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Risk Analysis of Sulfites Used as Food Additives in China*

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This study was to analyze the risk of sulfites in food consumed by the Chinese people and assess the health protection capability of maximum-permitted level (MPL) of sulfites in GB 2760-2011. Sulfites as food additives are overused or abused in many food categories. When the MPL in GB 2760-2011 was used as sulfites content in food, the intake of sulfites in most surveyed populations was lower than the acceptable daily intake (ADI). Excess intake of sulfites was found in all the surveyed groups when a high percentile of sulfites in food was intaken. Moreover, children aged 1-6 years are at a high risk to intake excess sulfites. The primary cause for the excess intake of sulfites in Chinese people is the overuse and abuse of sulfites by the food industry. The current MPL of sulfites in GB 2760-2011 protects the health of most populations.

According to Codex Alimentarius, risk analysis is a structural decision-making process consisting of risk assessment, risk management and risk communication which are interactive and interwoven with each other. Risk assessment and other factors for the health protection of consumers and all interested parties should be considered for food management process to select appropriate prevention and control measures. Apart from the interactive exchange of information and opinions among the participants and other interested parties, it is important to explain the risk assessment findings and the basis of risk management decisions to the public[1-2].

Food additives are synthetic chemicals or natural substances added to food for prolonging its preservation or improving its flavor, taste or appearance[3]. Sulfites refer to a series of multifunctional food additives, which are widely used in food industry as antioxidants, decolourants, flour treatment agents and preservatives. Sulfites approved as food additives in China include sulfur dioxide, potassium metabisulfite, sodium metabisulfite, sodium sulfite, sodium hygrogen bisulfite, and sodium hydrosulfite[3]. Sulfur dioxide is usually used to indicate the sulfite content in food[4].

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) reevaluated the dietary intake of sulfites at its 69th session, during which it was concluded that the dietary intake of sulfites in populations may exceed the ADI[4]. According to the National Food Safety Standard for Uses of Food Additives (GB 2760-2011), the usage of food additives should not be harmful to human health[3]. Therefore, the risk of sulfites used as food additives under current conditions must be assessed to provide information for the management of potential risks.

Risk assessment based on scientific knowledge consists of hazard identification, hazard characterization, exposure assessment and risk characterization[1]. As different dietary patterns may lead to different intake levels, the dominant sulphite sources for different Chinese population groups also need to be assessed respectively to support their specific management.

Point estimate is widely employed in the assessment of dietary exposure. If a rough estimate of dietary exposure among the surveyed populations is higher than the ADI or the provisional tolerable weekly intake (PTWI), more refined assessment methods such as point estimate are applied in further analysis. Point estimate uses the mean, median and high percentile values of the survey data or the maximum permitted level (MPL) of the target material proposed by national or international food authorities to estimate the dietary exposure in a certain population. It is comparatively accurate and easy to handle and is thus preferred by EFSA in modeling high consumers[5].

In the present study, the risk of sulfites in food was analyzed with food additive risk assessment techniques. The intake pattern of sulfites in different Chinese populations was estimated according to the Chinese dietary consumption pattern data and the

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actual sulfite content in food. The assessment was discussed and compared to the regulatory limits for sulfites in other countries with suggestions put forward for the risk management of sulfites in China.

Data Resources The dietary intake data of the 2002 China nutrition and health survey (CHNS) were used in this study. The survey was composed of inquiry, medical examination, laboratory tests and dietary survey. Of the 272 023 individuals included in this survey, 68 962 from 23 463 families (7 683 from urban areas) of 132 counties or areas participated in the dietary survey. A 3-day food intake was investigated in each family using the 24 h dietary recall method. The data of daily food intake in individuals were obtained using the information about both eating outside and at home[6].

The data of sulfites in different foods used in this study were derived from the national contaminant monitoring system (2003 to 2007)[7]. Intake of sulfites was assessed using the MPL of sulfites in GB 2760-2011 National Food Safety Standards for Uses of Food Additives.

Body weight from the 2002 CHNS was also used in this study[6].

Risk Assessment Method Hazard identification and hazard characterization have been applied in the assessment of food additives by JECFA for many years. The findings in their study are related to different races, genders and ages around the world. As a result, developing countries are able to rely on the determinations made by JECFA and do not necessarily set their own ADI or PTWI for food additives evaluated by JECFA[8]. The 17th Session of JECFA set the ADI for sulfite as 0-0.7 mg/kg·bw according to its evaluations[9]. Hazard identification and hazard characterization of sulfites reported by JECFA were used in this study.

Exposure assessment of dietary intake is the qualitative and/or quantitative evaluation of the likely intake of biological, chemical and physical agents via food, and exposures to other sources. It considers both food consumption data and food additive levels in food[5]. For this reason, the exposure assessment is closely related to the consumption patterns, thus varying significantly among different population groups. The surveyed populations in this study were divided into 1-3 years old group, 4-6 years old group, 7-10 years old group, 11-14 years old male group, 11-14 years old female group, 15-17 years old male group, 15-17 years old female group, 18+ years old male group, and 18+ years old female group according to their age and gender. Relative data about the 9 groups were further analyzed respectively. The exposure to sulfites in the 9 groups was assessed using the point estimate method.

The exposure values to sulfites in different groups were calculated according to the following formula:

$$y=\sum_{k=1}^{p} x_k \cdot c_k / \overline{w}$$

Where y means the daily intake of sulfites in a specific group, x_k indicates the daily consumption of food, c_k refers to the sulfites in food, w is the average body weight.

The average daily intake of each kind of food in each population group was calculated using the SAS statistical software. The average sulfite content and the P50, P95, P97.5 value in different foods were computed by EXCEL 2007 using the data from the national contaminant monitoring system (2003 to 2007). In order to address all possible exposure scenarios for each kind of foods, the average value and the P50, P95, P97.5 value of daily food intake were multiplied by those of sulfite content to represent different consumption patterns.

Moreover, the ratio of sulfite intake in each food category was calculated by dividing the intake of each food category for assessing the contribution of each kind of foods to the total intake of sulfites.

Risk characterization is described as the qualitative and/or quantitative estimation of attendant uncertainties, probability of occurrence and severity of known or potential adverse health effects in a given population based on hazard identification, hazard characterization and exposure assessment[10]. If the ADI or PTWI determined from the hazard characterization is larger than the total sulfite intake in a particular population group determined from the exposure assessment, the safety of this kind of additives is not concerned[8-9].

Sulfite Content The sulfite content in different foods is listed in Table 1. The sulfite content in compotes, dried vegetables, pickled vegetables, dried edible fungi, edible fungi and algae cans and rice-flour products permitted to use sulfites as food additives, exceeded the permitted level in the standard. The mean value of sulfite content in dried edible fungi and edible fungi and algae cans was even higher than the MPL in GB 2760-2011[3].

Sulfites were found in several kinds of food in which sulfites are not permitted, such as nuts and seeds, steamed bread and fresh edible fungi. For example, the maximum and average sulfite content in nuts and seeds was 18.07 g/kg and around 0.55 g/kg, respectively. Overuse and abuse of sulfites are shown in Table 1.

Risk Assessment Sulfites refer to a series of chemical materials, but only several of them are certified as food additives. When sulfites enter the human body, sulfite oxidase in cells oxidizes them into sulphates and then eliminates them through urine[11]. As a result, a certain amount of sulfites can be safely consumed. However, the consumption of sulfites may cause asthma in susceptible individuals[12-13]. Excess intake of sulfite may have severe adverse effects on human health[10].

The dietary intake of sulfites in the 9 groups is shown in Table 2. The main sources of sulfites were also studied, and the top 3 foods that contributed most with food intake P97.5-sulfites content P97.5 (hereinafter referred to as P97.5-P97.5) are listed in Table 3.

According to Tables 2 and 3, the intake of sulfites in 1-3 years old group exceeded the ADI at the P95-P97.5, P97.5-P95, P97.5-P97.5, and P97.5-MPL combinations at the nationwide level. The surveyed urban populations consumed more sulfites than rural populations under most consumption patterns. In addition, the intake of sulfites of P95-P95, P97.5-mean combinations also exceeded the ADI in urban populations. The main source of sulfites was biscuits.

The intake of sulfites exceeded the ADI at the P95-P97.5, P97.5-P95, P97.5-P97.5, and P97.5-MPL combinations in 4-6 years old group with a minimum intake of sulfites accounted for only 1.6% of the ADI. Generally, urban populations consumed more sulfites than rural populations. The main source of sulfites in this group was edible fungi. Urban people preferred to nuts and seeds while rural populations preferred to pickled vegetables.

Children aged 7-10 years consumed excess sulfites at P95-P95, P95-97.5, P97.5-P95, and P97.5-P97.5 consumption patterns, especially through edible fungi. The sources of sulfites in food varied significantly in people from different regions.

The intake of sulfites of P95-P97.5, P97.5-P95, and P97.5-P97.5 exceeded the ADI in 11-14 years old male group. As shown in Table 2, the urban populations consumed more sulfites than rural populations. The main sources of sulfites were dried edible fungi, nuts and seeds, fresh edible fungi for urban boys, and fresh edible fungi, pickled vegetables and steamed bread for rural boys.

Table 1. Sulfite Content (Expressed as Sulfur Dioxide) in Different Foods (g/kg)

Food	Sample Size	Mean	Standard Deviation	P50	P95	P97.5
Dried edible fungi	8	0.9054	1.3511	0.0260	3.0820	3.2220
Nuts and seeds	843	0.5525	1.6133	0.0150	3.1980	4.2890
Compotes	96	0.3150	0.7949	0.0495	1.1275	1.7250
Edible fungi and algae cans	210	0.1695	0.4283	0.0208	1.0355	1.7578
Fresh edible fungi	855	0.1386	0.8283	0.0061	0.6530	1.1465
Dried vegetables	30	0.0325	0.1431	0.0000	0.0680	0.3435
Pickled vegetables	785	0.0303	0.1428	0.0031	0.0980	0.2100
wine	453	0.0227	0.0302	0.0120	0.0804	0.0988
sugar	60	0.0164	0.0065	0.0170	0.0261	0.0281
Bean products	44	0.0148	0.0232	0.0060	0.0479	0.0499
Starch	35	0.0137	0.0068	0.0056	0.0135	0.0185
Steamed bread	20	0.0099	0.0060	0.0091	0.0203	0.0232
Biscuits	60	0.0062	0.0022	0.0050	0.0092	0.0096
Rice-flour products	18	0.0060	0.0175	0.0000	0.0295	0.0508
Fruit wine	41	0.0051	0.0063	0.0030	0.0200	0.0200
Juice	10	0.0042	0.0033	0.0049	0.0085	0.0088
Nuts and seeds cans	50	0.0000	0.0000	0.0000	0.0000	0.0000
Vermicelli and noodles made from bean or sweet potato starch	32	0.0000	0.0000	0.0000	0.0000	0.0000
Semi-solid compound seasoning	76	0.0000	0.0000	0.0000	0.0000	0.0000

Table 2. Daily Dietary Intake of Sulfites in Different Groups (mg/kg bw/d)

Group (age-gender-region)	Mean-mean*	Mean-P90	Mean-P95	Mean-P97.5	Mean-MPL	P95-mean	P95-P50	P95-P95	P95-P97.5	P95-MPL	P97.5-mean	P97.5-P50	P97.5-P95	P97.5-P97.5	P97.5-MPL
1-3-nationwide	0.0741	0.0121	0.3036	0.4428	0.0945	0.1881	0.0629	0.6775	1.1385	0.5576	0.3723	0.1124	1.3421	2.3423	1.0527
1-3-urban	0.1157	0.0155	0.4960	0.6920	0.1401	0.4395	0.0589	1.6987	2.2752	0.5383	1.5270	0.1279	6.7746	9.2532	1.4700
1-3-rural	0.0638	0.0112	0.2556	0.3805	0.0831	0.1983	0.0682	0.7113	1.1921	0.4790	0.4485	0.1120	1.7376	2.9801	0.9561
4-6-nationwide	0.0768	0.0115	0.3085	0.4311	0.0609	0.1603	0.0602	0.5495	0.9284	0.2821	0.6559	0.1091	2.3055	3.3412	0.7437
4-6-urban	0.1162	0.0134	0.4550	0.6285	0.0821	0.6012	0.0661	2.1354	3.0892	0.6066	1.5183	0.1124	6.0538	8.3663	0.9987
4-6-rural	0.0676	0.0111	0.2741	0.3849	0.0559	0.1032	0.0636	0.2650	0.4211	0.1947	0.3074	0.1055	1.0859	1.8361	0.6161
7-10-nationwide	0.0629	0.0109	0.2426	0.3495	0.0499	0.2005	0.0667	0.7186	1.2283	0.2261	0.4644	0.0963	1.6818	2.7287	0.5405
7-10-urban	0.0994	0.0109	0.3907	0.5420	0.0642	0.5426	0.0527	1.9562	2.7628	0.3798	1.1725	0.0874	4.8751	6.6913	0.6535
7-10-rural	0.0528	0.0110	0.2015	0.2960	0.0459	0.1628	0.0728	0.5150	0.8626	0.1831	0.3387	0.0997	1.2703	2.1733	0.3960
11-14-male-nationwide	0.0490	0.0087	0.1870	0.2641	0.0347	0.1411	0.0519	0.4924	0.8322	0.1581	0.3568	0.0719	1.2746	1.9902	0.3499
11-14-male-urban	0.0753	0.0088	0.2996	0.4057	0.0425	0.3170	0.0473	1.1215	1.5575	0.2862	1.0459	0.0729	4.1252	5.3398	0.4674
11-14-male-rural	0.0408	0.0087	0.1521	0.2203	0.0323	0.1244	0.0531	0.4025	0.6774	0.1169	0.2411	0.0757	0.8859	1.5140	0.2751
11-14-female-nationwide	0.0453	0.0080	0.1717	0.2452	0.0359	0.1310	0.0441	0.4669	0.7983	0.1600	0.2874	0.0703	0.9881	1.6332	0.3821
11-14-female-urban	0.0598	0.0080	0.2234	0.3225	0.0534	0.2108	0.0352	0.7567	1.2265	0.3390	0.5833	0.0546	2.0377	2.9430	0.5334
11-14-female-rural	0.0411	0.0080	0.1566	0.2226	0.0308	0.0814	0.0504	0.2062	0.3301	0.0889	0.1795	0.0666	0.5960	1.0620	0.2738
15-17-male-nationwide	0.0432	0.0079	0.1631	0.2298	0.0288	0.1234	0.0396	0.4488	0.7669	0.1514	0.3435	0.0628	1.2174	1.8307	0.2896
15-17-male-urban	0.0595	0.0078	0.2346	0.3303	0.0372	0.2712	0.0380	0.9846	1.4269	0.2461	0.5739	0.0548	2.2428	3.1516	0.3793
15-17-male-rural	0.0352	0.0079	0.1280	0.1806	0.0246	0.0698	0.0440	0.1720	0.2761	0.0942	0.1998	0.0660	0.7049	1.2383	0.2549
15-17-female-nationwide	0.0388	0.0063	0.1458	0.1999	0.0268	0.0980	0.0300	0.3556	0.6136	0.1622	0.3265	0.0512	1.2414	1.8358	0.3472
15-17-female-urban	0.0731	0.0065	0.2878	0.3863	0.0394	0.2585	0.0277	0.9648	1.3268	0.2085	0.8903	0.0519	3.5148	4.4484	0.3660
15-17-female-rural	0.0237	0.0062	0.0835	0.1182	0.0213	0.0566	0.0391	0.1346	0.2048	0.0946	0.1172	0.0546	0.3611	0.6032	0.2409
18+-male-nationwide	0.0427	0.0074	0.1690	0.2423	0.0273	0.1318	0.0386	0.4955	0.8483	0.1373	0.5910	0.0663	2.4169	3.3840	0.2984
18+-male-urban	0.0602	0.0078	0.2447	0.3461	0.0323	0.2763	0.0345	1.0748	1.5785	0.1906	0.7564	0.0574	3.1714	4.3607	0.3370
18+-male-rural	0.0319	0.0071	0.1222	0.1781	0.0243	0.1081	0.0462	0.3508	0.5890	0.1084	0.1840	0.0635	0.6310	1.1309	0.2578
18+-female-nationwide	0.0466	0.0070	0.1857	0.2667	0.0288	0.1439	0.0384	0.5510	0.9504	0.1561	0.6575	0.0668	2.7142	3.7699	0.2886
18+-female-urban	0.0681	0.0076	0.2795	0.3948	0.0358	0.3752	0.0370	1.5340	2.1613	0.2141	0.7552	0.0548	3.2260	4.4544	0.3713
18+-female-rural	0.0330	0.0067	0.1267	0.1860	0.0244	0.1124	0.0436	0.3759	0.6414	0.1220	0.1897	0.0603	0.6741	1.1907	0.2442

Note. * Data are listed under food intake-sulfite content combination.

The situation was similar in 11-14 years old female and male groups except for a lower intake of sulfites in 11-14 years old male group. As shown in Table 3, the main source of sulfites in 11-14 years old male group was edible fungi.

The 15-17 years old male group consumed excess sulfites at P95-P97.5, P97.5-P95, and P97.5-P97.5 combinations. The sources of sulfites in food were different in urban and rural populations, but the edible fungi were the dominant source of sulfites in both groups.

The intake of sulfites at the P95-P97.5, P97.5-P95, and P97.5-P97.5 combinations exceeded the ADI in 15-17 years old female group and was lower than the ADI in rural populations. Dried edible fungi, nuts and seeds were the main sources of sulfites in urban populations while fresh edible fungi and pickled vegetables were the main sources of sulfites in rural populations.

The adult males and females consumed excess

Table 3. The Contribution Rate of Different Foods to the Dietary Intake of Sulfites in Different Groups

Group (age-gender-region)	Top three foods
1-3-nationwide	biscuits (35%), rice-flour products (14%), Vermicelli and noodles made from bean or sweet potato starch (12%)
1-3-urban	biscuits (32%), Vermicelli and noodles made from bean or sweet potato starch (16%), dried vegetables (16%)
1-3-rural	biscuits (39%), rice-flour products (15%), Vermicelli and noodles made from bean or sweet potato starch (13%)
4-6-nationwide	Fresh edible fungi (41%), Dried edible fungi (33%), Pickled vegetables (12%)
4-6-urban	Dried edible fungi (33%), Nuts and seeds (29%), Fresh edible fungi (23%)
4-6-rural	Fresh edible fungi (59%), Pickled vegetables (22%), steamed bread (12%)
7-10-nationwide	Fresh edible fungi (54%), Dried edible fungi (16%), Pickled vegetables (13%)
7-10-urban	Nuts and seeds (37%), Dried edible fungi (28%), Fresh edible fungi (21%)
7-10-rural	Fresh edible fungi (70%), Pickled vegetables (16%), steamed bread (10%)
11-14-male-nationwide	Fresh edible fungi (49%), Dried edible fungi (21%), Pickled vegetables (14%)
11-14-male-urban	Dried edible fungi (41%), Nuts and seeds (31%), Fresh edible fungi (16%)
11-14-male-rural	Fresh edible fungi (67%), Pickled vegetables (18%), steamed bread (11%)
11-14-female-nationwide	Fresh edible fungi (46%), Pickled vegetables (16%), Dried edible fungi (15%)
11-14-female-urban	Dried edible fungi (42%), Fresh edible fungi (30%), Pickled vegetables (11%)
11-14-female-rural	Fresh edible fungi (48%), Pickled vegetables (26%), dried vegetables (7%)
15-17-male-nationwide	Fresh edible fungi (46%), Dried edible fungi (27%), Pickled vegetables (11%)
15-17-male-urban	Dried edible fungi (32%), Fresh edible fungi (32%), Nuts and seeds (21%)
15-17-male-rural	Fresh edible fungi (60%), Pickled vegetables (21%), steamed bread (12%)
15-17-female-nationwide	Fresh edible fungi (32%), Dried edible fungi (23%), Nuts and seeds (20%)
15-17-female-urban	Dried edible fungi (46%), Nuts and seeds (31%), Fresh edible fungi (16%)
15-17-female-rural	Fresh edible fungi (36%), Pickled vegetables (36%), steamed bread (21%)
18+-male-nationwide	Nuts and seeds (32%), Fresh edible fungi (27%), Dried edible fungi (25%)
18+-male-urban	Nuts and seeds (36%), Dried edible fungi (27%), Fresh edible fungi (26%)
18+-male-rural	Fresh edible fungi (55%), Pickled vegetables (20%), steamed bread (13%)
18+-female-nationwide	Nuts and seeds (34%), Fresh edible fungi (27%), Dried edible fungi (25%)
18+-female-urban	Nuts and seeds (42%), Dried edible fungi (25%), Fresh edible fungi (22%)
18+-female-rural	Fresh edible fungi (59%), Pickled vegetables (22%), steamed bread (11%)

sulfites at P95-P97.5, P97.5-P95, and P97.5-P97.5 combinations at the nationwide level. Urban adults consumed more sulfites than rural adults. Edible fungi, nuts and seeds, and pickled vegetables were the main sources of sulfites in food.

The urban populations tended to consume more sulfites than rural people, suggesting that more attention should be paid to the intake of sulfites in the urban populations.

Excess intake of sulfites was found in all the surveyed groups when the food intake and sulfite content were at high values, indicating that the intake of sulfites in most populations exceeds the ADI when a large amount of food with a high sulfite concentration is consumed, which causes adverse effects on human health.

When the sulfite contents in all kinds of food used the MPL set in GB 2760-2011, the intake of sulfites in the surveyed populations was lower than the ADI, except for 1-3 years old group and 4-6 years old group. When the food intake was set at the mean value and the sulfite content in all kinds of food was lower than the MPL, the intake of sulfites in the surveyed populations varied from 3.29% to 20.01% of the ADI. When the food intake was set to P95, the intake of sulfites in all the groups was increased to 12.7%-86.65% of ADI. The current MPL values set in GB 2760-2011 are able to protect the health of most populations by keeping intake levels below the ADI. However, children aged 1-6 years should be considered as the high risk group to intake excess sulfites.

The consumption of sulfites is safe in most populations when the sulfites content in food is lower than the MPL in GB 2760-2011. The main reasons for excess intake of sulfites are overuse and abuse of sulfites by the food industry. It is thus necessary to establish a more effective management system for the control of sulfites in the food industry.

As shown in Table 3, edible fungi (both dried and fresh), nuts and seeds, pickled vegetables and steamed bread are the main sources of sulfites in food in China. However, the food choice is different in urban and rural populations. People living in cities prefer to consume more dried edible fungi, nuts and seeds while those living in rural areas tend to consume more fresh edible fungi, pickled vegetables and steamed bread. More attention should thus be paid to the processing and production of edible fungi (both dried and fresh), nuts and seeds, pickled vegetables and steamed bread.

According to the dietary sulfites intake assessment of JECFA, the main sources of sulfites in food in some countries are dried fruits, sausages and non-alcoholic beverages. Juices and soft drinks are the main sources of sulfites in children and teenagers while dried fruits, sausages and beer are the main sources of sulfites in adults[9]. These suggested great differences in food choice and the main reason for these varieties should be the different consumption pattern among people of different countries.

Deficiencies and Limitations This study was carried out according to the 2002 CHNS[6] and the national contaminant monitoring system (2003-2007)[7]. Because of the limitations in these surveys, this study did not include all the food categories in which sulfites can be used as food additives. Since fresh fruits without surface handling, chocolate products and confectionaries, and starch sugar are not included in this study, the dietary intake of sulfites may be underestimated.

On the other hand, the handling processes may affect the sulfite content in certain foods. For example, edible fungi as the main source of sulfites in Chinese people should be cleaned, stir-fried or boiled before consuming. These handling processes may reduce the sulfite content in food due to the water solubility of sulfites. According to JECFA, sulfites in foods should be reduced during their storage and cooking. For example, the sulfites in fish products, potatoes and dried fruits should be reduced to 50%-75% of their original values after stored for 1 month. Cooking reduces the sulfites in Thai noodles by 70% and in dried mushrooms and peeled potatoes to a negligible level[9]. If the changes of sulfites due to their handling processes are not considered, the risk assessment will overestimate the dietary intake of sulfites.

Comparison to Other Regulations The maximum sulfites levels in different kinds of food permitted by Codex Alimentarius Commission (CAC)[14], European Union (EU)[15] and Food Standards Australia New Zealand (FSANZ)[16] and China are listed in Table 4.

According to Table 4, the food categories allowed to use sulfites in China are less than those in other countries. For example, sulfites are allowed to be used in aquatic products by CAC, EU and FSANZ clauses, rather than by Chinese regulations.

The MPL of sulfites is also different in different

Table 4. Maximum Sulfites Levels Permitted by CAC, EU, FSANA, and China in Different Kinds of Food (mg/kg)

Food Categories	CAC	EU	FSANZ	China	Suggestions for China
Fresh fruit with surface treatment	50			50	—
Dried fruits	1000	500-2000	3000	100	↑
Compotes	100			350	↓
Dried vegetables, fungi and algae; nuts and seeds	500	100	3000	200	↑
Dried potatoes		400		400	—
Vinegar, soy sauce, pickled vegetables and algae	100			100	—
Canned or bottled (pasteurized) or sterilized packaged vegetables and algae	50		2000	50	—
Starch	50	50		30	↑
Biscuits	50		300	100	↓
Fresh molluscs, crustaceans and echinoderms	100	150	100		Develop as needed
Frozen fish, fillet, and fish products; including molluscs, crustaceans and echinoderms	100	150	100		Develop as needed
Cooked molluscs, crustaceans and echinoderms	150	50	30		Develop as needed
The smoked, dried, fermentation, and / or salted fish and fish products, including molluscs, crustaceans and echinoderms	30	50	30		Develop as needed
Preserved fish and fish products, including canned and fermented fish and fish products, including molluscs, crustaceans and echinoderms	150	50	30		Develop as needed
sucrose, anhydrous glucose, single water glucose, fructose	15			200	↓
Icing sugar, powdered glucose	15	40	450	100	↓
Other sugar and syrup (e.g., xylose, maple syrup and sugar crest)	40	40	450	60	↓
Spices and condiments	200			50	↑
Juice	50		115	50	—
Vegetable juice	50		115	50	—
Beer and malt beverage	50	20	25	10	↑
Wine	350		250-400	250	↑
Fruit (not including grape) wine	200	200	200-300	250	↓
Mead	200	200			Develop as needed
liquor drinks with a alcohol content higher than 15%	200	50	150		Develop as needed

countries. The MPL in starch is 50 mg/kg in CAC and EU and is 30 mg/kg in China. CAC, EU and FSANZ set the MPL in wine at 250-400 mg/kg and China sets it at 250 mg/kg. However, China permits the MPL at 350 mg/kg while CAC sets it at 100 mg/kg for compotes.

Suggestions for Sulfites Risk Management The current MPL of sulfites in GB 2760-2011 can protect the health of consumers. However, overuse and abuse of sulfites by the food industry may lead to high health risks in some consumers. Close attention should thus be paid to the management of sulfites used as food additives and measures should be taken for the control of sulfites overuse and abuse.

First, more information regarding the proper use of sulfites should be provided to sulfites producers and users through guidance, trainings or directions. Second, use of sulfites as food additives in food industry should be supervised and inspected. Third, edible fungi, nuts and seeds, pickled vegetables and steamed bread should be more stringently managed because they are the main source of sulfites in foods of China.

Some suggestions are put forward for the more accurate risk assessment of sulfites. First, the content of sulfites in food should be monitored in a wider range by utilizing the National Contaminant Monitoring System to obtain a more comprehensive result. Second, the effect of processing and handling on sulfites content in foods should be studied. Third, data of sulfites content in ready-to-eat foods should be collected for the risk assessment of sulfites.

Compared to other regulations, GB 2760-2011 has many differences in the use of sulfites. Some of them may need to be adjusted after certain risk assessments. For example, the MPL in compotes, biscuits, sugar and fruit wine should be reduced while that in dried fruits, starch, wine and beer should be increased. In addition, the development of MPL for aquatic products and alcoholic beverages can be considered according to the requirement of the Chinese food industry.

As sulfur dioxide may cause asthma after consumed by susceptible populations, CAC has recommended that products with sulfites ≥10 mg/kg should always be declared[17]. Many other countries have the similar requirements of sulfites in foods and beverages, while China has no such mandatory regulation. Considering the benefits of consumers, relevant labeling requirements should be developed and perfected.

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REFERENCES

1. Joint FAO/WHO Food Standards Programme. Definitions for the purposes of the Codex Alimentarius. Codex Alimentarius Commission-Procedural Manual-17th edition., 2008; 41.
2. Fan YX, et al. Food Safety Risk Analysis–a Guide for National Food Safety Authorities. People's Medical Publishing House (Beijing), 2008; 11. (In Chinese)
3. National Food Safety Standard for Uses of Food Additives (GB 2760-2011). 2011; 1-2, 15. (In Chinese)
4. World Health Organization. Evaluation of certain food additives: Sixty-ninth report of the Joint FAO/WHO Expert Committee on Food Additives. WHO Technical Report Series no.952, 2009; 55-65.
5. Liu ZP, Li FQ, and Jia XD. Principles and Methods for the Risk Assessment of Chemicals in Food. People's Medical Publishing House (Beijing), 2012; 197-210. (In Chinese)
6. Wang DL. 2002 China Nutrition and Health Survey Report - consolidated report. People's Medical Publishing House (Beijing), 2005; 6. (In Chinese)
7. Yang J, Fan YX, Yang DJ, et al. Introduction and Thoughts on Physical and Chemical Indexes of Food Contaminant Monitoring System. Chinese Journal of Food Hygiene, 2009; 2, 161-8. (In Chinese)
8. Chen JS. Risk Assessment and Food Safety. Chinese Journal of Food Hygiene, 2003; 15, 3-6. (In Chinese)
9. The Joint FAO/WHO Expert Committee on Food Additives. Sulfur Dioxide. Summary of Evaluations Performed by the Joint FAO/WHO Expert Committee on Food Additives. http://www.inchem.org/documents/jecfa/jeceval/jec_2215.htm, 1998.
10. Renwick AG, Barlow SM, Tritscher A et al. Risk characterization of chemicals in food and diet. Food Chem, Tox. 41, 1211-71.
11. World Health Organization. Safety Evaluation of Certain Food Additives. WHO Food Additives Series no.42. http://www.inchem.org/documents/jecfa/jecmono/v042je06.htm, 1999.
12. Cleveland Clinic. Sulfites Sensitivity. http://my.clevelandclinic.org/disorders/sulfites_sensitivity/hic_sulfites_sensitivity.aspx, 2010.
13. California Department of Public Health. Food and Drug Branch. Sulfites. http://www.cdph.ca.gov, 2013.
14. Codex general standard for food additives. Codex stan 192-1995, 2008; 7, 191-3.
15. European Parliament and Council Directive 95/2/EC: Food Additives Other than Colours and Sweeteners, 1995; 18.3, 11-5.
16. Australia New Zealand Food Standards Code part 1.3 Substances Added to Food, standard 1.3.1 .Food Additives, 2012.
17. FAO/WHO. Codex general standard for the Labelling of Prepackaged Foods. CODEX STAN 1-1985, 2008.