Original Article

Dietary exposure to sulfites in Indonesians

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Background and Objectives: Information on dietary exposure to sulfites as preservative in consumer is needed as a scientific base for food safety policy making. The objective of this research was to conduct dietary exposure assessment to sulfites in consumers by using a deterministic method. **Methods and Study Design:** The scope of work was identification of food products containing sulfites, determination of food consumption data from the individual food consumption survey report of 2014, determination of sulfite concentration in food, and calculation of sulfite exposure. **Results:** 3,428 (9%) of 37,613 food products registered in National Agency of Drug and Food Control (2012-2015) may contain sulfite. The most used sulfite in food products was sodium metabisulfite. The mean of food containing sulfite consumption in all age groups was 131.4 g/person/day. The estimation of total exposure for all age groups were 0.27 mg/kgBW/day (38.6% ADI), 0.25 mg/kgBW/day (35.7% ADI) and 0.08 mg/kgBW/day (11.4% ADI) by using concentrations of Maximum Permitted Limit, reported maximum used level and reported maximum product test result, respectively. Food category contributed to the highest exposure in all age groups was spices, condiments, vinegar, powder or mixture for soups and broths, and other soy sauce category. **Conclusions:** The highest total exposure to sulfites was found in 0-59 month age group. The highest total exposure for the MPL (0.79 mg/kgBW/day) and the reported maximum used level (0.73 mg/kgBW/day) exceeded 112.9% ADI and 104.3% ADI, respectively while the exposure using reported maximum test result was still below ADI (0.25 mg/kgBW/day or 35.7% ADI).

Key Words: sulfite, dietary exposure, deterministic, food category, Individual Food Consumption Survey

INTRODUCTION

Sulfites are widely used as food additive. Codex Alimentarius Commission defines sulfites as antioxidant, preservative, bleaching agent, flour treatment agent and sequestrant.[1] Indonesia permits the use of sulfites as a preservative according to The Regulation of Health Minister number 033/2013 on Food Additives. Sulfites in the regulation include sulfur dioxide, sodium sulfite, sodium bisulfite, sodium metabisulfite, potassium metabisulfite, potassium sulfite, potassium bisulfite and calcium bisulfite. The maximum permitted levels (MPLs) of sulfites added to processed foods based on their food category are regulated in The Head of National Agency for Drug and Food Control (NADFC) Regulation Number 36/2013 on the Maximum Limit for Food Preservatives.

Sulfites may cause adverse health reaction to sulfite-sensitive individuals. According to Codex STAN 1-1985 on General Standards for the Labelling of Prepackaged Foods, at least 10 mg/kg of sulfite may cause hypersensitivity thus shall always be declared on the label.[2] To reduce the likelihood that sulfite-sensitive individuals would unknowingly consume food containing sulfites, in the 1980s and 1990s, the use of sulfites in fresh fruits and vegetables (except potatoes) was prohibited by the US Food and Drug Administration and is required to be declared on the labels, eventhough the sulfites are only used as a processing aid or a component of another ingredient in the food.[3]

Dietary exposure assessment is an important element for estimating risk as a science base to support policy making. Some countries have conducted dietary exposure assessment to evaluate daily intake of sulfites by their population. In Indonesia, a dietary exposure assessment of sulfites in food products has not been done. Indonesia conducted an Individual Food Consumption Survey

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(IFCS) nationwide in 2014 and in Total Diet Study in 2015 but the study did not include sulfites as parameters for analysis thus no exposure estimate of sulfites was available yet. Therefore, the objective of this research is to conduct dietary exposure assessment of sulfites to consumer in Indonesia by using consumption data from IFCS and sulfite concentration data from registered food products in NADFC. Deterministic method was applied to conduct the dietary exposure assessment.

METHODS

Identification of processed food products containing sulfites

The number of processed food products registered in NADFC during 2012–2015 was 37,613 items according to the registration data provided by Directorate of Food Safety Assessment of NADFC. The food products which might contain sulfites were identified from the registered products and grouped into two lists. The first list contained data of food products and concentration of sulfites added as preservatives and caramel IV ammonia sulfite process added as colorant in the products formulation. The second list consisted of food products containing sulfite based on certificate of analyses of sulfite submitted by manufacturer. Both lists were combined to obtain a list of food products containing sulfites added intentionally in the product formulation as preservative and a list of products containing sulfites as carry over additive from one or more ingredients of the product.

Determination of food consumption data from IFCS report 2014

Food consumption data used in this study is obtained from the IFCS report in Indonesia. IFCS used 1x24 hour recall method, involving 145,360 respondents. Food consumption data in the IFCS report in Indonesia was presented in 17 food groups as average food consumption per age group namely children 0-59 months, children 5-12 year old, adolescent 13-18 years, adult 19-55 year old, elderly >55 year old and all ages[4]. The data was matched into food categories according to Head of NADFC Regulation Number 21/2016 on Food Category[5] by putting food items and their mean of consumption according to IFCS food group into the most appropriate category of 16 food categories in the Regulation. Mean of food consumption in each age group of the food categories was calculated. The mean of food consumption in the food category allowed to use sulfite as preservative[6] was used for calculation of dietary exposure estimation.

The mean of nutrient intake such as protein, carbohydrate and fat by age group and the proportion to total energy intake of Indonesian population can also be obtained from the IFCS report.

Sulfite concentration in food

Sulfite concentration data for exposure estimation were categorized into three groups namely (1) MPL, (2) reported maximum used concentration and (3) reported maximum sulfite test result in food product.

MPL of sulfites is available in the Regulation of Head NADFC Number 36/2013 on the Maximum Limit for the Use of Food Preservatives. Reported maximum used concentration and reported maximum test result of sulfites in the food products were identified and inventoried from database of registered processed food products containing sulfite. List of food products containing sulfites as preservative which have data of used concentration and product test result of sulfite and list of products containing carried-over sulfite which only have final product test result were mapped into the food category. The data in both lists were analyzed to obtain maximum sulfite concentration in food products in each food category. The reported maximum used concentration of sulfites in each food category was obtained by analyzing the list of food products to which sulfites added as preservative, while the reported maximum test result of sulfites in the final product in food category was selected from the list of food products to which sulfites added as preservative and the list of products containing sulfite as carry over.

Calculation of exposure to sulfite using deterministic method

Sulfites intake was determined by deterministic method using their concentrations in the aforementioned three scenarios. The estimation of dietary exposure to sulfite in each food category was calculated by using formula as follows.[7]

Sulfites exposure (mg/kg/day) = (∑(concentration of sulfites in food (mg/kg) × food consumption (kg/day))) / "body weight (kg)"

The mean of body weight used in the exposure calculation was categorized based on age groups, namely 11.7 kg for 0-59 month old children, 27.5 kg for 5-12 year old children, 46.3 kg for 13-18 year old adolescent, 57.9 kg for 19-55 year old adult, 52.3 kg for >55 year old elderly and 50.8 kg for all ages.

Hazard Index (HI) was determined by calculating the ratio of sulfite exposure in each food category to sulfite Acceptable Daily Intake (ADI), 0.7 mg/kgBW,[8] according to the following equation:[9]

HI = [(Estimation Dietary exposure (mg/kgBW)) / Acceptable Daily Intake (mg/kgBW)] × 100%.

RESULTS

Processed food products containing sulfites

The number of processed food registered in NADFC during 2012–2015 was 37,613 products of which 3,428 (9%) of the registered products may contain sulfites. Sulfites in processed food products came from sulfites as preservatives, caramel IV ammonia sulfite process as colorant, carried-over sulfite from ingredient, and both carried-over sulfite and caramel IV ammonia sulfite process (Figure 1).

The use of sulfites as preservative was found in 704 registered food products. The types of sulfite used as preservatives in processed food products in Indonesia were sodium metabisulfite, potassium metabisulfite, sodium bisulfite, sodium sulphite, potassium bisulfite and potassium sulfite. Sodium metabisulfite (78%) and potassium metabisulfite (19%) were two major sulfites used as preservative in the food products. The number and percentage of processed food products using each type of sulfite preservative is shown in Figure 2.

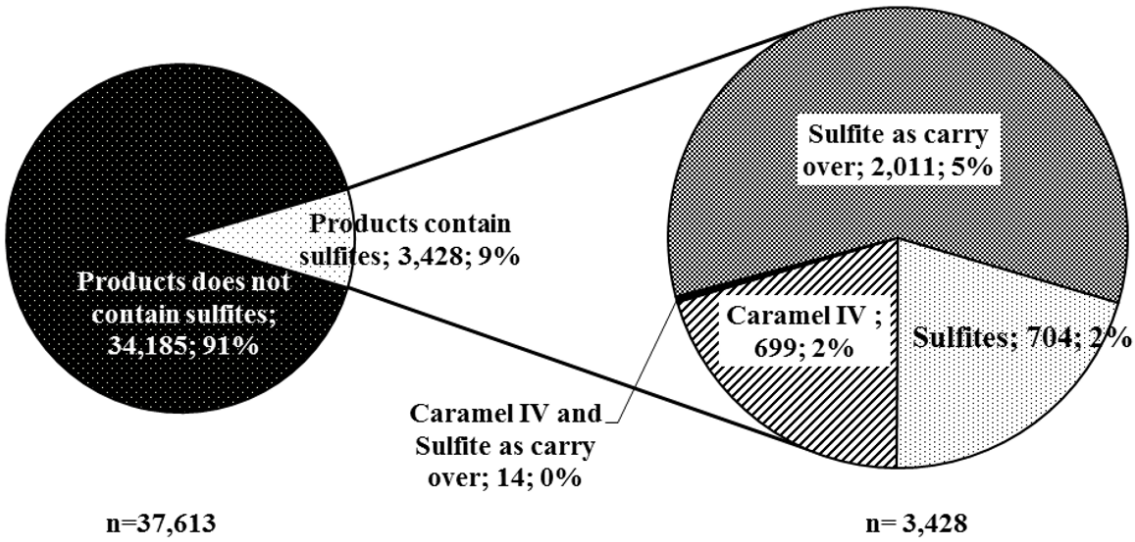

Figure 1. The amount and percentage of registered processed food products during 2012-2015 containing sulfites and its sources.

Food consumption

The matching between mean of food consumption from IFCS and food categories in which sulfite is allowed to use as preservative in food for all age groups is presented in Table 1. The matched list was divided into 13 food groups for exposure calculation purpose. The mean of total of food consumption for all age group was 131.4 g/person/day. The highest mean of total food consumption was 201.8 g/person/day in the 5-12 year age group.

The top five of food categories with the highest mean of food consumption for all age group were (1) pre-cooked pastas and noodles and like products, (2) concentrate (liquid or solid) for water-based flavored drinks, (3) seasonings and condiments, vinegars, mixer for soups and broths, and other soybean sauces, (4) cooked fish and fish products, and fully preserved (canned or fermented, including molluscs, crustaceans and echinoderms, fish and fishery products), and (5) cooked and fried vegetables and seaweeds.

The mean of protein, carbohydrate and fat intake from IFCS report is represented in Table 2. The highest mean of protein and carbohydrate intake were found in 19-55 year old group namely 65.0 g/person/day and 256.8 g/person/day, respectively while the highest mean of fat intake was found in 5-12 year and 13-18 year old group namely 56.8 g/person/day and 56.7 g/person/day, respectively.

Sulfite concentration in food

Sulfites concentration data used in the exposure assessment for each scenario is presented in Table 3. The maximum test result of sulfites in food product in all food categories was still below MPL. The maximum concentration of sulfites used by producers is high in 3 food categories namely crackers (excluding sweet crackers), cakes, cookies, pies (fruit filled or custard, vla), category of seasonings and condiments, vinegars, mixer for soups and broths, and other soybean sauces and category of

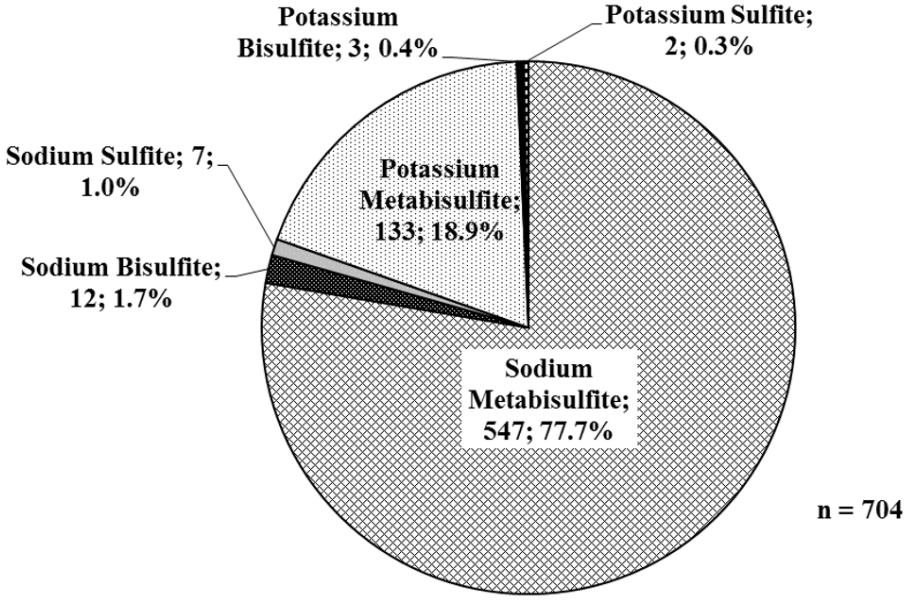

Figure 2. The amount and percentage of sulfite preservatives types added to the registered processed food products during 2012-2015.

Table 1. The matching between mean of food consumption suspected to contain sulfite from IFCS 2014 and food category (NADFC 2014) based on age groups

IFCS food groups	Food category	Consumption per age group (g/person/day)					
		0-59 months	5-12 years	13-18 years	19-55 years	>55 years	All ages
Sugar and confectionary (honey, jams, jellies)	04.1.2.5 Jams, jellies and marrmelades	4.1	4.8	2.1	0.5	0.4	1.2
Tubers and tuber products (cassava and cassava products)	04.2.2.8 Cooked vegetables and seaweeds	5.0	10.5	11.4	10.9	12.7	10.9
Sugar and confectionary (candy)	05.2.2 Soft candy	1.2	1.1	0.4	0.1	0.0	0.3
Cereals and cereal products (wheat flour products, other types cereal)	06.3 Breakfast cereals, including rolled oats	17.4	19.2	11.6	8.3	7.7	10.2
Cereals and cereal products (noodles)	06.4.3 Pre-cooked pastas and noodles and like products	19.9	50.4	55.5	30.6	11.2	32.6
Cereals and cereal products (wheat flour products)	07.1.2 Crackers (excluding sweet crackers); 07.2.1 Cakes, cookies, pies (fruit filled or custard, vla)	15.2	16.9	11.5	8.1	7.5	9.6
Meat and meat products (Poultry, cow, buffaloes, pigs meat products)	08.3.2 Heat treated processed comminute meat, poultry, and game products	8.9	12.6	10.5	6.4	2.5	7.2
Fish and fish products (fish products, shrimp, crab and crab products, squid, clams, snails and snail products)	09.2.4.1 Cooked fish and fish products; 09.4 Fully preserved (canned or fermented, including molluscs, crustaceans and ecinoderms, fish and fishery products)	5.1	10.1	10.7	13.8	12.1	12.5
Instant seasoning, dry seasoning, wet seasoning	12.2.2 Seasonings and condiments; 12.3 Vinegars; 12.5.2 Mixer for soups and broths; 12.9.2.3 Other soybean sauces	7.6	13.7	15.1	17.8	16.6	16.5
Oils, fats and fat products (others oils, fats and fat products), legumes and legume products (peanuts and peanut products)	12.6.2 Non-emulsified sauces (e.g. ketchup, cheese sauce, cream sauce brown gravi)	1.4	2.9	2.9	3.1	2.2	2.8
Sugar and confectionary (Syrup), Beverages (Beverage powder, liquid packing and others)	14.1.4.3 Concentrate (liquid or solid) for water-based flavored drinks	33.1	56.4	43.2	17.0	4.7	23.2
Beverages (alcoholic beverages)	14.2. Alcoholic beverages (including alcohol free and low alcohol counterparts)	0.0	0.02	0.4	1.3	0.9	1.0
legumes and legume products (peanuts and peanut products, other beans and other bean products)	15.2 Processed nuts, including coated nuts and nut mixtures (with e.g. dried fruit)	1.7	3.2	3.3	3.8	3.1	3.4
Total of food consumption that may contain sulfites		120.6	201.8	178.6	121.7	81.6	131.4
Total of food consumption per day		1162.3	1680.5	1853.1	2157.8	1916.3	2000.4
% food consumption that may contain sulfites		10.4	12.0	9.6	5.6	4.3	6.6

Table 2. Mean intake of protein, carbohydrate, and fat of Indonesia's population based on age groups[4]

No	Age groups	Average intake (g/person/day)		
		Protein	Carbohydrate	Fat
1	0-59 months	36.8	148.0	41.9
2	5-12 years	57.3	230.3	56.8
3	13-18 years	59.8	244.2	56.7
4	19-55 years	65.0	256.8	54.4
5	>55 years	55.9	225.2	43.4
6	All ages	61.2	243.9	52.9

Table 3. Mean intake of protein, carbohydrate, and fat of Indonesia's population based on age groups[4]

No	Food category	Sulfite consentration as SO_2 (mg/kg)		
		Maximum permitted level[†]	Reported maximum use level	Reported maximum product test result
1	Jams, jellies and marrmelades	100	6.7	6.6
2	Cooked vegetables and seaweeds	200	16.0	18.8
3	Soft candy	100[‡]	NA[§]	1.6
4	Breakfast cereals, including rolled oats	70[¶]	NA	20.7
5	Pre-cooked pastas and noodles and like products	20	11.1	9.2
6	Crackers (excluding sweet crackers), cakes, cookies, and pies (fruit filled or custard, vla)	50	232.4	10.7
7	Heat treated processed comminute meat, poultry, and game products	20[††]	NA	1.7
8	Cooked fish and fish productsand fully preserved (canned or fermented, including molluscs, crustaceans and ecinoderms, fish and fishery products)	200	6.7	8.6
9	Seasonings and condiments, vinegars, mixer for soups and broths, and other soybean sauces	300	576.6	198.4
10	Non-emulsified sauces (e.g. ketchup, cheese sauce, cream sauce brown gravi)	300	269.5	73.6
11	Concentrate (liquid or solid) for water-based flavored drinks	40[††]	0.7	12.8
12	Alcoholic beverages (including alcohol free and low alcohol counterparts)	50	230.6	49.9
13	Processed nuts, including coated nuts and nut mixtures (with e.g. dried fruit)	100[§§]	NA	7.5

[†]Head Regulation of National Agency for Drug and Food Control Number 36/2013 on the Maximum Limit for Food Preservatives.
[‡]Assumed to use the maximum limit of food category decorations (e.g. for fine bakery wares), toppings (non-fruit) and sweet sauce.
[§]Maximum reported use level of sulfite not available.
[¶]Assumed to use the maximum limit of food category flours and starchs.
[††]Sulfites are thought to come from sugar as raw materials so the maximum limit follows the food category soft white sugar, soft brown sugar, glucose syrup, dried glucose syrup, raw cane sugar.
[‡‡]Sulfites are thought to come from sugars in the form of syrup as raw materials so that the maximum limit follows the food category other sugar and syrup.
[§§]Assumed to use the maximum limit of food category 04.1.2.2 Dried fruits.

alcoholic beverages (including alcohol free and low alcohol counterparts).

Dietary exposure to sulfites

The exposure of sulfites in all age groups is presented in Table 4, while the HI of exposure to sulfite, express as percentage to ADI, is shown in Figure 3. The total exposure of sulfite in all age groups using the MPL, the reported maximum use level and the reported maximum products test result were 0.27 mg /kg BW/day (38.6% ADI), 0.25 mg/kg BW/day (35.7% ADI) and 0.08 mg/Kg BW/day (11.4% ADI), respectively.

The highest total exposure for all scenarios was found in the 0-59 month old group namely 0.79 mg/kg BW/day (112.9% ADI) for the maximum permitted sulfite level, 0.73 mg/kg BW/day (104.3% ADI) for the reported maximum use level and 0.25 mg/kg BW/day (35.71% ADI) for the reported maximum products test result.

Potential food categories that contribute to the highest sulfites intake in all ages and level of concentrations were seasonings and condiments, vinegars, mixer for soups and broths, and other soybean sauces. Cooked fish and fish products as well as the fully preserved products (canned or fermented of molluscs, crustaceans and echinoderms, fish and fishery products) and cooked and fried vegetables and seaweed categories contributed to high sulfites exposure using the maximum permitted sulfite level. While food categories contribute to high sulfites exposure by using reported maximum use level in the exposure calculation were crackers (excluding sweet crackers), cakes, cookies, pies (fruit filled or custard, vla). High sulfite exposure using reported maximum products test

Table 4. Sulfites exposure uses MPL, reported maximum use level and reported maximum products test result based on age group

No	Food category	Sulfites exposure uses maximum permitted level per age groups (mg/kg BW/day)						Sulfites exposure uses reported maximum use level per age groups (mg/kg BW/day)					
		0-59 months	5-12 years	13-18 years	19-55 years	>55 years	All ages	0-59 months	5-12 years	13-18 years	19-55 years	>55 years	All ages
1	Jams, jellies and marrmelades	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Cooked vegetables and seaweeds	0.09	0.08	0.05	0.04	0.05	0.04	0.01	0.01	0.00	0.00	0.00	0.00
3	Soft candy	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Breakfast cereals, including rolled oats	0.10	0.05	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
5	Pre-cooked pastas and noodles and like products	0.03	0.04	0.02	0.01	0.00	0.01	0.02	0.02	0.01	0.01	0.00	0.01
6	Crackers (excluding sweet crackers), cakes, cookies, and pies (fruit filled or custard, vla)	0.06	0.03	0.01	0.01	0.01	0.01	0.30	0.14	0.06	0.03	0.03	0.04
7	Heat treated processed comminute meat, poultry, and game products	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Cooked fish and fish productsand fully preserved (canned or fermented, including molluscs, crustaceans and ecinoderms, fish and fishery products)	0.09	0.07	0.05	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
9	Seasonings and condiments, vinegars, mixer for soups and broths, and other soybean sauces	0.19	0.15	0.10	0.09	0.10	0.10	0.37	0.29	0.19	0.18	0.18	0.19
10	Non-emulsified sauces (e.g. ketchup, cheese sauce, cream sauce brown gravi)	0.04	0.03	0.02	0.02	0.01	0.02	0.03	0.03	0.02	0.01	0.01	0.01
11	Concentrate (liquid or solid) for water-based flavored drinks	0.11	0.08	0.04	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
12	Alcoholic beverages (including alcohol free and low alcohol counterparts)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
13	Processed nuts, including coated nuts and nut mixtures (with e.g. dried fruit)	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.79	0.57	0.32	0.25	0.24	0.27	0.73	0.49	0.28	0.24	0.22	0.25

Table 4. Sulfites exposure uses MPL, reported maximum use level and reported maximum products test result based on age group (cont.)

No	Food category	Sulfites exposure uses reported maximum products test result per age groups (mg/kg BW/day)					
		0-59 months	5-12 years	13-18 years	19-55 years	>55 years	All ages
1	Jams, jellies and marrmelades	0.00	0.00	0.00	0.00	0.00	0.00
2	Cooked vegetables and seaweeds	0.01	0.01	0.00	0.00	0.01	0.00
3	Soft candy	0.00	0.00	0.00	0.00	0.00	0.00
4	Breakfast cereals, including rolled oats	0.03	0.01	0.01	0.00	0.00	0.00
5	Pre-cooked pastas and noodles and like products	0.02	0.02	0.01	0.01	0.00	0.01
6	Crackers (excluding sweet crackers), cakes, cookies, and pies (fruit filled or custard, vla)	0.01	0.01	0.00	0.00	0.00	0.00
7	Heat treated processed comminute meat, poultry, and game products	0.00	0.00	0.00	0.00	0.00	0.00
8	Cooked fish and fish productsand fully preserved (canned or fermented, including molluscs, crustaceans and ecinoderms, fish and fishery products)	0.00	0.00	0.00	0.00	0.00	0.00
9	Seasonings and condiments, vinegars, mixer for soups and broths, and other soybean sauces	0.13	0.10	0.06	0.06	0.06	0.06
10	Non-emulsified sauces (e.g. ketchup, cheese sauce, cream sauce brown gravi)	0.01	0.01	0.01	0.00	0.00	0.00
11	Concentrate (liquid or solid) for water-based flavored drinks	0.04	0.03	0.01	0.00	0.00	0.01
12	Alcoholic beverages (including alcohol free and low alcohol counterparts)	0.00	0.00	0.00	0.00	0.00	0.00
13	Processed nuts, including coated nuts and nut mixtures (with e.g. dried fruit)	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.25	0.19	0.1	0.07	0.07	0.08

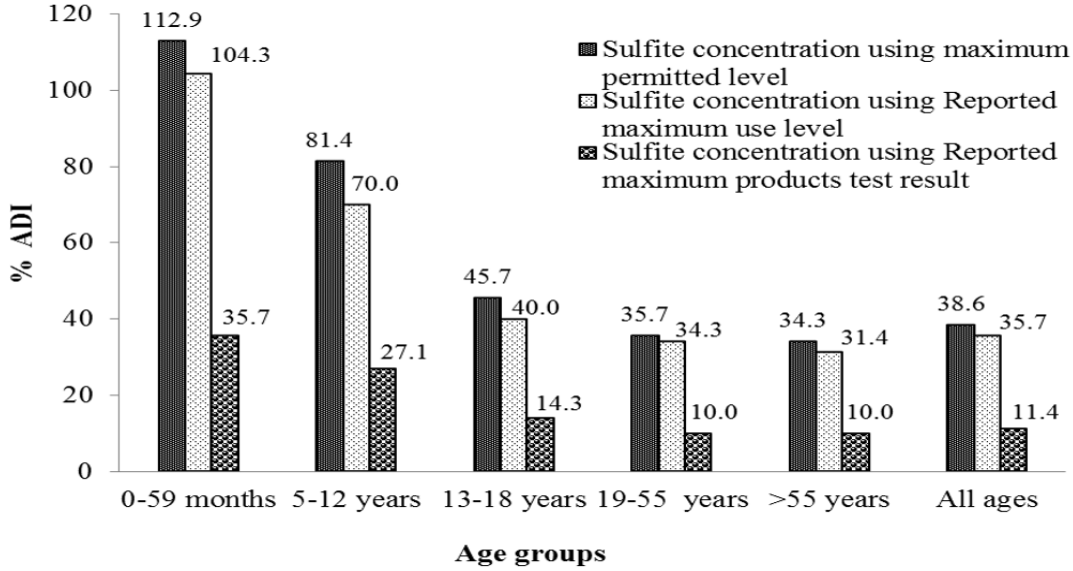

Figure 3. Percentage of exposure was compared with ADI sulfite in all age groups and concentrations.

result was given by concentrates (liquid or solid) for water-based flavored drinks and pre-cooked pastas and noodles and like products.

DISCUSSION

As many as 704 (20.5%) of 3,428 registered food products that may contain sulfite used sulfites as preservative. Sodium metabisulfite was the most widely used sulfite (78%) as preservative in those foods. This information is very useful for setting sulfite control priorities. More concern should be given on monitoring of the sodium metabisulfite in food.

The mean of food consumption that may contain sulfites in all age groups was 131.4 g which equal to 6.6% of the 2000.4 g mean of national food consumption. Food category with the highest mean of consumption for all age groups was pre-cooked pastas and noodles and like products (32.6 g). As comparison, consumption of instant noodles per capita per year in Indonesia was 1.24 servings (86.8 g) according to National Statistics of food consumption 2015.[10] Flours (6.60 g), sugar (5.03 g) and orange juice (4.49 g) showed the highest mean of food containing sulfite consumption in Korea according to Korean National Health and Nutrition Survey for all ages.[11]

The maximum reported sulfite concentration according to the products test result in all food categories is still below the MPL. The maximum reported sulfite used was high in 3 food categories, but the sulfites analysis in the final products showed decrease of sulfites concentration so that it does not exceed the MPL. The decrease was likely due to loss of sulfite during processing and storage of food products. Dried vegetables, to which may be added up to 5,000 mg/kg of sulfites, would have much lower sulfite concentration in the final product because of dehydration and cooking before consumption.[12]

Total sulfite exposure using MPL and reported maximum use level compared to ADI sulfite were not exceeding ADI except for the age group 0-59 month old. The exceeding ADI exposure in this group is due to high food containing sulfite consumption and low body weight of 0-59 month old consumer. In accordance with this, sulfites exposure in China using combination of food intake at P97.5 and the MPL of sulfites in food for 1-3 and 4-6 year old age groups also exceeded ADI of sulfite (106.2%-150.4%).[13] High sulfite exposure in infants and toddlers (1-3 years) using the MPL of sulfite occurred in Europe too which showed dietary exposure to sulfite 1.33-6.92 mg/kg BW/day or equal to 190%-988.6% ADI.[14] In New Zealand, daily exposure of sulfite exceeding ADI was found in the young (5-12 year old). Sulfites exposure in the 95th percentile consumers of 5–12 year-old males and females exceeded the ADI, while the exposure in respondents (total population) exceeded ADI in 5–12-year-old males.[15] In addition to those sulfite exposure using MPL and maximum usage level, sulfite exposure using reported maximum products test result compared to ADI sulfite for all age groups in Indonesia was below 100%.

High sulfite concentrations and food consumption levels were the primary factors for seasonings and condiments, vinegars, mixer for soups and broths, and other soybean sauces became the highest contributing sulfite intake in all age groups and all concentrations. These categories contributed to 37.0%, 76.0% and 75.0% of sulfite exposure using MPL, reported maximum use level and reported maximum products test result, respectively. In Europe, the main food categories that contributed to sulfite exposure for under five year old children were uncooked processed potatoes and dried fruits and vegetables whilst for other groups of youth and teenagers were dried fruit and vegetables and fruit and vegetable juices. As for adults and elderly, meat and wine were the main source of sulfites dietary exposure.[14] High sulfite exposure in New Zealand was contributed by sausages or dried fruits for young age groups and dried fruits and wine for adult group.[15] Wine is the main food that contributes to sulfite exposure to consumers in Korea for the 95th percentile[13] and wine and dried berries are the main contributors to sulfite exposure for the highest intake scenario in Austria.[16]

In this study, dietary exposure was calculated using the maximum concentration of sulfite to reflect the worst

case scenario. The level of exposure by using reported maximum products test result was below ADI thus the exposure estimate using more complex methods became unnecessary.[8]

Conclusions

The highest mean of total consumption of foods that may contain sulfite was found in the 5-12 year old age group. The reported maximum products test result concentration in all food categories was still below the MPL of sulfite. Total mean sulfite dietary exposure in all age groups using all scenarios of sulfite concentration in food did not exceed ADI except for the age group 0-59 months old using MPL and reported maximum use level. The highest sulfite exposure at all concentrations occurred in the 0-59 month old group. Food categories that contributed to the highest exposure in all age groups were seasonings and condiments, vinegars, mixer for soups and broths, and other soybean sauces.

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AUTHOR DISCLOSURES

The authors declare that they have no competing financial interests and that their freedom to design, conduct, interpret, and publish research is not compromised by any controlling sponsor.

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