# UNIVERSITI PUTRA MALAYSIA

# ASSESSMENT OF FREE DIETARY GLUTAMATE INTAKE AMONG MALAYS AND CHINESE IN THE KLANG VALLEY, MALAYSIA

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**MASTER OF SCIENCE**
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# ASSESSMENT OF FREE DIETARY GLUTAMATE INTAKE AMONG MALAYS AND CHINESE IN THE KLANG VALLEY, MALAYSIA

**By**

**KHAIRUNNISAK BINTI MOHSIN**

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**ASSESSMENT OF FREE DIETARY GLUTAMATE INTAKE AMONG MALAYS AND CHINESE IN THE KLANG VALLEY, MALAYSIA**

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**September 2009**

**Chairman : Azizah Abdul Hamid, PhD**

**Faculty : Food Science and Technology**

Dietary intake assessment is a qualitative or quantitative evaluation of the degree of intake likely to happen, in which the estimation is made by multiplying the food consumption by the chemical concentration in the respective foods. In the present study, assessment of free dietary glutamate has been carried out among 360 Malay and Chinese adults in the urban area of Klang Valley, Malaysia. The food consumption data was obtained through a survey using food frequency questionnaires (FFQ) and condiments usage forms. In addition to that, the free glutamate content of food and condiments were analysed by High Performance Liquid Chromatography (HPLC) utilizing pre-column derivatization and fluorescence detection. Subsequently, using both data from survey and sample analysis, the study estimated free dietary glutamate intake of the respondents involved in the study. Results from the survey revealed that the average total food consumption by total respondents was 843 g/person/day, with significant (p=0.017) higher consumption among the Chinese (948 g/person/day) compared to the Malays (793 g/person/day). The study also showed that consumption of

condiments by both Malay and Chinese households was comparable, at 7.56 and 6.87 g/person/day, respectively. Chinese respondents, however, used more types of condiments compared to Malays. Meanwhile, results from sample analysis showed that the average free glutamate content in processed foods ranged from 0.34 ± 0.20 to 4.63 ± 0.41 mg/g. In food dishes, it was as low as 0.24 ± 0.15 mg/g in *roti canai* to 8.16 ± 1.99 mg/g in *dim sum*. Relatively, the free glutamate content was found to be higher in condiments at 0.28 ± 0 mg/g in mayonnaise to 786.00 ± 0 mg/g in monosodium glutamate. Calculated free glutamate intake from food by total respondents was 1.96 g/person/day; with intake by the Chinese was shown to be significantly (p=0.001) higher than Malays at 2.34 and 1.77 g/person/day, respectively. On the other hand, the average total free glutamate intake from condiments by total respondents was 0.27 g/person/day. The average total intake by the Malays, however, was significantly (p=0.004) higher than Chinese at 0.35 and 0.15 g/person/day, respectively. Overall, the average consumer need not be alarmed about the intake of glutamate from typical diet in their daily dietary pattern. Despite that, with heavy free glutamate intake ($95^{th}$ percentile) at more than 3.0 g/person/day may expose the consumers with possible adverse health effects.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENILAIAN PENGAMBILAN GLUTAMAT BEBAS MELALUI PEMAKANAN DI KALANGAN KAUM MELAYU DAN CINA DI LEMBAH KLANG, MALAYSIA**

Oleh

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Penilaian pengambilan diet merupakan penilaian secara kualitatif atau kuantitatif terhadap tahap pendedahan pengambilan makanan. Anggaran ini dikira secara mendarabkan jumlah pengambilan makanan dengan kandungan bahan kimia yang terdapat di dalam makanan tersebut. Kajian penilaian pengambilan glutamat bebas di dalam makanan yang telah dijalankan ini melibatkan seramai 360 orang responden dewasa Melayu dan Cina di kawasan bandar, Lembah Klang, Malaysia. Data pengambilan makanan diperolehi melalui kaji selidik yang menggunakan borang soal selidik kekerapan pengambilan makanan (FFQ) dan penggunaan bahan perasa. Selain itu, kandungan glutamat bebas di dalam makanan dan bahan perasa telah dianalisis menggunakan alatan Kromatografi Cecair Berprestasi Tinggi (HPLC) berdasarkan terbitan pra-kolum dan pengesanan bersinar. Data daripada kedua-dua kaji selidik dan analisis sampel makanan kemudiannya digunakan untuk menganggar pengambilan

glutamat bebas di dalam makanan bagi responden yang terlibat di dalam kajian yang telah dijalankan. Keputusan daripada kaji selidik menunjukkan bahawa purata jumlah pengambilan makanan bagi kesemua responden adalah 843 g/orang/hari, dengan purata pengambilan makanan pada responden Cina (948 g/orang/hari) adalah ketara (p=0.017) lebih tinggi daripada responden Melayu (793 g/orang/hari). Kajian juga menunjukkan purata pengambilan bahan perasa bagi kedua-dua isi rumah Melayu dan Cina berada pada tahap yang sama, iaitu 7.65 dan 6.87 g/orang/hari masing-masing. Namun begitu, kaum Cina didapati lebih bervariasi dalam penggunaan bahan perasa berbanding kaum Melayu. Sementara itu, keputusan daripada analisis sampel makanan menunjukkan purata kandungan glutamat bebas di dalam makanan terproses berada diantara julat 0.34 ± 0.20 sehingga 4.63 ± 0.41 mg/g. Bagi hidangan makanan, julat kandungan glutamat bebas adalah 0.24 ± 0.15 mg/g dalam roti canai sehingga 8.16 ± 1.99 mg/g di dalam dim sum. Secara relatifnya, kandungan glutamat bebas adalah lebih tinggi dalam bahan perasa, iaitu 0.28 ± 0 mg/g di dalam mayonis sehingga 786.00 ± 0 mg/g di dalam monosodium glutamat. Anggaran pengambilan glutamat bebas daripada makanan bagi kesemua responden adalah 1.96 g/orang/hari; dengan pengambilan daripada kaum Cina adalah ketara (p=0.001) lebih tinggi berbanding kaum Melayu, iaitu pada 2.34 and 1.77 g/orang/hari masing-masing. Sementara itu, purata pengambilan glutamat bebas daripada bahan perasa bagi kesemua responden adalah sebanyak 0.27 g/orang/hari. Pengambilan di kalangan kaum Melayu adalah ketara (p=0.004) lebih tinggi daripada kaum Cina, iaitu sebanyak 0.35 dan 0.15 g/orang/hari masing-masing. Secara keseluruhannya, pengguna tidak perlu bimbang dengan pengambilan glutamat bebas daripada diet harian yang biasa. Walau bagaimanapun, pengambilan glutamat bebas yang tinggi (pada 95 persentil) melebihi 3.0 g/orang/hari memungkinkan penggunanya berhadapan dengan kesan sampingan kepada kesihatan.

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I certify that a Thesis Examination Committee has met on 15 September 2009 to conduct the final examination of Khairunnisak binti Mohsin on her thesis entitled "Assessment of Free Dietary Glutamate Intake among Malays and Chinese in the Klang Valley, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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## DECLARATION

I hereby declare that the thesis is based on my original work except for quotation and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

**KHAIRUNNISAK BINTI MOHSIN**

Date:

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## ABBREVIATIONS

| | |
|---|---|
| ADI | Acceptable daily intake |
| ANOVA | Analysis of variance |
| FAO | Food and Agricultural Organization |
| FBS | Food balance sheet |
| FFQ | Food frequency questionnaires |
| GEMS/Food | Global Environment Monitoring System/Food Contamination Monitoring and Assessment Programme |
| GRAS | Generally recognized as safe |
| JECFA | Joint FAO/WHO expect committee on food additives |
| LOAEL | Low observed adverse health effect |
| MANS | Malaysian adult nutrition survey |
| MOA | Ministry of Agriculture |
| MSG | Monosodium glutamate |
| NOAEL | No observed adverse health effect |
| SEAAGS | South East Asia Association of Glutamate Sciences |
| TDS | Total diet study |
| US FDA | United States Food and Drug Administration |
| WHO | World Health Organization |

# CHAPTER 1

# INTRODUCTION

Glutamic acid is one of the most common, natural amino acid that occurs naturally in various foods either bound (part of protein) or in the free form. In foods it primarily exists in its salt form, glutamate (Federal register 1996). Glutamate is required for proper cell function and is a major excitatory transmitter within the brain (Watkins and Evans, 1981). Studies have shown that protein-rich foods like cheese, milk and meat consisted of substantial amount of bound-form glutamate, whereas vegetables like tomatoes and mushrooms contained high levels of free glutamate (Food Technologist's Expert Panel on Food Safety & Nutrition 1987). Neither the protein-bound glutamic acid nor the D-configuration has the same capability of the free L-glutamic acid, in terms of the flavour-enhancing activity. Consequently, only the free L-glutamic acid, through its salt monosodium glutamate, (MSG) has been used as a flavour enhancer.

MSG was first discovered in 1908, when Professor Kikunae Ikeda identified the unique taste attributed by glutamic acid as 'umami' or savoury, meat or broth-like taste (Ninomiya, 2001). MSG is the free form, sodium salt of glutamate. In its pure form it appears as a white, practically odorless, free-flowing crystalline powder; when dissolved in water (or saliva) it rapidly dissociates into free sodium and glutamate ions. When MSG is added to foods, it provides a similar flavoring function as the glutamate that occurs naturally in food. It is commonly used to improve the flavors of meats, poultry, seafood, snacks, soups and stews. It is also frequently been added to ready-to-eat meals, flavorings, spices blends and vegetable. MSG is not only present in food as an added chemical, but also as a by-product of hydrolyzed vegetable proteins (HVP), which are widely used as seasonings and flavors in canned foods, dry mixes, sauces, and other manufactured products.

The U.S. Food and Drug Administration (FDA) has designated MSG as a Generally Recognised As Safe (GRAS) substance, along with many other common food ingredients such as salt, vinegar and baking powder. In addition, after many years of evaluations and meetings, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) decided that MSG to be assigned as "Acceptable Daily Intake not specified" (JECFA, 1988). This indicates no toxicological concerns associated with its use as a food additive in accordance with good manufacturing practice (GMP). In 1991, the European Community's Scientific Committee for Food (SCF) confirmed the safety of MSG and came to the same conclusion that specification of an ADI was unnecessary (McKevith 2003). No “low observed adverse effect level” and “no observed adverse effect level” (LOAEL and NOAEL) has been set for added glutamate, at least by the US Committee on Dietary Reference Intakes (Panel on Micronutrient, 2002).

Despite these evaluations and findings, there has been considerable debate regarding the usage and safety issues of MSG for the past three decades. The source of these controversies started in 1968 when it was speculated that MSG could be the cause of adverse reactions following the ingestion of Chinese restaurant foods (Kwok, 1968). Since then, MSG has been implicated for eliciting a variety of symptoms, including asthma (Allen *et al.* 1987; Hodge *et al.,* 1996), severe atopic dermatitis, (Van Bever *et al.*, 1989) headaches, facial burning, and abdominal pain (Yang *et al*., 1997; Geha *et al*., 2000). Hiroshi *et al.* (2002) reported that a diet with excess sodium glutamate over a period of several years may increase glutamate concentrations in the vitreous humour and may cause retinal cell destruction.

The issue arise in this case is whether high intakes might arise which could invalidate the assumption of safety at all foreseeable levels of exposure in food additive use. In addition to that, the assumption of absence hazard can be invalid with high intakes of MSG.

Different approach has been used to estimate the MSG intake around Southeast Asia countries; however, in many of the previous studies, the estimation of MSG consumption did not consider free glutamate that may exist in food. Therefore it is necessary that a complete study on the total exposure of the public to MSG and free glutamate from foods as well as from the condiments in Malaysia to be conducted. As it has not been comprehensively done, the population study using the exposure assessment approach has to be carried out.

Exposure assessment, as one of the crucial component of the risk assessment process, is defined as the qualitative and/or quantitative evaluation of the likely intake of biological, chemical or physical agents via food as well as exposure from other relevant sources (WHO, 1997). In the case of dietary exposure to glutamate it should be assessed by combining data on food consumption with data on the glutamate concentration of the respective food. The term “dietary exposure” is used synonymously with the term “dietary intake” as both are acceptable and used concurrently (WHO, 2008).

In the present study, assessment to free dietary glutamate among the Malays and Chinese adults in Klang Valley, Malaysia is evaluated from food as well as from condiments. The output of the study will be a link between the safety information derived from animal experiment and the current measure to manage the risk that may be generated by glutamate consumption of general population including heavy users. It also could be used as the database for the next study conducted on the other part of Malaysia.

The objectives of the study are generally to determine the usage, consumption and potential exposure (intake) of consumers to MSG and free glutamate in food and food products. Specifically, the objectives are:

1. To determine the food consumption pattern, also the household use of MSG and glutamate-containing condiments.
2. To determine the free glutamate levels in ready-to-eat foods, processed foods, dishes and condiments available to consumers.
3. To evaluate the total exposure to glutamate from food consumption data and free glutamate content.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Glutamic acid and glutamate

Glutamic acid was first identified from wheat gluten more than 100 years ago in Germany, but it was in Japan that its subtle effect on the taste of food was identified and given the name “umami” in 1908 by Professor Kikunae Ikeda. Ikeda was the first person who chemically isolated glutamate from dried kombu or sea tangle extract (*Laminiaria Japanica*) (Ninomiya, 2001). He also suggested that free glutamate elicits a taste that is distinct from the four known primary tastes: sour, sweet, salty, and bitter. In China, the word *xianwei*, which represents the taste common in fish and meat, corresponds to umami. The same is true for savoury in English, *osmazome* in old French, and *gulih* in Indonesian (Matheis, 1999; Maga, 2002; Sugita, 2002; Prescott, 2004).

Glutamic acid, being one of the 20 amino acids that make up human proteins, has many important functions in human body. It is important for proper cell function, one of the building blocks in protein synthesis, a major starting material in the biosynthesis of other amino acids and also important in brain function as an excitatory neurotransmitter (Watkins and Evans, 1981). The average adult body contains approximately 10 g free glutamate (of which 2.3 g is in the brain) and 2 kg of the bound form. The turnover of