectly via the addition of hydrolysed protein and yeast extracts which in themselves are rich sources of free amino acids. Whether consumed naturally from foods or

in the form of MSG added to foods, glutamate is absorbed and metabolised in the human body in exactly the same way. The average European intake of L-glutamate as a protein constituent and in its free form has been estimated to be approximately 10 and 1 g per day, respectively[5]. Thus, one would not expect an additional fraction of a gram of MSG consumed as a flavour enhancer to cause a health problem. The average intake of added MSG ranges from 0.3 to 0.5 g per day in European countries and 1.2 to 1.7 g per day in Asia (Table 1.2)[1]. In general, consumption of MSG is higher in Asian countries than in Western countries. This is due to traditional oriental cooking which uses many condiments, for example soy sauce, to supplement, enhance or round-off the flavours of many savoury-based processed foods.

Table 1.2: The daily intake of MSG in various countries, particularly the Far East

Country	Intake of MSG (g/day)
USA	0.55
Netherlands	0.66
Thailand	1.50
Japan	1.42
Indonesia	0.60
Korea	1.57
Malaysia	0.37
China	2.2

Adapted from *Loliger,* (2000)[1]. These are daily intake estimates from 1991. The Chinese daily intake estimate is an average value estimated over a fifteen year period from 1991 to 2006.

Glutamic acid is one of the fundamental building blocks of proteins. In humans, it is a non-essential amino acid, i.e., the body is capable of producing its own glutamic acid and is not dependent upon getting it from food. In addition to its role as a building block of protein, glutamic acid serves as an excitatory neurotransmitter vital to the transmission of nerve impulses in many parts of the brain or central nervous system (CNS). The brain makes its own glutamate from glucose. You need glutamate to think. Glutamate is also the precursor for the production of the inhibitory neurotransmitter GABA (gamma-amino butyric acid) within the CNS. GABA serves to dampen down neuronal cell activity and balance the excitation caused by glutamate and other excitatory signals. From a metabolic point of view, glutamate also plays an important role in the body's disposal of excess or waste nitrogen, ammonia detoxification, gut health in premature infants, as a major source of energy for the cells that line the intestinal tract and production and maintenance of the protective antioxidant compound, glutathione[6,7,8].

Presently, six additives identified as flavour enhancers and based on glutamate or its salts are permitted in the European Union. They all give rise to free glutamate and their associated metal ions in solution and are identified in *Codex Alimentarius* (the international body charged with standardising food labelling, food hygiene practices and food additives among other things), as glutamate (E620), monosodium glutamate (MSG, E621), monopotassium glutamate (E622), calcium diglutamate (E623), monoammonium glutamate (E624) and magnesium diglutamate (E625)[9].

The history of MSG

For the past 1000 years, Japanese cooks have known that certain foods taste better when prepared with a soup stock made from kombu – a type of seaweed or kelp — *Laminaria japonica*. At the beginning of the 20th-century, Professor Kikunae Ikeda of Tokyo Imperial University was investigating the taste of food: "*There is a taste which is common to asparagus, tomatoes, cheese and meat but which is not one of the four well-known tastes of sweet, sour, bitter and salty.*" His motivation was to increase the value of food through the enhancement of taste and that such an improvement in taste, especially amongst bland foods, might contribute to relieving malnutrition and increasing the short life expectancy of the Japanese at that time. It was not until 1908 that Professor Ikeda succeeded in extracting glutamic acid from "broth" (dashi) made from kombu. He found that his extract had a distinctive taste, different from sweet, sour, bitter and salty, and he named this fifth taste "*umami*" - a common Japanese word that is broadly translated as 'savoury'. Soon after Professor Ikeda's discovery, and recognising the market potential of MSG, the Ajinomoto Co. in Japan launched production of MSG in May of 1909 by extracting it chemically from acid-hydrolysed wheat gluten or defatted soybean and selling it as a flavour enhancer[10].

American interest in MSG came in the aftermath of World War II. Like pizza and vermouth, MSG was a taste American soldiers brought home with them. They weren't aware that the Japanese were partial to MSG but the US Army catering staff noticed that their men enjoyed the leftover ration packs of the demobilised Japanese Army much more than they did their own and began to ask why. MSG arrived in America at a key moment. Mass production of processed food was booming. However, canning, freezing and pre-cooking have one significant technical problem in common – loss of flavour. MSG was a cheap and simple additive that made everything taste better. It went into tinned soups, salad dressings, processed meats, carbohydrate-based snacks, ice cream, bread, canned tuna, chewing gum, baby food and soft drinks in addition to frozen, chilled and dehydrated ready meals. It turns out that MSG is crucial in no-fat or low-fat food, where natural flavour is lost with the extraction of the natural fats. Such is the story of a scientist and the seaweed, which lead him to a discovery that would make his fortune and change the nature of 20th-century food.

How is MSG made?

The industrial production of MSG via fermentation grew out of the ashes of WWII in Japan. From 1956, Japanese researchers led by Dr. Shukuo Kinoshita at Kyowa Hakko Kogyo Co. investigated, and then isolated, soil bacteria that produced large amounts of glutamic acid. Since then, strains of microbes from the genus or grouping called *Corynebacterium* have been cultivated to produce natural L-glutamic acid in high yield. Prior to the discovery of this organism, the commercial production of amino acids such as glutamic acid had relied on the decomposition of natural protein through chemical means (acid hydrolysis) and the isolation of each of its constituent building blocks or amino acids[11].

Today MSG is predominantly made from starch and sugar following fermentation by the microbe *Corynebacterium glutamicum*. Fermentations are common in the production of many foodstuffs including beer, vinegar, soy sauce and yogurt. The process begins with natural products such as molasses from sugar cane or sugar beet and food starch from tapioca or cereals. Globally these bacteria produce well over 2 million metric tons of glutamic acid annually as well as other important amino acids[11]. The crude glutamic acid produced is then filtered, purified and converted into monosodium glutamate. After further refinement, drying and sieving, MSG has the form of pure white crystals ready for packing and use. The worldwide trade names of MSG are Vetsin®, Accent® and Aji-no-moto®.

How is MSG used?

Adding MSG to meat, vegetables and just about any other type of prepared food imparts a savoury flavour - the *umami* taste – and thus helps enhance the flavour. This explains why glutamate is often deliberately added to foods by food processors and restaurants, either as pure MSG, hydrolysed protein, yeast extract or a variety of food ingredients rich in glutamates, such as cheese, tomato pastes, stocks and sauces. Though MSG can improve the taste, it cannot improve the quality of inferior-quality food or make up for poor cooking practices. It does not allow a cook to substitute low-quality for high-quality ingredients in a recipe, it is not a preservative and does not tenderise meat. MSG simply enhances the savoury flavours already present in food. However, over-use of MSG, or use with poor quality ingredients, will result in an unpalatable product.

Because MSG has no smell or specific texture of its own, it can be used in many different dishes for its ability to improve the palatability of foods by balancing and enhancing other flavours (e.g., sugar seems sweeter; salt seems saltier). MSG and other amino acids such as alanine, aspartate, and arginine are all used to improve the flavour of food. The basis of our ability to enjoy this *umami* taste is rooted in evolution. Animals require certain amino acids for growth and nutrition and these they get through eating protein-rich sources of food. From birth, specific taste receptors (taste buds) on the human tongue are responsive to many of the twenty amino acids naturally used in the production of proteins by all cells in the body. Glutamate triggers the strongest response by human taste receptors, thus providing a biochemical link to nutrient-rich and protein-rich sources[12]. Interestingly, those other flavouring agents known as 5'-nucleotides (e.g. IMP and GMP), greatly increase the *umami* response of the taste receptors to amino acids – causing a synergism of taste[2]. The addition of even a small quantity of MSG to food that contains these nucleotides produces an *umami* taste response that is 6 – 8 fold greater than that expected from the same quantity of MSG added alone[13].

The *umami* taste is not unique to Oriental cuisine. In fact, there is historical evidence for its popularity amongst the peoples of the ancient Roman world[3]. Even today, Italian cuisine, with rich and concentrated tomato sauces and added cheeses such as parmesan can provide even more glutamate than an ethnic Asian meal. When a consumer next grates parmesan cheese onto some dull spaghetti, what he or she will have done is add glutamate to stimulate their tongue's *umami* taste receptors, thus sending a message to the brain which signals a rich and full sense of deliciousness! Almost all foods have some naturally occurring glutamate in them but the ones with most include: ripe tomatoes, cured meats, dried mushrooms, soy sauce, yeast extract including well known products such as Bovril® and Marmite®, stock cubes and of course Worcester sauce and various fermented Asian fish sauces.

Should we be concerned about MSG?

In general, the public perception of food additives is a negative one and this has often been the case with MSG since the first description of the 'Monosodium glutamate symptom complex' in 1968 (Table 1.3). At that time, Robert Ho Man Kwok, M.D., reported in a light-hearted letter that about 20 minutes into a meal at certain Chinese restaurants he suffered numbness, tingling and tightness of the chest that lasted for approximately 2 hours with no residual effects[14]. "The cause is obscure" said Dr. Kwok who then went on to consider several possible causes including soy sauce, cooking wine, MSG and high salt. The New England Journal of Medicine gave Kwok's letter the title, "Chinese-Restaurant Syndrome" (CRS). Subsequently, a number of anecdotal reports and studies have attributed a variety of common and unspecific symptoms to the dietary ingestion of MSG[15]. Populist books like Russell Blaylock's "Excitotoxins - The Taste That Kills", have further tarnished the public perception of MSG[16]. Google 'MSG' today and one will find anecdotal claims for causing asthma attacks, migraines, obesity, hypertension and heart disease, dehydration, chest pains, depression, attention deficit disorder, anaphylactic shock, Alzheimer's and Parkinson's diseases and a host of other diverse allergies. It would seem "glutamania" is alive and well.

However, scientific studies have not shown any direct link between these symptoms and MSG under rigorously controlled conditions, even in studies with people who were convinced that they were sensitive to the compound[17-19]. Clinical trials have failed to identify a consistent relationship between the consumption of MSG and the range of symptoms that comprise the syndrome[20]. MSG does not cause allergic reactions nor is there any evidence that it provokes constriction of the lower airways in asthmatics[21]. There are many known 'triggers' for headaches, including diet and stress but no credible evidence that MSG alone is the agent responsible. For instance, a recent double-blind placebo controlled trial found no difference in headaches in subjects given either 1.5 or 3 g of MSG or a placebo (containing the milk sugar lactose) in capsules[22]. Transfer of glutamate from mother to foetus is highly unlikely even with high dietary consumption. The placenta in humans and animals is known to extract glutamate from both the maternal and foetal blood streams for use as a principal energy source[23]. The net effect is that glutamate levels in foetal blood do not rise in parallel with maternal levels.

Table 1.3: Symptoms of the MSG Symptom Complex

Burning sensation in back of neck, forearms, and chest
Facial pressure/tightness
Chest pain
Headache
Nausea
Palpitation
Numbness in back of neck, radiating to arms, and back
Tingling, warmth, weakness in face, temples, upper back, neck and arms
Bronchospasm (observed in asthmatics only)
Drowsiness
Weakness

Taken from *Williams & Woessner*, 2009[21]. Some individuals report sensitivity to the presence of MSG and may have mild and transitory reactions when they eat foods that contain large amounts of MSG. Studies designed to explore these claims have had mixed results with some symptoms apparent in individuals consuming large amounts of MSG on an empty stomach without accompanying food – a highly unrealistic scenario for the "Chinese-Restaurant Syndrome".

It is also erroneous to suggest that increases in the glutamate content of the blood stream following a meal are sufficient to lead to hyperactivity, other excited states or even predispose to convulsions and neuronal cell death. The use of MSG in ethnic cuisines does not represent a situation in which

dietary intakes might achieve unsafe levels, even among individuals claiming unusual intolerance of such foods[19]. Glutamate is a neurotoxin, a fact exploited by investigators using animal models *where very high levels of glutamate are allowed to rapidly permeate* into the CNS[24]. Under normal conditions, the glutamate concentration is maintained at very low concentrations in the external fluid of the CNS. Dietary MSG has little impact on this pool of neurotransmitter and there are no published reports with evidence of overstimulation of the nervous system due to MSG consumed in a meal or administered via the oral route.

The scientific community and major health organisations around the globe have continued to reaffirm the safe use of MSG in foods. At no time has any official governmental or academic body found it necessary to warn people against consuming MSG. Every concerned public body that has investigated MSG has given it a clean bill of health including the EU, the United Nations and the British, Japanese, New Zealand and Australian governments. MSG has been authorised for use in all Member States of the EU (under Directive 95/2/EC on food additives other than colours and sweeteners)[25] following rigorous safety assessments. In 1958, the U.S. Food and Drug Administration (FDA) declared MSG a Generally Recognized As Safe (GRAS) ingredient. In addition, in 1987 the Joint Expert Committee on Food Additives (JECFA) of the United Nations Food and Agriculture Organization (FAO) and the World Health Organization (WHO) confirmed that MSG is safe and the European Commission's Scientific Committee for Food agreed with this in 1991, indicating that it was unnecessary to set a limit value in legislation for MSG, termed the Acceptable Daily Intake (ADI) level[26,27]. A food additive is only categorised as ADI not specified when, on the basis of all of the available scientific data, the total intake of the substance following consumption of a typical diet will not represent a hazard to health. Directive 95/2/EC specifies no maximum level for glutamate and its salts individually or in combination when used in condiments and seasonings –an example of the '*quantum satis*' principle. The JECFA also noted the evidence that it was not necessary to treat pregnant women and infants as special cases; however, they retained the previously expressed position that food additives in general (glutamate included), should not be used in infant foods to be consumed before 12 weeks of age. Following a review of the literature, the safe use of MSG in foods was again confirmed in a 1995 report to the US Food & Drug Administration (FDA) by the Federation of American Societies for Experimental Biology[28]. A 2006 consensus statement by a group of German experts drawing on animal studies declared that a daily intake of glutamic acid of 6 grams per kilogram of body weight is safe[5]. From human studies, the experts noted that doses as high as 147 g per person per day produced no adverse effects in males when given for 30 days; in a 70 kg male this corresponds to 2.1 g per kg of body weight per day.

Is MSG an excitotoxin?

Glutamate excitotoxicity is a hypothesis that states excessive glutamate activity in certain regions of the brain causes selective neuronal cell damage or death through over activation of the glutamate NMDA-receptors on effected nerve cells[29]. Over activation results in a reinforced calcium influx into the cells leading to their death (apoptosis). It is believed that neuronal over-stimulation following different types of brain trauma such as stroke, increased intracranial pressure or neurodegenerative disorders such as Alzheimer's disease or lesions to the blood-brain barrier is a generalised condition that contributes to neuronal cell death[30].

The majority of the brain is protected from the blood stream by the blood-brain barrier which is largely impervious to blood levels of weakly acidic and charged compounds like glutamate. In fact, the brain actively pumps glutamate out into the bloodstream via specific one-way transporters so that the levels of free glutamate in the cerebrospinal fluid that surrounds all brain and spinal cord neuronal cells is much lower than that in the blood[31]. Damage or deficiencies in this barrier, due to lesions, underdevelopment or a lack of this anatomical structure, results in increased permeability to glutamate from the bloodstream and leads to excitotoxicity when very high levels of blood glutamate have been achieved rapidly through non-oral or systemic routes (i.e. infusion of glutamate by the subdermal, intravenous (*i.v.*) or intraperitoneal (*i.p.*) routes). Dietary routes through the gut are normally insufficient to raise plasma levels of glutamate to very high levels because of the tremendous metabolic requirement for glutamate as a source of energy by the gut itself[7]. The other routes of administration effectively short circuit this gut barrier for raising plasma levels of glutamate.

Meteoric increases in bloodstream glutamate achieved through massive subdermal, *i.v.* or *i.p.* dosing in neonatal or young rats is a well-known experimental procedure that causes the destruction of certain areas of the brain anatomically referred to as the ventromedial hypothalamic and arcuate nuclei (regions of the median eminence which is a circumventricular organ containing the hypothalamus)[32-35]. These include the median eminence, which is one of the few sites in the brain that normally has an incomplete blood–brain barrier. Since its description in 1969, MSG-treatment of neonatal animals resulting in localised brain cell death has been used to promote the idea that MSG is a neurotoxin and therefore is a dangerous additive to have in our food[24,36,37]. The point that is not so clear from MSG detractors is that dietary MSG does not cause this damage to the hypothalamus and neonatal rodents, unlike human babies at birth, have an immature blood brain barrier up to post-natal day 13[38-41,42]. Even before birth, the human foetus may be regarded as being in a protected compartment due to the selective activity of the placenta with regard to nutrients, amino acids and other compounds[23]. There is a distinct difference between the maternal and foetal blood streams when analysed for amino acid content[43,44]. All studies to date confirm there are no brain lesions

associated with the consumption of MSG when added to food[45]. Similarly, MSG dietary intake does not result in excessive body weight gain and obesity nor does it modify anterior pituitary hormone secretion in humans[46,47]. The studies which show obesity in rodents following MSG treatment do so by destruction of hypothalamic centres as described above which precipitates a lack of control between absorption and energy expenditure[34].

The JECFA studies referred to earlier, focused their attention on claims of MSG neurotoxicity, especially in children, and the effects ascribed to CRS[26]. In relation to neurotoxicity, the Committee considered reports of 59 studies conducted on mice, rats, hamsters and other animals. As expected, lesions in the arcuate nucleus of the hypothalamus were observed reproducibly within hours of administration in rodents and rabbits after *i.v.* or subcutaneous administration of MSG. However, no such lesions were seen when MSG was given at 10% of the diet even though plasma glutamate levels were doubled, nor was damage observed after administration at high concentrations in drinking water which was freely available for consumption[45].

MSG contains sodium so does it promote high blood pressure?

Although sodium is required for normal human body functions, table salt (sodium chloride) consumption levels in Europe significantly exceed nutritional requirements. The body only needs around 1 g of table salt per day to function, but actual intake in many Western European countries is significantly higher[48]. The European Food Safety Authority (EFSA) estimates that the average daily intake is 3 – 5 g of sodium (the equivalent of 8 – 11 g of table salt) throughout Europe. Excessive sodium in our diet has been associated with an increased risk of developing high blood pressure, stroke, coronary artery disease, heart and kidney stones, calcium loss and osteoporosis, as well as stomach cancer[49-54]. Therefore, international and national authorities advocate salt reduction in food as a cost-effective strategy to improve public health. The American Dietary Approaches to Stop Hypertension (DASH) Sodium trial, coupled with other research, has demonstrated that we should be consuming far less than 1.5 g of sodium daily to reduce problems with high blood pressure[55]. One approach to compensate for salt reduction in processed foods is to use flavour enhancers such as MSG which do not have a salty taste in themselves, but enhance the saltiness of products when used in combination with table salt[48]. The addition of a small amount of MSG allows for reduced amounts of table salt without altering the palatability of a dish or food product. The net effect is a reduction in overall dietary sodium intake because a teaspoon of MSG has about three times less sodium content than a teaspoon of table salt (13% *vs* 40% by weight). So by adding MSG in appropriate amounts during the preparation of soups, salad dressings, sauces, French fries, chips, etc., the contribution by table salt may be reduced by 30 – 40 % while maintaining the same perception of saltiness[56]. Results

of tasting studies on processed foods indicate that an MSG level of 0.1 – 0.8 % of food by weight is optimal for the enhancement of the natural food flavour[1]. It therefore makes little sense from a public health perspective to advocate the removal of MSG from food when the likely consequence will be an increased reliance on table salt and other salty ingredients.

Current labelling requirements and limitations of use

MSG and other glutamates are among a group of food additives (alongside pepper, sugar, vinegar and baking powder) generally permitted in foods due to their safety. EU-food labelling law and Irish legislation requires that the use of the term 'enhancer' has to be declared and the name or E-number of the salt has to be given for glutamate additives used in pre-packaged foodstuffs. EU Directive 95/2/EC specifies a maximum level of addition to 'foodstuffs in general' for several glutamate-based food additives including glutamic acid (E 620), monosodium glutamate (E 621), monopotassium glutamate (E 622), calcium diglutamate (E 623), monoammonium glutamate (E 624) and magnesium diglutamate (E 625) of 10 g/kg Individually or in combination. Glutamic acid is the same as free glutamate: therefore, the legislation clearly sets an upper limit for free glutamate from MSG or other sources. The exceptions are condiments and seasonings for which the legislation does not specify an upper limit for glutamate-based additives – the '*quantum satis*' principle, and baby foods, in which glutamate and its salts are not allowed[25]. As is the case for all food additives, MSG cannot be added to unprocessed foods such as honey, butter, milk, cream, unflavoured live fermented milk products, natural mineral water and spring water, coffee, tea, sugars, dry pasta and buttermilk.

Labelling laws help consumers to make an informed choice about pre-packaged foods. Sometimes however food manufacturers use "clean labels" i.e., labels that contain only ingredient names that consumers may not recognise as containing glutamate including 'hydrolysed soy protein', 'hydrolysed vegetable protein' , 'sodium caseinate', 'natural flavourings', 'natural flavour', or 'yeast extract'. Others advertise "No MSG," "No MSG Added," or "No Added MSG," even though their products contain glutamate. It is possible that such labelling may be regarded as deceptive and therefore reinforces the belief that glutamate is harmful or an unsafe ingredient[57].

MSG-containing food in a catering environment

MSG can be added to many foods, including Asian foods such as curries and black bean sauce, at concentrations considered necessary to achieve the overall desired flavour. Therefore, it can be used according to the wishes of the food business operator as an additive similar to table salt or it may be present as a constituent of an ingredient such as curry powder or black bean sauce to which it can be

added *quantum satis*. The final level in the food product must not exceed 10 g per kg as prescribed by EU Directive 95/2/EC and national statutory legislation[25]. In reviewing the amount of MSG that is added to a meal, it is important to take account of not only any crystalline MSG that is added but also other food sources rich in free glutamates such as stocks, sauces (soy sauce, fish sauce), premixes, mushrooms, tomatoes, parmesan cheese, peas and corn etc. These will all singularly contribute to the total glutamate load of the meal. Good cooking practice dictates that the total content of free glutamate in a meal, whether derived from MSG or from other sources, should not exceed 10 g/kg.

Written warnings only make sense where the risk to public health and safety is real and it can be reasonably assumed that the specific target group is unaware of the potential risk to their health. Therefore, a statement is needed to alert them to that risk. Such is the case for potential allergens such as peanuts, seafood and eggs or components such as phenylalanine (specific to individuals suffering from phenylketonuria – a genetic deficiency of the enzyme phenylalanine hydroxylase). The available scientific evidence indicates that there is no justification for singling out MSG for more stringent requirements than those currently applying to potentially dangerous food allergens and components like those mentioned above. At present, the legislation does not require food outlets to state if MSG is used in their products. Some food outlets already provide advice on MSG absence in meals via menus or signage.

MSG-free claims are permitted under food law, provided they are not false, misleading or deceptive. However, such claims also have the potential to be misleading if not communicated clearly to consumers and so restaurants and other food outlets should take care when making such claims. Consideration must be given not only to the technical accuracy of the claim but also to the overall impression created by the claim. For instance, if a claim is made that a meal contains 'no added MSG', patrons would expect that it contains no added MSG irrespective of whether the MSG was added directly to the meal or as part of another ingredient of the meal (e.g. a sauce, vegetable, dressing etc.).

As glutamates occur naturally in most foods, vendors should make sure that consumers are aware of this fact. For example, a 'no MSG' claim on a tomato-based product would be false because tomatoes naturally contain high levels of glutamates. Also, a claim of 'no added MSG' on the same product, while technically accurate, may be potentially misleading or deceptive because many consumers, unaware that MSG occurs naturally in tomatoes, could interpret the claim as being the same as 'no MSG'.

Conclusions concerning MSG

There is no convincing evidence that MSG is responsible for any severe side effects following its consumption in a meal. Studies investigating the so-called CRS have failed to demonstrate a direct link with MSG. Symptoms resembling those of CRS may be provoked in a clinical setting in small

numbers of individuals when large amounts of glutamate are eaten in the absence of any other food. These symptoms are neither persistent nor serious. Not all individuals who report as MSG-sensitive react to MSG in well-designed and controlled studies (double blind challenges), suggesting that they may not actually be sensitive to MSG. In summary:-

- The level of glutamates and free amino acids increases considerably after ripening or seasoning of certain foods such as Parmesan cheese, tomatoes, tomato products and soy sauce. Adding any of these food items is a natural way of enhancing the flavour of a meal.
- By adding MSG in appropriate quantities, the sodium chloride content can be reduced by 30 – 40 % while maintaining the same perception of saltiness. Replacing table salt with MSG may help prevent or lower high blood pressure. It could also reduce the loss of calcium in the urine and may help reduce the risk of osteoporosis and kidney stones.
- As with adding any condiment to a dish, too much will spoil the taste and enjoyment of a meal. A little MSG goes a long way, the best flavour enhancement is between 0.1 – 0.8 % by weight of the food (i.e. between 1 – 8g per kilo). The largest palatable dose for humans is about 60mg per kg body weight – for a 70kg adult this equates to about 4.2g in a single meal.
- Large doses of MSG (5g or more) consumed on an empty stomach in a liquid or broth soup might elicit some symptoms in individuals who believe that they react adversely to MSG. Studies conducted where MSG is consumed with a carbohydrate meal, show no evidence of CRS. Even so, a consumer has the right to ask about the MSG content in a food and make an informed choice as to whether they want a meal with, or without, added MSG.
- Food outlets should be aware of the public concerns in relation to MSG. They should also be in a position to provide accurate advice to their customers. Liberal use of MSG should be reviewed, as reducing the amounts used may limit the occurrence of unpleasant reactions in some people.
- In terms of providing advice to customers about the MSG content of foods, care should be taken to inform the customer of all potential sources of MSG. Consumers who are sensitive to MSG not only need to know if crystalline (pure) MSG has been added, but also if MSG-containing ingredients (such as stocks and sauces) have been used.
- Claims that MSG causes neurological damage in the foetus, newborns, or adults currently are without any scientific merit. Claims that MSG causes Alzheimer's disease, Parkinson's disease, multiple sclerosis or Lou Gehrig's disease (ALS) are baseless.
- Claims that MSG causes allergic reactions or asthma attacks in people have not been demonstrated in properly designed and blinded studies. In contrast, serious adverse reactions such as the allergic (IgE antibody mediated) reactions experienced by some people in response

to peanuts, or the triggering of asthmatic attacks such as experienced by some asthmatics in response to sulphites, are well documented and proven.

- Foods are complex mixtures of ingredients. While an individual may suspect MSG as the cause of unpleasant effects after eating, it may in fact be some other ingredient which is causing the problem, in which case they may be unnecessarily avoiding MSG-containing foods. Proper assessment should help to confirm the true components or environmental factors that are causing these symptoms.
- Negative attitudes towards MSG are propagated by a lot of disinformation that is published on the internet. This is largely the result of unsubstantiated claims of health problems which are blamed on MSG. All consumers should be wary of exaggerated claims and shock headlines. MSG use in food does not present a health hazard. To put things in perspective, even table salt or water are lethal if sufficient quantities are consumed within a brief period of time – yet it would be unthinkable to classify a glass of pure water as toxic!

As Alex Renton of The Observer wrote in 2005: "...[here] lies one of the world's great food scare conundrums. If MSG is bad for you...why doesn't everyone in China have a headache?"

2 Results

Sampling location

This *safe*food commissioned survey was carried out in the Republic of Ireland (ROI) and Northern Ireland (NI). Sampling of ethnic Oriental take–away restaurants offering Thai, Chinese and Indian dishes was carried out by Environmental Health Officers in the Cork and Belfast areas. Fifty food premises in total were visited; 32 food premises were sampled in Cork and 18 in Belfast. Premises were not contacted in advance of each visit. No premises was visited more than once.

Samples

A single sample consisted of a main meal dish choice. Two samples were taken in each premises. In total, 100 samples were analysed for free glutamate content that would also have included MSG added during cooking. In all Chinese and most Thai and Indian premises, one sample was representative of the 'standard' selection of dishes available to customers and the potential for MSG addition was assumed. The second sample was of the same dish (where possible), but was requested as an 'MSG-free' option. In 32 premises the standard and MSG-free options were of the same dish as these premises claimed not to use any MSG in their dishes. In three Thai and two Indian premises, two MSG-free dishes were purchased. In total, 45 standard and 55 MSG-free dishes were purchased. A sampling form (Appendix 1) was completed by the officer for each sample purchased. This form also contained a brief questionnaire with a series of questions directed towards the staff in each premises relating to their awareness and knowledge of the use of MSG in the food that they were selling to customers. Each sample was sealed in a containment bag and transported to the Cork Public Analyst's Laboratory. There they were recorded in the computerised laboratory information management system before being frozen until required for free glutamate analysis.

Sample analysis

A robust and validated procedure (accredited by the Irish National Accreditation Board) was used for the analysis of free glutamate in each whole blended food sample. The method was sensitive for total free glutamate derived from MSG and other sources. Free glutamate was extracted with hot water and spun and filtered to remove particulates. It was then diluted and treated with an amino acid chemical reagent (*o*-phthaldialdehyde) to convert the glutamic acid to a stable fluorescent derivative easily detected and quantified by High Performance Liquid Chromatography.

MSG sampling – key findings

In this survey, different types of oriental dishes were sampled from 50 ethnic take-away restaurants (Table 2.1). These included 32 Chinese, 10 Thai and 8 Indian premises. Several comparisons were performed between standard dishes and those offered as an MSG-free option. Comparisons were also drawn between cuisine type and the free glutamate content.

Table 2.1: An overview of free glutamate content of the dishes obtained in a variety of ethnic food premises.

Ethnic cuisine	Sample dish (no. analysed)	Standard dishes		MSG-free Dishes	
		Free glutamate content (g/kg)	No. analysed	Free glutamate content (g/kg)	No. analysed
Chinese	Chicken and black bean with peppers	5.7	10	1.3	11
	Beef in black bean sauce	6.0	8	1.0	4
	Mixed vegetable satay	2.7	1	0.2	2
	Vegetable chow mein	2.5	1		
	Beef chow mein	8.0	1	7.8	1
	Chicken chow mein	6.4	5	1.8	5
	Shahi vegetable korma	0.0	1	0.3	1
	Chicken curry	6.0	2		
	Chicken, black beans and oyster sauce	4.8	1		
	Chicken satay	10.5	2	0.9	1

	Stir Fry chicken with Garlic and onions			0.7	1
	Sweet and Sour Chicken			1.1	1
	Beef Curry			0.1	1
	Chicken with Ginger and Pineapple			0.3	2
	Beef in Black Pepper sauce			0.9	1
	Beef Chop Suey			0.9	1
Thai	Thai Red Vegetable Curry	0.9	1	1.1	1
	Beef in Oyster Sauce	1.8	1		
	Sweet and Sour Vegetables	0.5	1	0.4	1
	Chicken and Black Bean Sauce	2.6	1	1.1	1
	Penang Chicken	1.2	1		
	Chicken and Cashew Nuts	1.5	1		
	Stir Fry Chicken			1.6	1
	Chicken Noodles in Black Bean Sauce			0.5	1
	Thai Chicken Green Curry			1.1	5
	Thai Chicken Red Curry	0.5	1	0.9	1
	Mussaman Beef			1.1	1
	Homemade Yellow Curry			0.0	1
Indian	Chicken Curry	1.1	3	0.7	2
	Tandoori Chicken	0.5	2	0.6	2

	Chicken Pathai	0.7	1		
	Chicken Masala			0.2	2
	Chicken Pakora			1.0	2
	Chicken Biryani			0.1	2

Where more than one sample of each dish type was analysed, an average free glutamate content value in grams per kg of food is given. Dishes rich in sauces tend to have the high quantities of free glutamate and include Chow Mein, Satay and Black Bean sauce based dishes. One 'MSG-free' option, which consisted of a beef chow mein dish purchased in a Chinese premises, was shown to contain 7.8 g free glutamate per kg. This was deemed to be erroneous and was subsequently omitted from the data analysis.

The sample with the highest free glutamate content (20 g per kg) in the survey was a standard Chicken Satay dish purchased in a Chinese restaurant. The same dish offered as an MSG-free option from the same premises contained only 0.2 g per kg. A cursory glance at Table 2.1 will indicate three things; (1) in general, Chinese dishes contained the highest quantities of free glutamate, (2) MSG-free dishes had lower quantities of free glutamate and the difference was often substantial, and (3) dishes rich in sauces tended to have high quantities of free glutamate. Chinese food, for the most part, consists of fresh vegetables that are cooked quickly. MSG is typically added at the end as a condiment. It can be omitted at the customer's request and thus the dish can be classed as MSG-free.

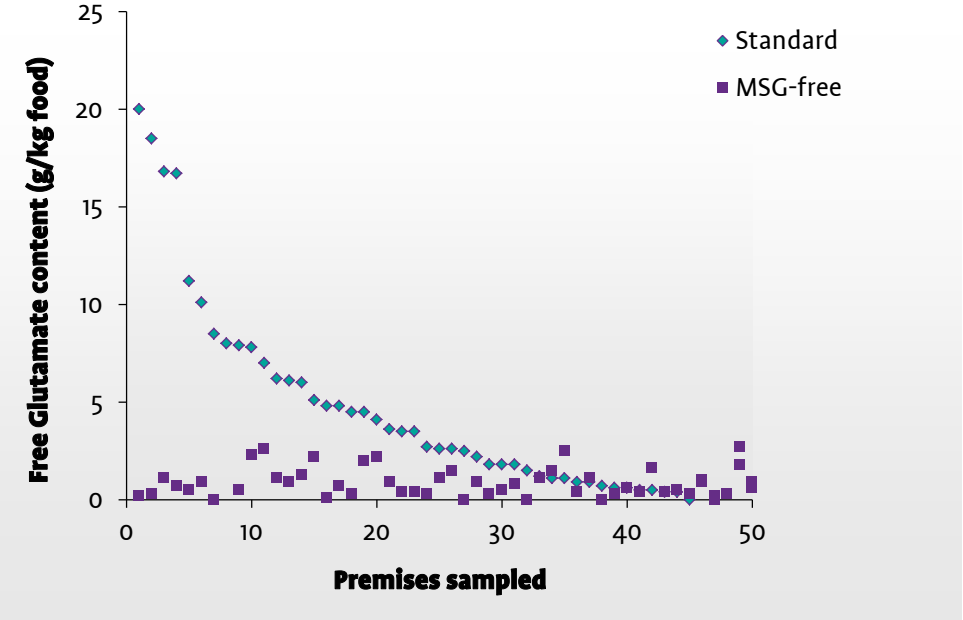
The free glutamate content of standard and MSG-free dishes

A comparison of the free glutamate content in standard and MSG-free dishes is presented in Figure 2.1. The free glutamate content in the standard dishes was highly variable ranging from 0 – 20 g/kg food. In the majority of premises, the MSG-free dishes contained less free glutamate than the corresponding standard option, and this difference was often substantial. There was less variability in the MSG-free dishes which ranged from 0 – 2.7 g/kg food. The highest free glutamate content in MSG-free options was detected in 5 Chinese chicken in black bean sauce dishes, 1 Chinese chicken chow mein dish and 1 Thai chicken green curry dish. Just under half (49 %) of the standard dishes had a free glutamate content that fell within the range associated with MSG-free dishes.

Therefore, MSG-free does not actually mean 'zero' free glutamate: it simply indicates the likelihood that MSG was not deliberately added during cooking. Free glutamate can still be present in the MSG-free samples and this 'background' level may be due to native glutamates in other components of the dish such as mushrooms, tomatoes, pastes and soy sauce, or MSG may be already present in some of the processed ingredients. Sauces

are a particularly rich source of free glutamate (e.g. soy sauce with 4 – 12 g per kg), while tomatoes (2.5 g per kg), peas (1.1 g per kg), mushrooms (0.4 – 0.7 g per kg), kelp (16 g per kg) and parmesan cheese (16.8 g per kg) can all add significant quantities of free glutamate to a dish without ever having to reach for the mill of crystalline MSG[58]. Another possible source of free glutamate is due to cross transfer between dishes cooked from the same cookware.

Figure 2.1: Free glutamate content of all the standard and MSG-free dishes sampled



Sample total = 99; premises sampled = 50. In general, a request for an MSG-free dish resulted in a reduction in the free glutamate content compared to the standard dish choice. In many premises, there was no real difference between the free glutamate content of the standard and MSG-free dishes. Free glutamate was not detected in one standard and five MSG-free dishes. Note, in five premises two MSG-free dish samples were purchased as these premises claimed not to use MSG in their cooking at all.

For regulatory purposes, the final free glutamate content of the food must not exceed 10 g/kg, whatever the source. The results show that 94 % of all dishes (99 in total) have a concentration of free glutamate less than 10 g/kg food. Therefore, 6 samples (6 % of the total) exceeded the maximum allowable level of free glutamate as prescribed in current legislation. This corresponds to 13 % of the total number of standard dishes (45 in total) that were sampled. All of these samples were Chinese dishes and came from independent premises. None of them were described as MSG-free. The MSG-free option from these premises contained substantially less free glutamate that was well below the statutory limit of 10 g per kg (Table 2.2).

Table 2.2: The six standard dishes in breach of the statutory limit for free glutamate and the associated MSG-free option from the same premises

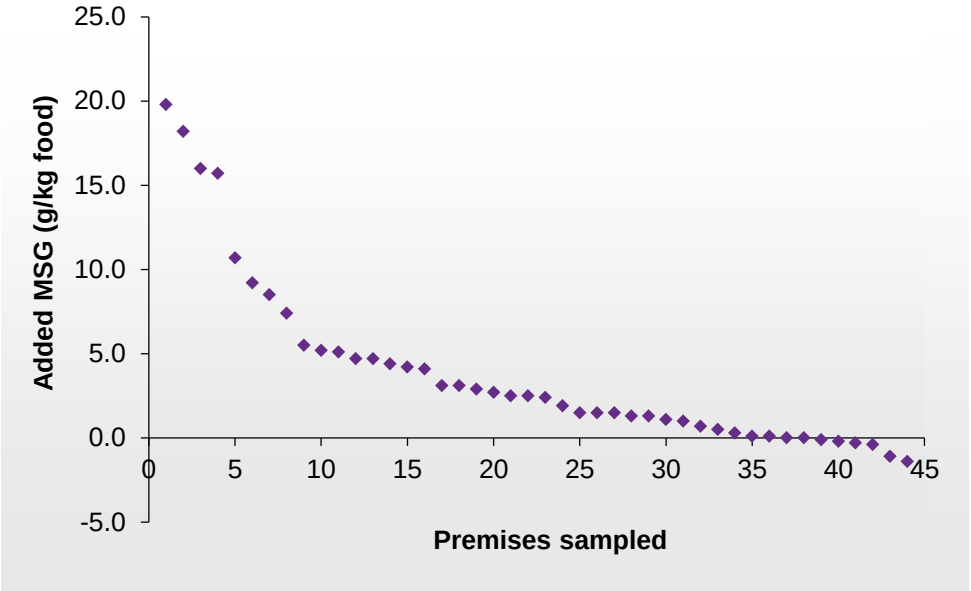
Premises	Standard dish	Free glutamate g/kg	MSG-Free option?	Free glutamate g/kg
1	Curried chicken	11.2	Stir-fried chicken & garlic & onions	0.5
2	Chicken & green pepper in black bean sauce	18.5	Same dish	0.3
3	Chicken curry	16.7	Sweet & sour chicken	0.7
4	Beef and black bean sauce	16.8	Beef curry	1.1
5	Chicken satay	20.0	Same dish	0.2
6	Beef and black bean sauce	10.1	Beef in black pepper sauce	0.9

Each dish was obtained from independent Chinese premises.

Estimating the amount of MSG added to the standard dishes

We can make a crude estimate of the free glutamate content in a range of standard dishes that was due to the addition of MSG during the cooking process. This was possible in 44 premises where standard and MSG-free options were purchased. In 31 of these premises, both options were of the same dish. Figure 2.2 shows the free glutamate content of the standard dishes corrected for the free glutamate content of the MSG-free dishes from the same premises. This is assumed to be due to direct MSG addition to standard dishes during cooking and ranged from 0 to 19.8 g/kg. All estimates of added MSG greater than 2.0 g/kg were for Chinese dishes. In total, added MSG was detected in 36 out of a possible 44 standard dishes (or 82 %). It can be seen that, for 8 standard dishes, MSG may not have been routinely added as there was no difference in the free glutamate content between these and the corresponding MSG-free options (some of the content values are negative). In these dishes, the free glutamate was already present from other ingredients, maybe even from MSG in a processed food product.

Figure 2.2: Estimate of the MSG added to the standard samples during cooking

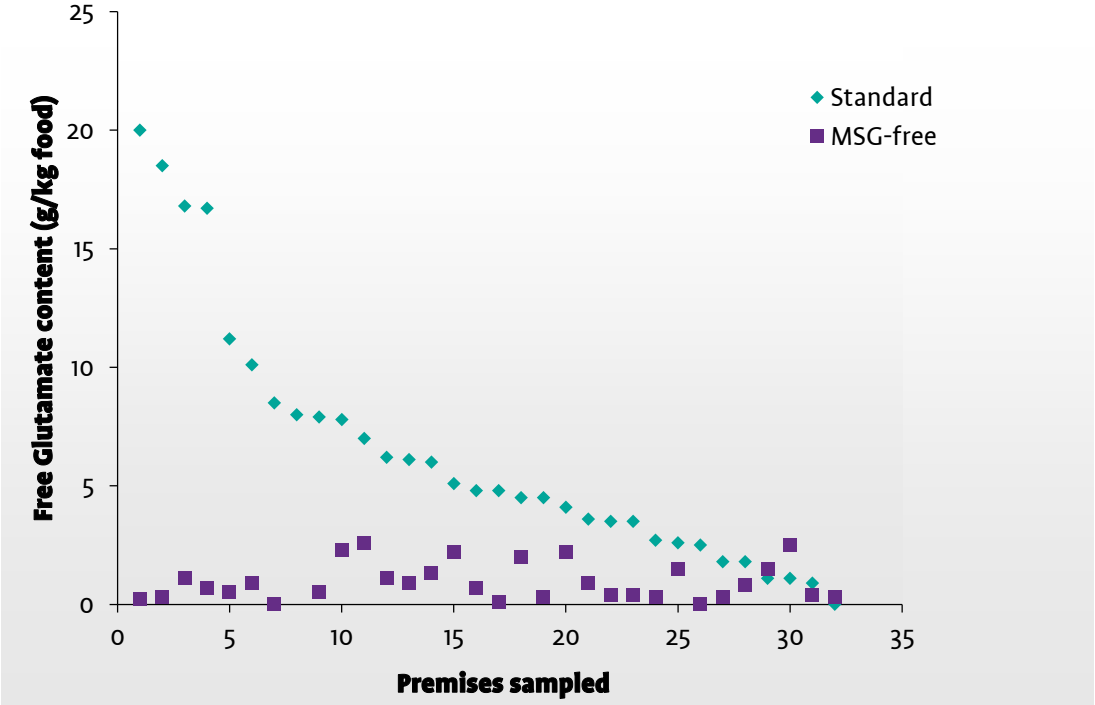


The difference between the free glutamate concentrations in the standard and MSG-free dishes from each premises is plotted. The samples were obtained in 44 premises. At the higher concentration values, the free glutamate content is probably due to the direct addition of MSG during the cooking process. However, this becomes increasingly difficult to state with any confidence with decreasing free glutamate content. The free glutamate content of the MSG-free dishes from certain premises was actually higher than that of the standard dishes; hence the negative content values.

The free glutamate content of the different ethnic cuisines

Chinese Cuisine: In this section we look at the breakdown of free glutamate results according to the type of premises. Figure 2.3 shows the data for the free glutamate content of both standard and MSG-free dishes from Chinese premises. At once it can be appreciated that the levels of free glutamate are quite variable from one dish to the next. Six of the 32 standard dishes sampled (almost 1 in 5) breached current regulatory guidelines. MSG-free dishes generally showed a reduction in free glutamate content compared to the standard dishes, the free glutamate content ranging from 0 – 2.6 g/kg. The background level of free glutamate must account for this variability. More than 75 % (24 out of 32 dishes) of the standard dishes exceed 2.6 g free glutamate per kg (the highest content of the MSG-free dishes). It was possible to estimate the amount of deliberately added MSG in 31 standard Chinese since these could be corrected for the free glutamate content of the MSG-free dishes from the same premises. The added MSG content ranged from 0.5 to 19.8 g/kg and was detected in 28 dishes. This implies that deliberately added MSG was detected in standard dishes from 88 % of Chinese premises (32 in total). The estimate for three standard dishes was less than zero suggesting the absence of deliberately added MSG.

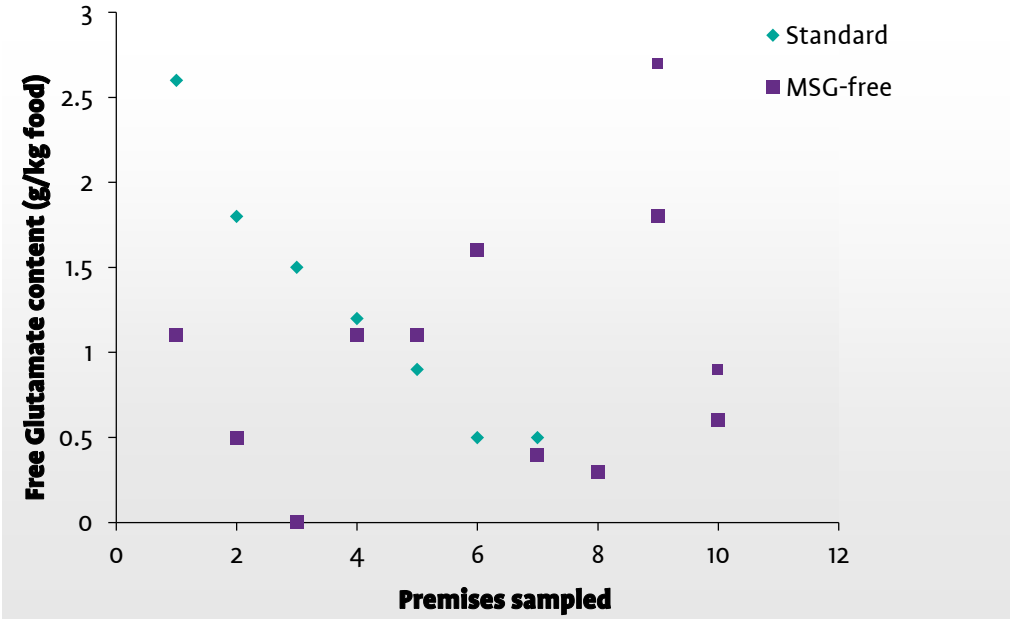
Figure 2.3: Free glutamate content of standard and MSG-free dishes from Chinese premises



Sample total = 63. The data clearly shows (1) highly variable free glutamate levels in the standard and, to a much lesser extent, the MSG-free dishes, (2) more samples of MSG-free dishes with low levels of free glutamate relative to the number of standard dishes with low levels of free glutamate and (3) the free glutamate content in a number of standard dishes is similar to that in the matched MSG-free dishes.

Thai Cuisine: Figure 2.4 shows the free glutamate content measured in a range of dishes obtained from Thai premises. The free glutamate levels of the standard dishes were generally much lower than in Chinese cuisine while there is little to distinguish Thai from Chinese MSG-free dishes. The range of free glutamate content of both standard and MSG-free Thai dishes overlaps at 0.5 – 2.6 and 0 – 2.7 g/kg, respectively. In some cases the MSG-free dishes had the same, or more, free glutamate than the standard samples. This suggests that free glutamate was introduced via the ingredients (possibly as MSG) or maybe even cross-transfer from one dish to another as opposed to deliberate addition. Three Thai premises sampled claimed not to use MSG in their cooking. Hence the samples from these premises were classified as MSG-free.

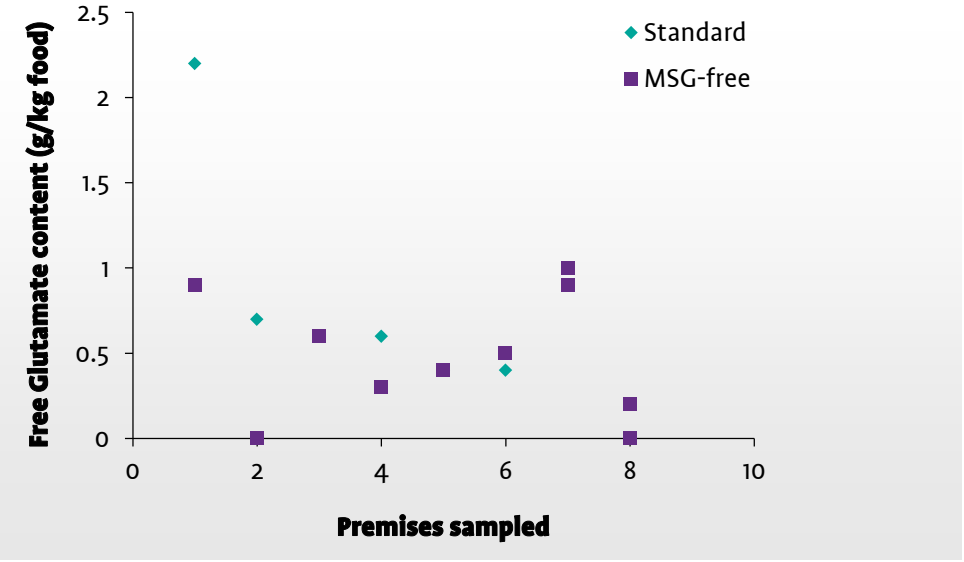
Figure 2.4: Free glutamate content of standard and MSG-free dishes from Thai premises



Sample total = 20. There are fewer samples, making interpretation more difficult but it would appear there is little to distinguish standard from MSG-free dishes.

Indian Cuisine: Figure 2.5 shows the free glutamate content measured in a range of dishes obtained from Indian premises. The free glutamate levels of the standard dishes were generally much lower than in Chinese cuisine while there is little to distinguish Indian from Chinese MSG-free dishes. However, sample numbers are also low (16) making it difficult to draw any firm conclusions. As with the Thai samples, some of the MSG-free options had the same or more free glutamate compared to the standard options. This suggests that free glutamate was introduced via the ingredients (possibly as MSG) or maybe even cross-transfer from one dish to another as opposed to deliberate addition. Only 1 dish out of 16 had a free glutamate level greater than 2 g per kg (chicken curry). The MSG-free option of the same dish from the same premises recorded an free glutamate level of 0.9 g per kg. Two Indian premises sampled claimed not to use MSG in their cooking. Hence the samples from these premises were all classified as MSG-free.

Figure 2.5: Free glutamate content of standard and MSG-free dishes from Indian premises



Sample total = 16. Indian dishes contained the lowest levels of free glutamate.

Summary

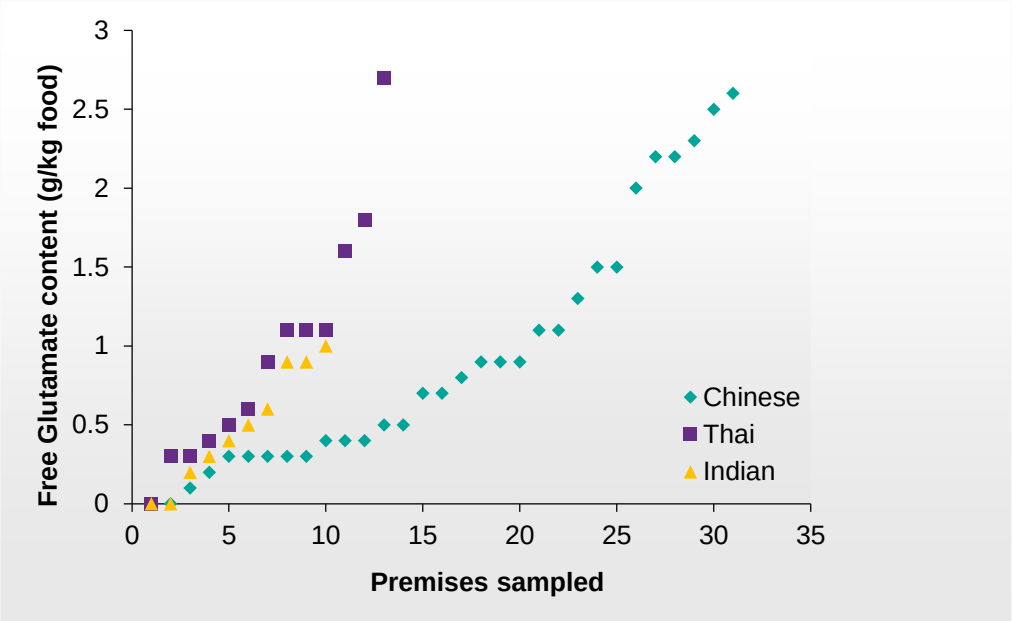
Table 2.3 shows all the data organised into discreet intervals or free glutamate concentration ranges. It is a useful tool in summarising many individual measurements. At a glance it is clear that Chinese dishes had the greatest levels and variability in their free glutamate content. MSG-free dishes contain reduced amounts of free glutamate, some of which are undetectable while others had up to 2.6 g per kg (Chinese), 2.7 g per kg (Thai) and 1 g per kg (Indian). Figure 2.6 confirms the range of free glutamate in the Indian MSG-free dishes was lower than that in the Chinese and Thai MSG-free dishes where the free glutamate ranges were about the same.

Table 2.3: Free glutamate data compiled and organised into discreet concentration ranges.

Free glutamate (g/kg)	All dishes	All dishes (standard)	All dishes (MSG-Free)	Chinese dishes (standard)	Chinese dishes (MSG-Free)	Thai dishes (standard)	Thai dishes (MSG-free)	Indian dishes (standard)	Indian dishes (MSG-Free)
0.00-1.00	47	10	37	2	20	3	7	5	10
1.01-2.00	18	7	11	4	6	3	5	0	0
2.01-4.00	14	8	6	6	5	1	1	1	0
4.01-6.00	7	7	0	7	0	0	0	0	0
6.01-8.00	6	6	0	6	0	0	0	0	0
8.01-10.00	1	1	0	1	0	0	0	0	0
10.01-15.00	2	2	0	4	0	0	0	0	0
15.01-20.00	4	4	0	4	0	0	0	0	0
Mean (g/kg)	2.7	4.8	0.9	6.4	0.94	1.3	1	0.8	0.5
Range (g/kg)	0.0-20	0.3-20	0.0-2.7	0.0-20	0.0-2.6	0.5-2.6	0.0-2.7	0.4-2.2	0.0-1.0
Number analysed	99	45	54	32	31	7	13	6	10

Tabulated values are the number of dishes within a particular free glutamate range. The sample of a beef chow mein dish that was purchased as an MSG-free option in a Chinese premises, and that was subsequently found to contain 7.8 g free glutamate per kg, was judged to be erroneously described and therefore omitted from the table. The table confirms that, in the standard samples, the free glutamate levels are generally highest in Chinese cuisine relative to Thai and Indian cuisine (i.e. by looking at the mean free glutamate values). It also confirms the more variable results associated with the Chinese dishes, probably a consequence of the variety of dishes and therefore ingredients used during cooking, as well as a more liberal approach to the use of MSG in a similar fashion to salt. In general, MSG-free dishes have less free glutamate than the standard dish alternatives but this is not always the case. On average, the Chinese and Thai MSG-free dishes have similar free glutamate contents while the lowest content was recorded in Indian MSG-free options.

Figure 2.6: Comparison of the free glutamate content of MSG-free dishes from Chinese, Thai and Indian premises



Sample total = 31 Chinese, 13 Thai and 10 Indian MSG-free samples. The Indian dishes showed the smallest range of free glutamate content while the range in the Chinese and Thai MSG-free dishes was essentially the same.

MSG Survey Questionnaire – key findings

Staff in all 50 ethnic takeaway restaurants were asked seven questions to ascertain their knowledge on the use and presence of MSG in their products and determine the availability of an MSG-free option when requested by customers. The 7th question was used to assess the integrity of communication between staff and clientele by recording any difficulties with communication with the English language. The questions were:

Q1. Did staff add MSG to their dishes?

Q2. If yes, then roughly in what percentage of their dishes?

Q3. If yes, what reasons did they give for using MSG?

Q4. Do the ingredients used in the dishes contain MSG already?

Q5. Had they ever received a customer request for a meal without MSG?

Q6. If asked to do so, could they prepare a meal without MSG?

Q7. Was there any problem due to language difficulty?

A summary of the answers to the MSG Survey questionnaire is given in Table 2.4. This questionnaire was designed to determine whether staff in these ethic food premises were aware of the use of MSG as an additive during the cooking process in a similar fashion as salt is used in cooking throughout the world. The answers to question 1 (*Did staff add MSG to their dishes?*) shows that staff in 97 % of Chinese premises use MSG in their dishes. Only 20% of staff in Thai premises and 25 % of staff in Indian premises use MSG in their dishes. In all, 70 % of staff across all food premises surveyed, responded yes, they did use MSG in their dishes.

When the answers to question 2 (*If Yes, then roughly in what percentage of their dishes?*) were reviewed, staff in 32 Chinese premises, 2 Thai premises and 2 Indian premises answered the question clearly. However, only the answers from the Chinese premises are valid since too few responses are recorded for the other premises. There was a wide range of replies to this question in Chinese premises. The results show that 73.5 % of Chinese premises produce between 50 % and 100 % of their dishes containing MSG. Only 7.5 % of Chinese premises sell between 10 % and 20 % of their dishes containing MSG and a further 19 % of Chinese premises sell between 2 % and 10 % of dishes containing MSG.

The results from question 3 (*If yes, what reasons did they give for using MSG?*) showed that for 58 % of staff, MSG was used in ethnic dishes to improve the flavour of the meal. Worryingly though is the fact that a significant number of staff, 32 %, may not know or gave no answer to this question. About 10 % of respondents were rather vague giving various answers such as better quality or Chinese restaurants always use MSG.

This questionnaire was also designed to determine whether staff in these ethic food premises were aware of the presence of MSG in food ingredients. The answers to Question 4 (*Do the ingredients used in their dishes contain MSG already?*) yielded some interesting data. The staff in Indian premises were almost equally divided

Table 2.4: Staff knowledge on the use and presence of MSG

1. Did staff add MSG to their dishes?			
	Yes	**No**	**Don't know/no answer**
All premises	70 %	30 %	
Chinese premises	97 %	3 %	
Thai premises	20 %	80 %	
Indian premises	25 %	75 %	
2. What percentage of Chinese dishes contain MSG?			
	% Premises	**% Dishes**	
All Chinese premises	19.0 %	2-10 %	
	7.5 %	20 %	
	22.0 %	50-60 %	
	7.5 %	70-80 %	
	44.0 %	90-100 %	
3. Why did restaurants and take-aways use MSG?			
All premises	56 %		Correctly answered that MSG was used for the improvement or enhancement of the flavour
Chinese premises	78 %		
Thai premises	20 %		
Indian premises	13 %		
4. Do the ingredients used in the available dishes contain MSG already?			
	Yes	**No**	**Don't Know/no answer**
All premises	38 %	48 %	14 %

Proportion of Chinese premises	41 %	47 %	13 %
Proportion of Thai premises	60 %	40 %	0 %
Proportion of Indian premises	0 %	63 %	38 %
5. Have customers requested MSG-free food?			
	Yes	**No**	**Don't Know/no answer**
All premises	70 %	20 %	10 %
Proportion of Chinese premises	78 %	19 %	3 %
Proportion of Thai premises	70 %	20 %	10 %
Proportion of Indian premises	38 %	25 %	38 %
6. Was MSG-free food available in the premises?			
	Yes	**No**	**Don't know/no answer**
All premises	76%	4%	20%
Proportion of Chinese premises	94%	3%	3%
Proportion of Thai premises	50%	0%	50%
Proportion of Indian premises	38%	13%	50%
7. Were there any language difficulties in the premises			
All premises	22 %		Percentage of premises where a difficulty in communicating due to language skills was recorded
Proportion of Chinese premises	22 %		
Proportion of Thai premises	30 %		
Proportion of Indian premises	13 %		

Staff in all 50 ethnic food restaurants and takeaways were asked seven questions to establish their knowledge on the use and presence of MSG. Note, figures that total greater than 100 % are due to rounding up (e.g. 12.5 % becomes 13 %).

between 'No' MSG in their ingredients and not knowing if MSG was present while 41 % of staff in Chinese premises and 60 % of staff in Thai premises answered 'Yes', MSG was present in their food ingredients.

The next two questions in the questionnaire were included in the survey in order to ascertain what interest there may be amongst customers in purchasing MSG-free options of oriental dishes and to determine the extent to which oriental food premises could deliver such options. Answers to question 5 (*Have they ever received a request from a customer for a meal without MSG?*) showed that 78 % of Chinese premises had requests from customers for MSG-free dishes while 70 % of Thai premises and 38 % of Indian premises also confirmed such requests.

The answers to question 6 (*If asked to do so, could they prepare a meal without MSG?*) showed that 50 % of Thai premises, 94 % of Chinese premises and 38 % of Indian premises were able to offer MSG-free food to customers.

In question 7 (*Was there any problem due to language difficulty?*) sampling officers noted the level of understanding of English by the staff in the premises visited. Language problems could render analysis of the questionnaire details difficult. Difficulties in language were experienced and ranged from just over 12 % in Indian premises to 22 % and 30 % in Thai and Chinese establishments, respectively. It would appear that in the majority of cases, answers to questions relating to the use of MSG in ethnic dishes can be interpreted with confidence.

3 Discussion

In the first part of this study a total of 100 ethnic dishes were analysed for their free glutamate content. One beef chow mein dish that was purchased as an MSG-free option in a Chinese premises had a very high level of free glutamate. This was considered to be an error and the dish was omitted from the data analyses giving a total valid data cohort of 99 dish samples. In total, a variety of oriental dishes were sampled from 32 Chinese, 10 Thai and 8 Indian premises. A total of 12 Chinese, 5 Thai and 5 Indian establishments were sampled in Belfast and 20 Chinese, 5 Thai and 3 Indian establishments were sampled in Cork. A sample of a standard dish and an MSG-free option was obtained from most premises with the exception of three Thai and two Indian premises which declared that MSG was not used in their cuisine. Both samples purchased from each of these premises were described as MSG-free.

The total free glutamate content of the dishes sampled

In premises where standard and MSG-free dish options were sampled, the standard dishes almost invariably had a higher content of free glutamate. The difference was often substantial. Dishes rich in sauces tended to have the highest free glutamate levels. For the most part these were recorded in Chinese premises and consisted of black bean, curry or satay sauces. As can be seen in Figure 2.1, the free glutamate content of the standard dishes ranged from 0 to 20 g/kg. By contrast, the free glutamate content of the MSG-free dishes varied from 0 to 2.7 g/kg. This is the background level of free glutamate present in the dishes without the further addition of MSG during cooking. It is probably due to free glutamate naturally present in different food ingredients or indeed the presence of MSG in processed food ingredients. Furthermore, there may be carry-over of added MSG due to improper cleaning of cooking utensils between the preparation of different dishes. Figure 2.6 shows the range in Chinese and Thai MSG-free dishes was essentially the same while that in Indian dishes was much lower. Although a smaller number of samples were taken in Indian premises, there may well be a lower level of free glutamate associated with Indian cuisine, albeit in the types of dishes that were sampled. While clear differences in the free glutamate content of standard and MSG-free Chinese options are evident in Figure 2.3, it is difficult to deduce similar differences in Thai (Figure 2.4) and Indian (Figure 2.5) cuisine where the sample numbers were much lower and the range of free glutamate content in both standard and MSG-free options overlapped considerably.

Estimating the amount of MSG added during cooking

A rough estimate of the amount of MSG that was added during the cooking of the standard dishes was made by correcting the free glutamate content of each standard dish for that associated with the corresponding MSG-free dish purchased in the same premises. This was possible for standard dishes obtained from 44 premises. It was also probably more accurate where the standard and MSG-free options were of the same dish as was the case in 32 premises. However, in some premises where a different dish was sampled as the MSG-free option, the difference in free glutamate content between the standard and MSG-free options was still substantial indicating the presence of added MSG. Figure 2.2 shows the estimated content of free glutamate due to direct MSG addition to standard dishes which ranged from 0 to 19.8 g/kg. Added MSG was detected in 82 % of the standard dishes which corresponded to 88 %, 71 % and 50 % of Chinese, Thai and Indian premises, respectively. The highest estimates overall (more than 2.0 g/kg) were in Chinese dishes. The highest estimates in Thai and Indian dishes were 1.5 and 1.3 g/kg, respectively. Some MSG-free dishes had the same, or even greater, free glutamate content than the standard dishes. This highlights the difficulty of detecting added MSG at low free glutamate levels.

In total, 97 % of questionnaire respondents in Chinese premises reported using MSG in most of their dishes. Although this corroborates the added MSG findings, the range of values was quite wide with indications of over-use in some cases, while in others the estimated added MSG was so low as to be in doubt. Only 20 % and 25 % of Thai and Indian premises, respectively, reported using MSG in their dishes and while added MSG was detected in 71 % and 50 % of Thai and Indian premises, respectively. The levels were substantially lower than in Chinese samples and the free glutamate levels showed considerable overlap between standard and MSG-free samples. So if MSG was deliberately added in these cuisines, it was at very low levels similar to normal background free glutamate levels.

Dishes that breached the regulatory guidelines

Directive 95/2/EC specifies a maximum level of addition to 'foodstuffs in general' for several glutamate-based food additives of 10 g/kg individually or in combination. Glutamic acid is the same as free glutamate: therefore, the legislation clearly sets an upper limit for free glutamate from MSG or other sources. The results of this survey show that 94 % of all dishes (99 in total) have a concentration of free glutamate less than 10 g/kg food. In total, 6 out of 45 (13 %) standard dishes had free glutamate content > 10 g/kg and therefore, breached current regulatory guidelines. Since all of these dishes were purchased in Chinese premises, the actual failure rate was almost 1 in 5 (32 standard dishes in total). We know from the staff responses that, at least in four of these premises, none of the ingredients contained MSG which was only added during cooking. We can conclude that the breaches were due to liberal use of MSG during cooking.

Staff knowledge and awareness of MSG

Overall, only 56 % of the takeaway restaurants surveyed knew why MSG was added to food. However, the level of awareness varied significantly depending on the type of premises with 78% of Chinese staff answering correctly while only 20 % and 13 % of Thai and Indian staff, respectively, did so. Perhaps this reflects the lower level of MSG usage in these ethnic cuisines: after all, three Thai and two Indian premises survey claimed not to use MSG at all in their dishes and the levels of free glutamate detected in these cuisines was relative low. So, given the degree of MSG usage in Chinese premises it is important that these staff are aware of the purpose of MSG.

When queried as to the MSG content of their ingredients, the response was very different for each of the premises types. Similar numbers of Chinese staff said their ingredients did or did not contain MSG while most Indian staff said their ingredients did not (many did not know). Conversely, most Thai staff said their ingredients did contain MSG. It is difficult to adjudicate on the accuracy of these responses without knowing the actual MSG content of the range of processed ingredients which each premises uses. However, free glutamate was detected in all cuisine types and this may well have resulted from added MSG in processed ingredients. Staff in ethnic takeaway restaurants should be aware of the fact that their dishes probably contain free glutamate to begin with (up to 2.7 g/kg, according to this study) and should therefore be clear about what 'MSG-free' actually means. Staff need to be better informed that free glutamate is present in foods not only as a flavour enhancer, but also a by-product of hydrolysed vegetable proteins and yeast extracts which are widely used as seasonings and flavouring agents in canned foods, dry mixes and sauces. In addition, certain food processing procedures such as the ripening of tomatoes and cheeses leads to protein breakdown with an increase in free amino acids such as glutamate; a similar occurrence is also true in the curing of meats and fish.

Facilitating consumer choice

Three questions were asked to garner the staff's experience of customers requesting MSG-free food and their ability to accommodate same. Nearly 80 % of Chinese and 70 % of Thai staff report customers have requested a meal without MSG while Indian staff report a lower 38 %. These results may reflect consumer attitudes regarding MSG usage. Consumers may readily associate Indian meals with a high usage of spices and not normally consider MSG or free glutamate in general. Only 25 % of Indian restaurant staff reported using MSG anyway and the results in this survey returned levels of free glutamate similar to background levels. Interestingly, only 20 % of Thai restaurant staff reported using MSG while 70 % receive requests for MSG-free food. It would appear that consumers associate Thai cuisine with MSG usage similar to Chinese cuisine whereas this may not in fact be accurate. Further investigation into the use of MSG in Thai cuisine and the free glutamate content of the ingredients used would confirm or dispel consumer perceptions.

On average, 76 % of all ethnic food premises can offer MSG-free options if requested to do so. Therefore, the majority of staff appear willing to accommodate their customers. Almost all Chinese premises reported being

able to accommodate a request for MSG-free food. This can only be expected given the high rate of requests and the generally high levels of free glutamate shown in this survey. Importantly, the survey also showed that, when requested to do so, the Chinese premises could produce dishes with a free glutamate content that was within the background range. Only 50 % of Thai premises claimed they could accommodate a request for MSG-free food. Although 80 % said they didn't use MSG at all, so it is not an issue, nonetheless 70 % received requests for same from their customers. So there is a clear commercial imperative for these establishments to advise their customers that either (a) they don't add MSG to their dishes anyway, or (b) where it is added, this step can be omitted. This advice is apt for the Indian premises as well which still receive some requests for MSG-free food.

Good communication between staff and customers is essential if the customer's needs are to be met. In many catering establishments, English may not be the primary spoken language of the staff member and this can lead to difficulties when interacting with customers. In this survey, difficulties in language were experienced in 13 % of Indian premises, 22 % of Chinese premises and 30 % of Thai premises. Therefore, language difficulties were experienced in approximately one fifth and one third of Chinese and Thai premises, respectively. This must be factored into any measure that strives to increase the knowledge and awareness of MSG usage among staff. Nonetheless, it has to be said that all requests for MSG-free meals were met, even where the standard dishes had a high free glutamate content.

4 Project Recommendations

Several recommendations can be made based on this brief investigation into the use of MSG in oriental dishes on sale in ethnic take away restaurants on the island of Ireland:-

1. When food is being prepared using crystalline or pure MSG as a flavouring agent, only known or pre-weighed amounts should be added to each dish rather than being added "*Quantum Satis*". It is probable that the dishes with free glutamate levels in excess of the statutory limits arose because of the liberal usage of MSG in a similar fashion to table salt. The use of excess MSG does not make food taste better. MSG works best with salty or sour flavoured savoury foods at an optimum amount of around 0.1 – 0.8 % by weight (i.e. 1 – 8 g per kg food).

2. Restaurateurs should strive to accommodate their customers who may prefer the MSG-free meal option. Customers who request 'MSG-free' food should be advised by the staff in the restaurant or take-away premises that such meals may unavoidably contain small quantities of free glutamate similar to MSG, or MSG which may already be present in some of the ingredients used in the preparation of the dishes. Staff should do this even if they do not routinely use MSG in their cuisine. Perhaps the term 'No added MSG' should be employed by staff instead of 'MSG-free'.

3. Staff in ethnic food premises should be fully informed about MSG and trained in its proper use. They should also be fully informed about the nature of free glutamate in different types of foods and ingredients as well as those processes that result in higher levels of free glutamate due to protein breakdown, etc.

4. Barriers to good staff-customer communication such as language difficulties should be taken into account in any measures that strive to increase the knowledge and awareness of MSG usage among staff.

5. Consumers on the island of Ireland should have access to all the facts about MSG. There certainly appears to be a lot of publically available misinformation particularly on the internet. Misinformation can result in needless worry and avoidance of foods for which there is no evidence of a harmful effect.

5 Appendices

Appendix 1: EHS FOOD SAMPLING PRO-FORMA

N.B. PLEASE COMPLETE THIS FORM IMMEDIATELY AFTER LEAVING THE PREMISES

An investigation into the usage patterns of MSG in catering industry ethnic food

General Sample Ref. Number: _____

Cost (€): _____

MSG-free Sample Ref. Number: _____

Cost (€): _____

Samples collected by: _____(name of sampling officer)

Reporting to: _____

Office address: _____

Office Phone number: _____

Signature of sampler: _____

Samples collected at: (time) _____ on (date) ____/____/____

Premises details:

Sampling area: _____

Premises Name: _____

Premises Address: _____

Type of Restaurant: _____

Sample details:

General Sample Name: _____(as per menu)

Sample description: _____

MSG-free Sample Name: _____(as per menu)

Sample description: _____

INTERACTIVE RESPONSES:

1. Did the staff use MSG in their dishes? Yes No

Comments: _____

2. If yes, then roughly in what percentage of your dishes?

Comments: _____

3. If yes, what reasons did they give for using MSG?

Comments: _____

4. Do the ingredients they use in their dishes contain MSG already?

Comments: _____

5. Have they ever received a customer request for a meal without MSG?

Comments: _____

6. If asked to do so, could they prepare a meal without MSG?

Comments: _____

7. Was there any problem due to language difficulty? Yes No

Comments: _____

8. Any other observations or comments? Yes No

Comments: _____

Appendix 2: Analytical Results for All Samples

SAMPLE DETAILS	MSG Free?	Cuisine	Free glutamate (g/kg)
Gaeng Peht Gai Chicken Curry	No	Thai	0.5
Gai Phad Pet Jan Ruan Stir Fry Chicken	Yes	Thai	1.6
Chicken Curry & Chips	No	Indian	0.4
Chicken Curry	Yes	Indian	0.4
Chicken & Black Bean with Peppers	No	Chinese	4.1
Chicken & Black Bean with Peppers	Yes	Chinese	2.2
Chicken in Black Bean Sauce with vegetables	No	Chinese	6.2
Chicken in Black Bean Sauce with vegetables	Yes	Chinese	1.1
Tandoori Chicken in Tandoori Sauce	No	Indian	0.4
Tandoori Chicken in Tandoori Sauce	Yes	Indian	0.5
Beef in Black Bean Sauce	No	Chinese	1.1
Beef in Black Bean Sauce	Yes	Chinese	1.5
Red Vegetable Curry	No	Thai	0.9
Red Vegetable Curry	Yes	Thai	1.1
Buttered Chicken Tandoori	No	Indian	0.6
Buttered Chicken Tandoori	Yes	Indian	0.6
Chicken with Black Bean Sauce	No	Chinese	3.5
Chicken with Black Bean Sauce	Yes	Chinese	0.4
Beef Chop Suey	Yes	Chinese	0.9
Beef with Black Bean Sauce	No	Chinese	6.1
Beef in Black Bean Sauce	No	Chinese	4,5
Beef in Black Bean Sauce	Yes	Chinese	0.3
Beef in Oyster Sauce	No	Thai	1,8
Chicken Noodles in Black Bean Sauce	Yes	Thai	0.5

Beef in Black Bean Sauce	No	Chinese	2.6
Beef in Black Bean Sauce	Yes	Chinese	1.5
Mixed Vegetable Satay	No	Chinese	2.7
Mixed Vegetable Satay	Yes	Chinese	0.3
Vegetable Chow Mein	No	Chinese	2.5
Mixed Vegetable Satay	Yes	Chinese	0
Beef Chow Mein	No	Chinese	8.0
Beef Chow Mein	Yes	Chinese	7.8
Chicken Black Bean Sauce	No	Chinese	3.5
Chicken Black Bean Sauce	Yes	Chinese	0.4
Fried Chicken & Green Pepper in Black Bean Sauce	No	Chinese	3.6
Fried Chicken & Green Pepper in Black Bean Sauce	Yes	Chinese	0.9
Chicken Chow Mein	No	Chinese	7.9
Chicken Chow Mein	Yes	Chinese	0.5
Chicken Chow Mein	No	Chinese	6.0
Chicken Chow Mein	Yes	Chinese	1.3
Chicken Chow Mein	No	Chinese	4.5
Chicken Chow Mein	Yes	Chinese	2.0
Sweet & Sour Vegetables	No	Thai	0.5
Sweet & Sour Vegetables	Yes	Thai	0.4
Chicken & Black Bean Sauce	No	Chinese	7.8
Chicken & Black Bean Sauce	Yes	Chinese	2.3
Chicken in Black Bean Sauce with Green Pepper	Yes	Chinese	2.5
Chicken in Black Bean Sauce with Green Pepper	No	Chinese	1.1
Shahi Vegetable Korma	No	Chinese	0
Shahi Vegetable Korma	Yes	Chinese	0.3
Chicken Chow Mein	Yes	Chinese	2.2

Chicken Chow Mein	No	Chinese	5.1
Stir Fried Chicken + Garlic & Onions	Yes	Chinese	0.5
Curried Chicken	No	Chinese	11.2
Thai Chicken Green	Yes	Thai	0.6
Thai Chicken Red Curry	Yes	Thai	0.9
Chicken & Green Pepper in Black Bean Sauce	No	Chinese	18.5
Chicken & Green Pepper in Black Bean Sauce	Yes	Chinese	0.3
Chicken Masala	Yes	Indian	0
Chicken Pathia	No	Indian	0.7
Chicken & Black Bean Sauce with green Pepper	No	Chinese	1.8
Chicken & Black Bean Sauce with green Pepper	Yes	Chinese	0.3
Chicken & Black Bean Sauce	No	Thai	2.6
Chicken & Black Bean Sauce	Yes	Thai	1.1
Chicken Curry	No	Chinese	16.7
Sweet & Sour Chicken	Yes	Chinese	0.7
Beef Curry	Yes	Chinese	1.1
Beef & Black Bean Sauce	No	Chinese	16.8
Chicken & Black Bean Sauce	Yes	Chinese	0.7
Chicken in Black Bean Sauce & Oyster Sauce	No	Chinese	4.8
Thai Green Curry	Yes	Thai	0.3
Thai Green Curry	Yes	Thai	0.3
Chicken Pakora	Yes	Indian	0.9
Chicken Pakora	Yes	Indian	1.0
Green Chicken Curry	Yes	Thai	1.8
Green Chicken Curry	Yes	Thai	2.7
Chicken with Ginger & Pineapple	Yes	Chinese	0.1
Beef with Green Pepper & Black Bean Sauce	No	Chinese	4.8

Chicken Satay	Yes	Chinese	0.4
Chicken Satay	No	Chinese	0.9
Chicken Curry in Spicy Sauce	No	Indian	0.6
Chicken Masala	Yes	Indian	0.3
Chicken in Black Bean Sauce	Yes	Chinese	2.6
Chicken in Black Bean Sauce	No	Chinese	7.0
Penang Chicken in Massaman Curry Paste	No	Thai	1.2
Mussaman Beef in Massaman Curry Paste	Yes	Thai	1.1
Chicken Satay	No	Chinese	20.0
Chicken Satay	Yes	Chinese	0.2
Beef in Black Bean Sauce	No	Chinese	10.1
Beef in Black Pepper Sauce	Yes	Chinese	0.9
Beef & Black Bean Sauce	Yes	Chinese	0.8
Beef & Black Bean Sauce	No	Chinese	1.8
Chicken Chow Mein	No	Chinese	8.5
Chicken Chow Mein	Yes	Chinese	0
Chicken &Cashew Nuts	No	Thai	1.5
Homemade Yellow Curry	Yes	Thai	0
Chicken Biryani	Yes	Indian	0.2
Chicken Biryani	Yes	Indian	0
Chicken Curry	No	Indian	2.2
Chicken Curry	Yes	Indian	0.9

Total number of samples: 100

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