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# Free Glutamate Intake From Foods Among Adults: Case Study in Bogor and Jakarta

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**Abstract.** *Monosodium glutamate (MSG) is a flavor enhancer which has been used for nearly a century to bring out the best flavor of food. Its principal component is an amino acid called glutamate or L-glutamic acid. Free glutamate also exists naturally in foods. The aim of the present study was to estimate the exposure of consumers to free glutamates from foods in Jakarta and Bogor, Indonesia. The study was conducted in Jakarta urban area and rural area of Bogor with 222 respondents above 19 years of age. The survey used Food Frequency Questionnaire to estimate the consumption of food predicted to contain free glutamate. The data of food consumption was used to design food samples to be taken from the survey site and analyze for free glutamate content. Analyses of free glutamate content in food were conducted using HPLC with fluorescent detector. The results revealed the most frequent and the highest amount of food consumed both in Jakarta and Bogor area was dish menus of cereal categories. The average food consumption, excluding rice, in Bogor was 816.73 g/cap/day, while in Jakarta was 823.82 g/cap/day with dish menus contribution accounted to more than 70%. Free glutamate content of food samples ranged from undetected to more than 6 mg/g. Free glutamate intake in Bogor was comparable with that of Jakarta, i.e. 2013.76 mg/cap/day and 2068.97 mg/cap/day respectively. The main source of glutamate intake in both in Bogor and Jakarta was dish menus contributing to more than 80% of the total free glutamate intake. Free glutamate intake from food prepared outside the household was comparable with that of food prepared at home.*

***Keywords****: free glutamate intake, free glutamate in foods, food consumption, dish menus, processed foods*

**Abstrak.** Monosodium glutamat (MSG) adalah zat penegas rasa yang lebih dari 100 tahun digunakan untuk melezatkan masakan. Senyawa utama yang terkandung dalam MSG adalah asam amino glutamat atau disebut juga L-asam glutamat. Asam glutamat bebas juga terdapat secara alami dalam bahan pangan. Tujuan penelitian ini adalah untuk mengkaji paparan asam glutamat bebas yang berasal dari pangan pada masyarakat. Kajian dilakukan di Jakarta (perkotaan) dan Bogor (pedesaan) dengan jumlah responden 222 orang berusia >19 tahun. Survei konsumsi pangan yang diduga mengandung asam glutamat bebas menggunakan *Food Frequency Questionnaire*. Data konsumsi pangan yang diperoleh digunakan untuk merancang pengambilan contoh di lokasi survei dan untuk analisis kadar asam glutamat bebas dalam pangan. Jumlah asupan atau paparan asam glutamat dihitung sebagai perkalian jumlah konsumsi pangan dengan kadar asam glutamat bebas dari berbagai sumber. Analisis asam glutamat bebas dilakukan dengan metode HPLC menggunakan detektor sinar fluoresen. Hasil kajian menunjukkan jenis pangan yang paling tinggi dikonsumsi adalah menu komposit kategori serealia. Rata-rata konsumsi pangan –tidak termasuk nasi– di Bogor dan Jakarta adalah 816.73 dan 823.82 g/kap/hari; serta menu komposit menyumbang lebih dari 70%. Kadar asam glutamat bebas pada pangan berkisar dari tidak terdeteksi hingga lebih dari 6 mg/g. Asupan asam glutamat bebas di Bogor hampir sama dengan di Jakarta yaitu masing-masing 2013.76 dan 2068.97 mg/kap/hari. Jenis pangan yang berkontribusi utama dalam asupan asam glutamat bebas adalah menu komposit yaitu sebesar leboh dari 80% dari total asupan asam glutamat bebas. Asupan asam gluta-mat bebas dari pangan jajanan (restoran) hampir sama dengan pangan yang dimasak di rumah tangga.

**Kata Kunci:** Asupan asam glutamat bebas, asam glutamat bebas dalam pangan, konsumsi pangan, menu komposit, pangan olahan

**Practical Application:** The present research finding provided a data base of food consumption including amount and frequency but excluding rice and drinks; and free glutamate content in foods, both processed food and dish menus that could be used as a reference for other studies. No recent studies on glutamate intake from foods based on food consumption have been published recently, hence this research finding updated the figures of glutamate intake from foods. Free glutamate intake obtained from this study was considered being more accurate than the estimation done in the previous studies.

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## INTRODUCTION

Monosodium glutamate (MSG) has been used as flavor enhancer in food prepared at home, vendors, restaurants or food industries especially by the Asian. Glutamate is found naturally in protein containing foods such as meat, poultry and milk. However, free glutamate, not bound in protein, is the effective form to intensify, enhance or improve food flavors. In the early 1900s, glutamate was extracted from natural protein rich foods, such as seaweed and it was also prepared by the acid hydrolysis of wheat gluten or soybean protein which were expensive materials. Nowadays glutamate is produced mainly through microbial means using certain strains of bacteria, such as Corynebacterium sp. and Brevibacterium sp. Mollases, glucose or hydrolyzed starch is the usual carbon source (Sano, 2009).

MSG is a white crystalline powder and rapidly dissociates into free sodium and glutamates when dissolved in water. Free glutamate also present in many food additives such as hydrolyzed vegetable protein (HVP), plant protein extract, yeast extract, autolyzed yeast, textured protein, malt extract, bouillon, flavoring (natural or beef or chicken), seasonings and condiments. Recent study conducted in Bogor and Jakarta showed that among seasonings and condiments used in Bogor and Jakarta, premix contained the second highest of free glutamate after MSG, followed by oyster and fish sauce and sweet soy sauce (Andarwulan et al., 2012). MSG and premix seasoning were used by most households both in Bogor and Jakarta.

Based on extensive evaluation on the safety of MSG, its use has been confirmed to be safe by the different scientific communities including the Joint FAO/ WHO Expert Committee on Food Additives (JECFA) in 1988 (Walker and Lupin, 2000); European Scientific Committee for Food – Commission of the European Communities in 1991 (Walker and Lupin, 2000); and by the Federation of American Societies for Experimental Biology (FASEB) in 1995. In 1995 Center for Food Safety and Applied Nutrition (CFSAN) - Food and Drugs Administration (FDA) has also recognized that MSG and related substances are safe food ingredients for most people when eaten at customary levels (US Department of Health and Human Services, 1995). The JECFA has allocated an "acceptable daily intake (ADI) not specified" to glutamic acid and its salts (Walker and Lupin, 2000). This indicates no toxicological concerns associated with its use as a food additive. FAO/WHO regulates use of MSG in food in accordance with Good Manufacturing Practice (GMP). National Agency for Drug and Food Control (PerKBPOM No. 23, 2013) also regulated addition of MSG as flavor enhancer in food as under GMP.

Despite those findings and approval on the use of MSG as safe ingredient, there has been considerable debate regarding the use and safety of MSG. Different approach has been used to estimate MSG consumption. Geha et al. (2000) stated that the average daily intake of MSG is estimated to be 0.3–1.0 g in industrialized countries, but can be higher occasionally, depending on the MSG content of individual food items and an individual's taste preferences. Survey on consumption of MSG was done by Saidin et al. (1990) in three provinces (West Java, West Kalimantan and South Sulawesi) which were divided into 6 districts and involving 3063 households. The study revealed that the mean intake of MSG for infant was 0.1 g/day, children 0.22 g/day, pregnant woman 0.39 g/day and lactating mother 0.40 g/day. A recent survey conducted by Hardinsyah et al. (2005) involving 5040 households in 4 provinces (West Java, Lampung, South Sulawesi and East Nusa Tenggara) showed the prevalence of MSG consumption of mothers was 84.71%, while that of children was 80.39%. The later study also estimated a higher MSG intake than the result of the study by Saidin et al. (1990), i.e. 4.59 g/day for mother and 4.05 g/day for children. Study done by Andarwulan et al. (2012) in Bogor and Jakarta revealed that the average condiment/ seasonings usage in Bogor (5.39 g/cap/day) was lower than that in Jakarta (9.62 g/cap/day), but the free glutamate intake from condiment/seasonings in Bogor (847.04 mg/ cap/day) was higher than that in Jakarta (615.87 mg/ca p/day). This was due to the high contribution of MSG that used in higher amount in Bogor. In those studies, the estimation of MSG consumption did not consider free glutamate that may exist in foods. Therefore it is necessary to do a complete study on the total exposure of the consuming public to MSG and free glutamate containing foods in Indonesia. The aim of the present study was to determine food consumption pattern and to estimate the intake of free glutamate from foods taken at home or outside among adults with age of 19 years above.

## METHODS

### Study Area

The study was conducted in Jakarta as urban area and rural area of Bogor district in Java Island with 222 respondents of adults aged 19 years above. The respondents in Bogor were considered as poor family, while the rest was considered as non-poor family. The number of respondent in each area (N) is calculated using following formula:

$$N = \frac{1.69^2 \text{ x } P\ (1\text{-}P)}{d^2}$$

where 1.96 was Z value for p = 0.05 or 95% confidence limit; P was estimated prevalence of free glutamate consumption (0.5); d was desired precision 0.1 for ±10%. Required number of each group = 96 approximately 100. By taking that calculation, the respondent of urban (Jakarta) was 112 respondents and that of rural (Bogor) was 110 respondents.

### Survey Method

Crosssectional survey of Food Frequency Survey (FFS) was conducted using the questionnaire of Food Frequency Questionnaire (FFQ) which covered the information on how frequent and how much the consumption of food predicted containing free glutamate or added MSG,

both for prepared at home and outside home. The foods were categorized into 6 categories as follows: (1) cereals and cereals products (cereals, legumes, roots and tubers), (2) bakery wares, (3) meat and meat products including poultry and game, (3) fish and fish products including mollusks, crustacean, and echinoderms (5) ready to eat savories, and (6) composite foods. Category 1 to 5 was processed food, while all dishes menu was categorized as composite foods and they were further sub-categories into (a) fruits and vegetables, (b) cereals and cereal products, (c) bakery wares, (d) meat and meat products, (e) fish and fish products and (f) egg and egg products.

**Data Survey Analyses**

Data survey analyses were started from data verification and input. Based on the data obtained, the consumption of each food group was calculated for total respondent. Total consumption per capita of each age group and each area and frequency of consumption were also calculated.

**Laboratory Analysis**

***Sampling plan.*** The sampling plan was developed based on percentage of consumption of each food subgroups. The criteria used for foods to be sampled were (1) contribute to total consumption of more than 0.5% total consumption or (2) consumed by more than 40% respondents although their consumption <0.5%. Sample for analyses was prepared as composite sample calculated based on min. 90% of the total proportion of each food consumed in each area. Total sample for free glutamate analyses in food were 49 samples taken from Bogor and 57 samples taken from Jakarta.

***Sampling methods for processed foods and composite foods (dish menus).*** Foods of rural were purchased from food stalls in Bogor, whereas those of urban were purchased from restaurants in Jakarta. The foods were immediately brought to laboratory and blended individually with a blender, then stored in freezer until weighed. Before weighing, the thawing was done by allowing the foods in refrigerator for 1 to 5 hours. Each sample of foods was made by weighing them according to the sample proportion of sampling plan. The final samples (single or composites) were then stored in freezer until used for analysis.

***Analysis method of free L-glutamic acid content.*** Free L-glutamic acid content was determined by the method of Williams and Winfield (1982) as described by Andarwulan et al. (2012). The method consisted of three steps, i.e. extraction, dansylation and analysis by reverse phase high performance liquid chromatography (RP-HPLC). Each sample of food was analyzed in two replicates (from extraction to derivatization-HPLC analysis). The result was reported as an average of two measurements.

***Analysis method of moisture content.*** Moisture content was measured by gravimetric method following the AOAC method (AOAC, 1999).

**Data Analysis and Estimation of Total Exposure to Free Glutamate**

Data analyses were done using SPSS (Statistical Package for the Social Sciences) version 13.0 for Windows. It included coding, editing, entry, and analyses. Before analyses proceeded, the data were evaluated for their distribution to determine if the data follow normal distribution. Data distribution was tested using normality data test (Kolmogorov-Smirnov). The test used significance value (Sig.). If $t > 0.05$ the data considered as normal data, but if $t < 0.05$ the data considered as not distributed normally. Data distributed normally was tested using t-test to differentiate between 2 variables and analysis of variance (ANOVA) to differentiate between several variables. The abnormally distributed data was tested using non-parametric analyses with two independent sample test (Mann-Whitney U), test for several independent samples (Kruskal-Wallis H), and two related samples tests (Wilcoxon). Free glutamate intake was estimated using data obtained from the survey and laboratory analysis. The Mann-Whitney U test was used to evaluate the difference in food consumption and free glutamate intake from foods. Kruskal-Wallis H test was used to evaluate the difference in food consumption and free glutamate intake based on respondent charac-teristics in rural (Bogor) and urban (Jakarta). While Wilcoxon test was used to determine the relation between food consumption and free glutamate intake from food, with parameter analyses on the difference between processed food and dish menu, and between food prepared outside and at home.

## RESULTS AND DISCUSSION

**Characteristics of Respondents**

The age of respondents was between 19 and more than 60 years old with the dominant was below 50 years old (Table 1). Female respondent was higher than male respondent both in Bogor and Jakarta area. Based on the poverty status (determined based on National Standard/ National Family Planning Board (BKKBN) standard), more than 60% of respondent in Bogor were categorized as "poor family". Meanwhile, more than 70% of respondent in Jakarta area came from "non-poor family".

**Table 1.** Characteristic of respondents in Bogor and Jakarta area based on age and sex

| Age Group (years) | Bogor Area | | | Jakarta Area | | |
|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total |
| 19 - 29 | 6 | 39 | 45 | 11 | 16 | 27 |
| 30 - 39 | 5 | 38 | 43 | 11 | 26 | 37 |
| 40 - 49 | 2 | 9 | 11 | 5 | 15 | 20 |
| 49 - 59 | 4 | 7 | 11 | 3 | 13 | 16 |
| > 60 | 0 | 0 | 0 | 2 | 10 | 12 |
| Total | 17 | 93 | 110 | 32 | 80 | 112 |

**Table 2.** Frequency of food consumption (times/cap/month) of each food group for adult in Bogor and Jakarta area

| Food categories /groups | Bogor | | | Jakarta | | |
|---|---|---|---|---|---|---|
| | Prepare at Home | Prepare Outside | Total | Prepare at Home | Prepare Outside | Total |
| **I. Processed Foods** | | | | | | |
| • Cereal and Cereal Product (Cereal, Legumes, root, Tubers) | 2.57 | 18.47 | 21.05 | 5.13 | 6.02 | 11.14 |
| • Bakery Wares | 0.01 | 1.11 | 1.12 | 0.49 | 3.71 | 4.20 |
| • Meat and Meat Product including Poultry and Game | 0.08 | 0.37 | 0.45 | 1.65 | 3.18 | 4.83 |
| • Fish and Fish Product including Mollusks, Crustaceans, and Echinoderms | 0.75 | 1.18 | 1.94 | 0.46 | 0.53 | 0.98 |
| • Ready to Eat Savouries | 3.00 | 26.15 | 29.15 | 1.44 | 23.42 | 24.86 |
| **II. Dish Menus** | | | | | | |
| • Fruit and Vegetables | 61.50 | 2.17 | 63.67 | 40.66 | 3.96 | 44.63 |
| • Cereals and Cereals Product (Cereal, Legumes, Root, Tubers) | 57.20 | 56.61 | 113.81 | 43.14 | 60.89 | 104.04 |
| • Bakery Wares | 0.00 | 0.05 | 0.05 | 0.01 | 0.95 | 0.96 |
| • Meat and Meat Product including Poultry and Game | 11.69 | 10.07 | 21.76 | 16.76 | 9.58 | 26.34 |
| • Fish and Fish Product including Mollusks, Crustaceans, Echino-derms | 41.06 | 3.58 | 44.65 | 23.14 | 6.26 | 29.40 |
| • Eggs and Egg Products | 18.19 | 0.22 | 18.41 | 14.13 | 0.31 | 14.44 |

**Table 3.** Food consumption in Bogor and Jakarta area

| Food Groups/Categories | Bogor | | Jakarta | |
|---|---|---|---|---|
| | Consumption (g/cap/day) | % Consumption | Consumption (g/cap/day) | % Consumption |
| **Processed Foods** | | | | |
| • Cereal and Cereal Product (Cereal, Legumes, root, Tubers) | 136.10 | 16.66 | 75.67 | 9.18 |
| • Bakery Wares | 1.83 | 0.22 | 9.75 | 1.18 |
| • Meat and Meat Product including Poultry and Game | 0.60 | 0.07 | 5.72 | 0.69 |
| • Fish and Fish Product including Mollusks, Crustaceans, and Echinoderms | 2.66 | 0.33 | 1.72 | 0.21 |
| • Ready to Eat Savouries | 25.22 | 3.09 | 20.22 | 2.45 |
| **Total Processed Foods** | **166.40** | **20.37** | **113.08** | **13.71** |
| **Dish menus** | | | | |
| • Fruit and Vegetables | 150.02 | 18.37 | 131.25 | 15.93 |
| • Cereals and Cereals Product (Cereal, Legumes, Root, Tubers) | 327.82 | 40.15 | 396.23 | 48.10 |
| • Bakery Wares | 0.18 | 0.02 | 4.54 | 0.55 |
| • Meat and Meat Product including Poultry and Game | 95.64 | 11.71 | 100.30 | 12.18 |
| • Fish and fish Product including Mollusks, Crustaceans, Echinoderms | 43.57 | 5.33 | 49.91 | 6.06 |
| • Eggs and Egg Products | 33.03 | 4.04 | 28.52 | 3.46 |
| **Total Dish Menus** | **650.33** | **79.63** | **710.75** | **86.29** |
| **Total** | **816.73** | **100** | **823.82** | **100** |

**Frequency of Consumption**

The FFQ survey revealed that fruit and vegetables category was not found in processed foods consumed by the respondents. Hence the processed foods consisted of 5 categories, while dish menus consisted of 6 categories (Table 2). Dish menus were the most frequent consumed by the respondents both in Bogor and Jakarta. Within the dish menus, cereals and cereal products was the most frequent consumed followed by fruits and vegetables (Table 2). Food prepared at home was the most frequent consumed. In Jakarta slightly different figure for processed food under category cereals and cereal products

in which the respondent more frequently consumed those foods prepared outside home, mean-while in Bogor for this category, the frequency of consumption food prepared at home was almost similar to that prepared outside home. Among processed foods, fish and fish product was the least frequent consumed in Jakarta, while among dish menus, bakery wares was the least. In Bogor, the least frequent foods consumption was meat and meat products among processed foods, while bakery wares was among dish menus. The frequency of consumption of bakery wares; meat and meat products were higher in Jakarta than in Bogor.

**Average of Consumption**

Food consumption in Bogor and Jakarta are presented in Table 3, 4, 5 and 7. Total food consumption, excluding rice, in Jakarta and Bogor were almost similar, i.e. 816.73 g/cap/day and 823.82 g/cap/day respectively. The dish menus were the main contributor to food consumption both in Jakarta and Bogor, i.e. 79.63% and 86.29% respectively (Table 3) and significantly different with processed foods (Table 7). Respondent in Jakarta consumed more dish menus than those in Bogor. Based on the source of foods, in Bogor the respondents consumed more food prepared at home, while in Jakarta, the respondents consumed more food prepared outside (Table 7).

Cereals and cereal products both in Bogor and Jakarta was the highest amount consumed among processed foods and dish menus, i.e. 327.82 g/cap/day (40.15% of total consumption) and 396.23 g/cap/day (48.10% of total consumption). Among processed food under category cereal and cereal products, noodles type products was the most contributor to food consumption figures both in Bogor and Jakarta (Table 4 and 5). Type of foods under cereals and cereal products in the dish menus group were different with the processed foods. Within cereals and cereal products of dish menu, traditional cakes and snacks was the highest foods consumed, both in Bogor and Jakarta, followed by tempe and tofu base products. Fish and fish products, meat and meat products, and egg and egg products were consumed to a lesser extend both in Bogor and Jakarta.

Among processed food, the least foods consumed in Bogor were meat and meat products; while in Jakarta were fish and fish products. Meanwhile among dish menus, bakery wares were the least consumed both in Jakarta and Bogor (Table 3).

**Free Glutamate Content in Foods**

Free glutamate content of food samples were depicted in Table 4 and 5. The free glutamate content of cereals and cereals products ranged from 0.60 to 2.83 mg/g. Table 4 and 5 show that instant noodle consumed as drained noodle, had glutamate content about 3-4 times higher than noodle soup. No free glutamate was detected in samples of bakery wares. Free glutamate content of meat and meat products ranged from 1.26 to 3.04 mg/g. Free glutamate content in fish and fish products ranged from 0.55 to 7.04 mg/g. Free glutamate content in canned sardines was 9 to 11 times lower than in other products. Relative high free glutamate content ranged from 5.22 to 9.78 mg/g was found in ready to eat savories.

Within dish menus, free glutamate content in fruits and vegetables ranged from not detected to 7.83 mg/g. In Bogor, the highest glutamate content was found in dish menu of stir fried leaf vegetables (7.83 mg/g). In Jakarta, the highest glutamate content was found in dish menu of stir fried sprout (vegetables) (7.40 mg/g). Free glutamate content in cereal and cereal products ranged from not detected to 7.93 mg/g in Bogor, and to 6.74 mg/g in Jakarta. The highest glutamate content was found in fried wheat flour based-noodle in Bogor, and in *oncom* based dish menu in Jakarta. No glutamate content was found in pizza samples, however, the glutamate content was found in burger and hotdog samples at a significant level of 2.05 mg/g.

The free glutamate content in meat and meat products in Bogor ranged from 0.96 to 8.46 mg/g which is higher than in Jakarta ranging from 0.22 to 3.36 mg/g. Within meat and meat products of dish menus, in Bogor, the dish menu with the highest glutamate content was found in fast food, whereas in Jakarta found in chicken soup. The free glutamate content in fish and fish product of dish menus ranged from not detected to 4.87 mg/g. No glutamate can be detected in egg dish menus of Bogor, but that of Jakarta had glutamate at a range of 2.85 to 8.85 mg/g. Typical Chinese restaurant meal contains between 0.1 and 15 mg of MSG per g (Freeman, 2006). The free glutamate content in the dish menus obtained in the present research was within this range and the maximum content was lower.

**Estimation of Free Glutamate Intake from Foods**

Total free glutamate intake from foods was 2,013.76 mg/cap/day in Bogor and 2,068.97 mg/cap/day in Jakarta. Those figures show no significant free glutamate intake between Bogor and Jakarta. The free glutamate intake estimated in the present research was higher than the survey results of Muhilal *et al.* (1988) with estimation of intake of MSG for infant of 0.1 g/day, children 0.22 g/day, pregnant woman 0.39 g/day and lactating mother 0.40 g/day. In this survey, the MSG intake was calculated based on the food consumed and the MSG used for cooking the corresponding food. The results of the present study, however, lower than estimation done by Hardinsyah (2005) i.e. 4.59 g/day for mother and 4.05 g/day for children. The discrepancies were due to the method of estimation.

The present survey was considered to provide more accurate figures as the estimation was done based on the food consumption and the free glutamate content in the corresponding foods. In Japan and Korea, the estimated average MSG intake in the 1990s was 1.2–1.7 g/d, however it is speculated that the average daily MSG intake may be up to 10 g/d (He *et al.*, 2011). This figures were

**Tabel 4**. Food Consumption, glutamate content and free glutamate intake from food in Bogor area

| Food Groups | Food consumption (g/cap/day) | % Consumption | Free glutamate content (mg/g) | Free glutamate intake (mg/cap/day | % Glutamate Intake |
|---|---|---|---|---|---|
| A. **Processed Foods** | | | | | |
| **Cereal and Cereal Product (Cereal, Legumes, root, Tubers)** | **136.10** | **16.66** | | **169.76** | **8.43** |
| Instant, Noodles, Drained | 35.04 | | 2.83 | 99.17 | |
| Instant, Noodles, Soup | 96.41 | | 0.60 | 57.85 | |
| Instant, Glass Noodle, Soup | 0.12 | | 0.60 | 0.07 | |
| Instant, Macaroni | 4.53 | | 2.80 | 12.68 | |
| **Bakery Wares** | **1.83** | **0.22** | | **0.00** | **0.00** |
| Bread | 1.69 | | n.d | 0.00 | |
| Crakers | 0.14 | | n.d | 0.00 | |
| **Meat and Meat Product including Poultry and Game** | **0.60** | **0.07** | | **1.23** | **0.06** |
| Processed/Composite Meat (Dendeng and Abon)[1] | 0.09 | | 1.26 | 0.11 | |
| Processed/Composite Meat (Sausage and Corned)[1] | 0.15 | | 2.07 | 0.30 | |
| Processed/Composite Chicken Meat | 0.36 | | 2.27 | 0.82 | |
| **Fish and Fish Product including Mollusks, Crustaceans, and Echinoderms** | **2.66** | **0.33** | | **3.02** | **0.15** |
| Processed/Composite (Sarden) | 2.46 | | 0.66 | 1.63 | |
| Processed/Composite (Fish Ball and Kaki Naga) | 0.20 | | 7.04 | 1.39 | |
| **Ready to Eat Savouries** | **25.22** | **3.09** | | **137.37** | **6.82** |
| Extrudates | 2.00 | | 8.09 | 16.19 | |
| Chips | 23.22 | | 5.22 | 121.18 | |
| **Total Processed Foods** | **166.40** | **20.37** | | **311.39** | **15.46** |
| B. **Dish Menus** | | | | | |
| **Fruit and Vegetables** | **150.02** | **18.37** | | **327.14** | **16.25** |
| Bulb Vegetables, Stir Fry | 5.74 | | 2.68 | 15.37 | |
| Fruit Vegetables, Stir Fry | 8.54 | | 6.53 | 55.75 | |
| Fruit Vegetables, Soup | 10.01 | | 1.66 | 17.65 | |
| Leaf Vegetables, Stir Fry | 17.16 | | 7.83 | 134.36 | |
| Leaf Vegetables, Soup | 24.57 | | 0.36 | 8.85 | |
| Mix All Vegetables, Stir Fry | 4.04 | | 3.38 | 13.66 | |
| Mix All Vegetables, Soup | 62.57 | | 0.81 | 50.68 | |
| Mix All Vegetables, Steam | 4.78 | | n.d | 0.00 | |
| Mushroom, Stir Fry | 0.55 | | 7.83 | 4.33 | |
| Mushroom, Soup | 1.13 | | 1.66 | 1.87 | |
| Sprout Vegetables, Stir Fry | 6.00 | | 1.39 | 8.35 | |
| Legume Vegetables, Stir Fry | 4.93 | | 3.44 | 16.96 | |
| **Cereals and Cereals Product (Cereal, Legumes, Root, Tubers)** | **327.82** | **40.15** | | **786.43** | **39.05** |
| Tempe based | 39.92 | | 5.82 | 232.33 | |
| Tofu based | 34.42 | | 1.66 | 57.13 | |
| Oncom based | 16.35 | | 4.61 | 75.38 | |
| Peanut and others | 24.60 | | 3.93 | 96.67 | |
| Traditional Cakes and Snacks | 85.05 | | 0.60 | 51.03 | |
| Glass Noodle, Fried | 7.99 | | 4.42 | 35.32 | |
| Glass Noodle, Soup[1] | 1.32 | | 0.61 | 0.81 | |
| Noodle Wheat Flour Based, Fried | 10.10 | | 7.93 | 80.06 | |
| Noodle Wheat Flour Based, Soup | 8.14 | | 0.61 | 4.96 | |
| Noodle, Rice Flour Based, Fried | 0.09 | | 7.93 | 0.69 | |
| Noodle, Rice Flour Based, Soup | 0.12 | | 0.61 | 0.07 | |
| Wheat Flour Dishes | 4.28 | | 1.03 | 4.41 | |
| Rice Cake With Vegetables | 9.24 | | n.d | 0.00 | |
| Rice Porridge | 28.15 | | 1.80 | 50.66 | |
| Fried Rice | 25.27 | | 1.83 | 46.24 | |
| Spicy Steam Rice | 17.58 | | n.d | 0.00 | |
| Steam Rice With Fish/Chicken/Beef/Egg/Vegetables | 5.44 | | 3.50 | 19.05 | |
| Spaghetti and others | 0.40 | | 2.47 | 0.99 | |
| French Fries | 0.47 | | 0.44 | 0.20 | |
| Noodle Wheat Flour Based with meat balls, Soup (bakso campur) | 3.66 | | 4.66 | 17.07 | |
| Noodle Wheat Flour Based with meat balls, Soup (bakso malang) | 5.33 | | 2.51 | 13.37 | |
| **Bakery Wares** | **0.18** | **0.02** | | **0.23** | **0.01** |
| Pizza | 0.07 | | n.d | 0.00 | |
| Burger, Hot Dog | 0.11 | | 0.44 | 0.23 | |
| **Meat and Meat Product including Poultry and Game** | **95.64** | **11.71** | | **520.00** | **25.82** |
| Chicken, Fried, Steamed | 19.74 | | 1.56 | 30.79 | |
| Chicken, Soup | 23.11 | | 5.09 | 117.65 | |
| Chicken, Grilled | 4.21 | | 2.52 | 10.60 | |
| Chicken Offal, Fried, Steamed | 2.43 | | 0.96 | 2.33 | |

**Tabel 4**. Food Consumption, glutamate content and free glutamate intake from food in Bogor area (continue…)

| Food Groups | Food consumption (g/cap/day) | % Consumption | Free glutamate content (mg/g) | Free glutamate intake (mg/cap/day | % Glutamate Intake |
|---|---|---|---|---|---|
| Beef, Fried, Steamed | 1.48 | | 0.90 | 1.33 | |
| Beef, Soup | 2.17 | | 2.66 | 5.78 | |
| Beef Offal, Fried, Steamed | 0.19 | | 0.90 | 0.17 | |
| Beef Offal, Soup | 0.35 | | 2.66 | 0.93 | |
| Lamb, Soup | 0.28 | | 0.32 | 0.09 | |
| Lamb, Grilled | 0.36 | | 2.52 | 0.90 | |
| Fast Food, meat products | 41.30 | | 8.46 | 349.41 | |
| Lamb, steamed | 0.01 | | 0.90 | 0.01 | |
| **Fish and fish Product including Mollusks, Crustaceans, Echinoderms** | **43.57** | **5.33** | | **68.57** | **3.41** |
| Aquacultures Fish | 8.78 | | 1.11 | 9.75 | |
| Catch fish, Salted | 20.02 | | 1.33 | 26.62 | |
| Catch fish, Unsalted | 7.02 | | 2.21 | 15.50 | |
| Crustaceans, Salted | 0.64 | | 4.87 | 3.11 | |
| Crustaceans, unsalted | 5.58 | | 1.91 | 10.66 | |
| Mollusks, Unsalted | 1.53 | | 1.91 | 2.92 | |
| **Eggs and Egg Products** | **33.03** | **4.04** | | **0.00** | **0.00** |
| Eggs, Boiled | 0.07 | | - | 0.00 | |
| Eggs, Fried | 17.59 | | n.d | 0.00 | |
| Eggs, Spicy | 15.37 | | n.d | 0.00 | |
| **Total Dish Menus** | **650.33** | **79.63** | | **1,702.37** | **79.63** |
| **Total** | **816.73** | **100** | **NA** | **2,013.76** | **100** |

**Tabel 5**. Food Consumption, glutamate content and free glutamate intake from food in Jakarta area

| Food Groups | Food consumption (g/cap/day) | % Consumption | Free glutamate content (mg/g) | Free glutamate intake (mg/cap/day | % Glutamate Intake |
|---|---|---|---|---|---|
| A. **Processed Foods** | | | | | |
| **Cereal and Cereal Product (Cereal, Legumes, root, Tubers)** | **75.67** | **9.18** | | **123.19** | **5.95** |
| Instant, Noodles, Drained | 24.02 | | 2.80 | 67.26 | |
| Instant, Noodles, Soup | 49.40 | | 1.04 | 51.37 | |
| Instant, Glass Noodle, Fried | 0.17 | | 2.80 | 0.46 | |
| Instant, Glass Noodle, Soup | 2.84 | | 1.04 | 0.87 | |
| Instant, Macaroni | 1.04 | | 2.80 | 2.92 | |
| Instant, Rice and Porridge | 0.08 | | 1.04 | 0.08 | |
| Instant, Pasta | 0.05 | | 2.80 | 0.14 | |
| Instant, soup | 0.07 | | 1.04 | 0.07 | |
| **Bakery Wares** | **9.75** | **1.18** | | **0.00** | **0.00** |
| Bread | 9.67 | | n.d | 0.00 | |
| Crakers | 0.08 | | n.d | 0.00 | |
| **Meat and Meat Product including Poultry and Game** | **5.72** | **0.69** | | **9.59** | **0.46** |
| Processed/Composite Meat (Dendeng and Abon) | 1.27 | | 1.26 | 1.61 | |
| Processed/Composite Meat (Sausage and Corned) | 0.74 | | 2.07 | 1.54 | |
| Processed/Composite Chicken Meat | 3.70 | | 1.74 | 6.44 | |
| **Fish and Fish Product including Mollusks, Crustaceans, and Echinoderms** | **1.72** | **0.21** | | **2.99** | **0.14** |
| **Ready to Eat Savouries** | **20.22** | **2.45** | | **119.26** | **5.76** |
| Extrudates | 1.88 | | 9.78 | 18.40 | |
| Chips | 18.34 | | 5.50 | 100.86 | |
| **Total Processed Foods** | **113.08** | **13.71** | | **255.02** | **12.33** |
| B. **Dish Menus** | | | | | |
| **Fruit and Vegetables** | **131.25** | **15.93** | | **355.92** | **17.20** |
| Bulb Vegetables, Stir Fry | 3.73 | | 4.11 | 15.32 | |
| Fruit Vegetables, Stir Fry | 3.06 | | 6.53 | 20.00 | |
| Fruit Vegetables, Soup | 7.65 | | 1.48 | 11.32 | |
| Leaf Vegetables, Stir Fry | 7.12 | | 6.93 | 49.36 | |
| Leaf Vegetables, Soup | 22.98 | | 0.43 | 9.88 | |
| Mix All Vegetables, Stir Fry | 5.46 | | 5.59 | 30.52 | |
| Mix All Vegetables, Soup | 65.32 | | 2.83 | 184.87 | |
| Mix All Vegetables, Steam | 9.28 | | n.d | 0.00 | |
| Mushroom, Stir Fry | 0.16 | | 6.93 | 1.13 | |
| Mushroom, Soup | 0.77 | | 1.48 | 1.13 | |
| Sprout Vegetables, Stir Fry | 3.40 | | 7.40 | 25.12 | |
| Legume Vegetables, Stir Fry | 2.12 | | 3.44 | 7.28 | |
| Fast Food, vegetables and fruits salad | 0.21 | | - | 0.00 | |
| **Cereals and Cereals Product (Cereal, Legumes, Root, Tubers)** | **396.23** | **48.10** | | **940.65** | **45.46** |
| Tempe based | 40.99 | | 1.68 | 68.86 | |
| Tofu based | 36.46 | | 4.75 | 173.17 | |
| Oncom based | 4.12 | | 6.74 | 27.74 | |

**Tabel 5**. Food Consumption, glutamate content and free glutamate intake from food in Jakarta area (continue..)

| Food Groups | Food consumption (g/cap/day) | % Consumption | Free glutamate content (mg/g) | Free glutamate intake (mg/cap/day | % Glutamate Intake |
|---|---|---|---|---|---|
| Peanut and others | 20.94 | | 3.34 | 69.92 | |
| Traditional Cakes and Snacks | 55.15 | | 0.92 | 50.74 | |
| Glass Noodle, Fried | 10.95 | | 0.45 | 4.93 | |
| Glass Noodle, Soup | 1.87 | | 2.56 | 4.78 | |
| Noodle Wheat Flour Based, Fried | 13.94 | | 3.35 | 46.70 | |
| Noodle Wheat Flour Based, Soup | 10.72 | | 2.56 | 27.43 | |
| Noodle, Rice Flour Based, Fried | 0.96 | | 3.35 | 3.23 | |
| Noodle, Rice Flour Based, Soup | 0.74 | | 2.56 | 1.88 | |
| Wheat Flour Dishes | 12.07 | | 0.13 | 1.57 | |
| Rice Cake With Vegetables | 13.32 | | 5.64 | 75.11 | |
| Rice Porridge | 30.62 | | 0.43 | 13.17 | |
| Fried Rice | 33.29 | | 3.13 | 104.21 | |
| Spicy Steam Rice | 25.89 | | 0.06 | 1.55 | |
| Steam Rice With Fish/Chicken/Beef/Egg/Vegetables | 39.02 | | 0.41 | 16.00 | |
| Spaghetti and others | 6.48 | | 2.47 | 16.01 | |
| French Fries | 3.02 | | 0.44 | 1.33 | |
| Noodle Wheat Flour Based with meat balls, Soup | 35.69 | | 6.51 | 232.31 | |
| **Bakery Wares** | **4.54** | **0.55** | | **5.72** | **0.28** |
| Pizza | 1.75 | | n.d | 0.00 | |
| Burger, Hot Dog | 2.79 | | 2.05 | 5.72 | |
| **Meat and Meat Product including Poultry and Game** | **100.30** | **12.18** | | **215.44** | **10.41** |
| Chicken, Fried, Steamed | 31.21 | | 2.11 | 65.86 | |
| Chicken, Soup | 31.80 | | 3.36 | 106.86 | |
| Chicken, Grilled | 7.88 | | 1.18 | 9.29 | |
| Chicken Offal, Fried, Steamed | 4.19 | | 0.22 | 0.92 | |
| Chicken Offal, Soup | 0.01 | | 3.36 | 0.04 | |
| Beef, Fried, Steamed | 4.13 | | 0.90 | 3.72 | |
| Beef, Soup | 4.26 | | 2.66 | 11.33 | |
| Beef Offal, Fried, Steamed | 2.03 | | 0.90 | 1.83 | |
| Beef Offal, Soup | 1.78 | | 2.66 | 4.73 | |
| Lamb, Fried, Steamed | 0.04 | | 0.90 | 0.03 | |
| Lamb, Soup | 5.60 | | 0.32 | 1.79 | |
| Lamb, Grilled | 2.60 | | 1.18 | 3.06 | |
| Fast Food, meat products | 4.78 | | 1.25 | 5.97 | |
| **Fish and fish Product including Mollusks, Crustaceans, Echinoderms** | **49.91** | **6.06** | | **113.75** | **5.50** |
| Aquacultures Fish | 17.50 | | n.d | 0.00 | |
| Catch fish, Salted | 5.07 | | 3.50 | 17.76 | |
| Catch fish, Unsalted | 18.37 | | 3.42 | 62.82 | |
| Crustaceans, Salted | 0.06 | | 4.87 | 0.29 | |
| Crustaceans, unsalted | 8.36 | | 3.66 | 30.61 | |
| Mollusks, Unsalted | 0.34 | | 3.66 | 1.25 | |
| Fast Food, fish products | 0.20 | | 4.99 | 1.02 | |
| **Eggs and Egg Products** | **28.52** | **28.32** | | **182.48** | **8.82** |
| Eggs, Boiled | 0.72 | | - | 0.00 | |
| Eggs, Fried | 17.21 | | 8.85 | 152.29 | |
| Eggs, Spicy | 10.59 | | 2.85 | 30.19 | |
| **Total Dish Menus** | **710.75** | **86.29** | | **1,813.96** | **87.67** |
| **Total** | **823.82** | **100** | **NA** | **2,068.97** | **100** |

considered were underestimated as it was not included the MSG content in processed foods. In 1991, the average intake of MSG in United Kingdom was 580 mg/day for general population individual and 4.68 g/day for extreme users (Husarova and Ostatnikova, 2013). Estimation done by expert in Germany in a consensus meeting, in EU countries the mean intake ranges from 0.3 to 0.5 g/day; in Asian countries people consume in average 1.2–1.7 g/day (Beyreuther et al. 2007). The individual glutamate intake from food additives shows broad variations; high consumers in Europe may reach up to 1 g/day, in Asian countries 4 g/day. The expert also estimated total intake of glutamate from food in European countries being estimated ranged from 5 to 12 g/day consisting of free glutamate ca. 1 g, protein-bound ca. 10 g, and added as flavor ca. 0.4 g.

Similar to food consumption, the dish menus were the most contributors to free glutamate intake both in Bogor and Jakarta (Table 4, 5) and significantly different with the intake from processed foods (Table 7). Free glutamate intake from dish menus in Jakarta was significantly higher than in Bogor. Within food categories, cereals and cereal products both in processed foods and dish menus were the most contributors to free glutamate intake. These figure correlated with the amount of food consumed under this food categories. Within processed food, ready to eat savories was the second contributor to free glutamate intake.

Within dish menus, cereals and cereal products was the highest contributor to total free glutamate intake both in Bogor and Jakarta and correlated with the amount of food consumed of this category; while the second highest contributor was different between Bogor and Jakarta. In Bogor the second highest contributor to free glutamate intake from dish menus was meat and meat products. Although of meat and meat products in Bogor was lower than consumption of dish menus of fruit and vegetables, however, high content of free glutamate in meat and meat products consumed in Bogor has made this group of food contribute quite significant to free glutamate intake. In Jakarta, the second highest contributor to free glutamate intake from dish menus was fruit and vegetables that correlate with the amount of consumption of this food group.

Of processed foods, food prepared outside home contributed higher to free glutamate intake, in contrast to dish menus in which foods prepared at home contributed higher to free glutamate intake than those prepared outside (Table 6). However, overall in Bogor, free glutamate intake from food prepared outside was comparable with that from food prepared at home. Different figure observed in Jakarta where food prepared at home contributed to free glutamate intake significantly higher than food prepared outside (Table 7). Free glutamate intake from food prepared at home in Jakarta was significantly higher than in Bogor. This figure was consistent with the free glutamate intake from dish menus.

## CONCLUSION

The most frequently consumed food and the highest amount food consumed in Bogor and Jakarta was dish menus of cereals and cereal products, followed by fruits and vegetables dish menus. Dish menus were the highest amount of food consumed in Bogor and Jakarta and consistently provided highest contribution to free glutamate intake in Bogor and Jakarta. In Bogor, respondents consumed more food prepared at home, in contrast to respondent in Jakarta who consumed more foods prepared outside home. Within the dish menus, cereals and cereal products provided the highest contributors to free glutamate intake. Free glutamate intake from foods of respondents in Bogor and Jakarta was almost similar, i.e. 2,013.76 mg/cap/day and 2,068.97 mg/cap/day. Foods prepared at home contributed to free glutamate intake in respondent in Jakarta higher than food prepared outside. However, in Bogor, free glutamate intake from food prepared outside was similar to that of food prepared at home.

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## REFERENCES

Andarwulan N, Nuraida L, Madanijah S, Lioe HN, and Zulaikhah. 2011. Free glutamate content of condiment and seasonings and their intake in Bogor and Jakarta, Indonesia. Food Nutr Sci 2:764-769. DOI: 10.4236/fns.2011.27105.

Association of Official Analytical Chemist (AOAC). 1999. Official Method of Analysis of the Association of Official Analytical Chemist International, 16th Edition, 5th Revision. AOAC International, Gaithersburg, Maryland, USA.

Beyreuther K, Biesalski HK, Fernstrom JD, Grimm P, Hammes WP, Heinemann U, Kempski O, Stehle P, Steinhart H, and Walker R. 2007. Consensus meeting: monosodium glutamate – an update. Eu J Clin Nutr 61:304–313. doi:10.1038/sj.ejcn.1602526.

Codex General Standard for Food Additives (GSFA) Online Database. http://www.codexalimentarius.net/gsfaonline/additives/details.html?id=276.

Federation of American Societies for Experimental Biology (FASEB). 1995. Analysis of Adverse Reaction to Monosodium Glutamate (MSG), Report, Life Sciences Research Office, Federation of American Societies for Experimental Biology, Washington DC.

Freeman M. 2006. Reconsidering the Effects of Monosodium Glutamate: A Literature Review. J Am Acad Nurse Pract. 18(10):482-486.

Geha RS, Beiser A, Ren C, Patterson R, Greenberger PA, Grammer LC, Ditto AM, Harris KE, Shaughnessy MA, Yarnold PR, Corren J, and Saxon A. 2000. Review of alleged reaction to monosodium glutamate and outcome of a multicenter double-blind placebo-controlled study. J Nutr 130:1058S–1062S.

Hardinsyah, Madanijah, S, Sukandar D, Khomsan A, and Heryanto Y. 2005. Individual Dietary Intake of Potential Foods for Vitamin A Fortification. Center for Food and Nutrition Policy Study, Bogor Agricultural University, Ministry of Health, Ministry of Industry and Trade, Unicef Indonesia.

He K, Du S, Xun P, Sharma S, Wang H, Zhai F, and Popkin B. 2011. Consumption of monosodium glutamate in relation to incidence of overweight in Chinese adults:

China Health and Nutrition Survey. Am J Clin Nutr 93(6):1328-36. doi: 10.3945/ajcn.110.008870. Epub 2011 Apr 6.

Husarova V and Ostatnikova D. 2013. Monosodium Glutamate Toxic Effects and Their Implications for Human Intake: A Review. JMED Research. 2013:1-12. doi: 10.5171/2013.608765.

National Agency for Drug and Food Control (Badan Pengawas Obat dan Makanan) RI. Peraturan Kepala Badan Pengawas Obat dan Makanan Republik Indonesia No. 13 Tahun 2013 tentang Batas Maksimum Penggunaan Bahan Tambahan Pangan Penguat Rasa.

Rhys-Williams A, Winfield S, and Belloli R. 1982. Rapid, Specific Method for Diethylstilbestrol Analysis Using an In-Line Photochemical Reactor with High-Performance Liquid Chromatography and Fluorescence Detection. J Chromatograph 235 (2):461-470. doi: 10.1016/S0021-9673(00)85910-5.

Saidin M, Sutarto A, Raoef, R, Soekarno H, Noer S, and Muhilal. 1990. Consumption of Seasoning in Food in Rural Area: A Study as Basic Information for Vitamin A Fortification. J Indones Nutri Associat. 15 (1): 14-22.

Sano C. 2009. History of glutamate production. Am J Clin Nutr. 90 (suppl):728S–32S.

U.S. Department of Health and Human Services. 1995. FDA and Monosodium Glutamate. Food and Drug Administration, FDA Backgrounder. http://vm.cfsan.fda.gov/~lrd/msg.html.

Walker R and Lupien JR. 2000. The Safety Evaluation of Monosodium Glutamate. J Nutr. 130: 1049S–1052S.

JMP08-14-002 - Naskah diterima untuk ditelaah pada 25 Agustus 2014. Revisi makalah disetujui untuk dipublikasi pada 12 September 2014. Versi Online: http://journal.ipb.ac.id/index.php/jmp