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RESEARCH ARTICLE

Determination Of Sulfites In Dried Fruits And Its Health Risk Assessment

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Abstract

Sulfur dioxide belongs to sulfiting agent group that is widely used in food products as a preservative. This study aims to assess the concentration of sulfite in dried fruits and its health risk assessment. Three types of dried fruits: apricots, raisins and dates were sampled in this study. The results indicated that the dried fruits: apricots, raisins and dates sold in bulk have higher concentration of sulfite compared to the same fruits sold in package. The mean concentration for apricots, raisins and dates sold in bulk were 1230.0 mg/kg, 1228.6 mg/kg and 1218.8 mg/kg, respectively. The reason of this difference could be due to the rate of sulfur dioxide (SO_2) loss which depends on the food product composition as well as storage temperature. All of dried fruits for both bulk and packaged were within the permissible limit of Malaysian Food Regulations 1985. Apricots with the highest sulfite concentration in bulk dried fruits also have the highest ratio of Hazard Index (HI) which is > 1. However, such frequent consumption of the highest residues was unlikely. Children were the most vulnerable group compared to adult. Consumers who have allergies for sulfites should caution the intake of dried fruits. Thus, continuous monitoring and stricter regulation of sulfites use in food products should be in place.

Keywords: *Food preservatives, sulfur dioxide, dried fruits, health risk assessment*

INTRODUCTION

Sulfite is a group of sulfur-based compounds that is capable to release sulfur dioxide (SO_2) and they belong to the group known as sulfiting agents (Garcia-Fuentes et. al., 2015). Sulfiting agents are usually used in food products such as dried fruits, dehydrated vegetables, biscuits, jellies, mustard and wines (Yilmaz, 2007). Sulfite, with its great efficiency of preventing oxidation and bacterial growth, is widely used as food preservatives (Li & Zhao, 2006). Sulfites are commonly used as they inhibit development of both enzymatic and non-enzymatic browning in a variety of processing and storage situations (Altunay & Gürkan, 2015). Sulfites or sulfur act as an antioxidant to prevent rancidity and as a chemical in attacking enzyme that can cause ripening, rotting and discoloration which usually happen in fruits after they are harvested (Gunduz & Akman, 2015).

Although sulfite is widely used as food additive for preservation purpose, recently it has drawn much attention because of its allergenic effect on hypersensitive people. Sulfur dioxide released from sulfite can inhibit specific nerve signals, restrict lung performance and is a direct allergen (Gunduz & Akman, 2014). The concentration of the sulfur dioxide in foods is regulated by the food legislations to ensure that the public is protected against health hazards and fraud in the preparation, sale and use of food. The maximum permitted levels of sulfur dioxide in foods are stipulated in the Malaysian Food Regulations 1985.

METHODOLOGY

Sample Preparation and Sulfite Analysis

The samples were taken from a shop in Shah Alam that supply many and various dried fruits such as raisins, dates, figs, prunes, apricots and nuts. Both samples of dried fruits sold in bulk and packaged were taken. A total of 30 dried fruits samples were collected. Five samples for each dried fruits of apricots, raisins and dates sold in bulk and packaging were taken. All of

the samples were dried in the oven at 70-80°C for 24 hours. Then, the dried samples were ground to powder. To digest the sample, 2.5 g of dried samples were added in a 100 mL of beaker with the alkaline extract solution which is the mixture of ethanol and sodium hydroxide (NaOH).

Then, the samples were covered to prevent from oxidation and left overnight. The next day, samples were digested for 10 minutes with ultrasonic bath (300 watt, 50 Hz) at 45°C. The samples were centrifuged at 4000 rpm for 2 minutes and then filtered by using a filter paper into 50 ml volumetric flask and diluted with distilled water. The analysis of sulfite concentration in dried fruits was conducted with DR5000, a UV-Vis spectrophotometer.

Health Risk Assessment

Health risk assessment were carried out to identify the probable risk associated with the exposure of sulfite concentration in dried fruits among the consumers. To assess the probable risk of sulfite concentration exposure among consumer, the estimated daily intake dose (EDI) and hazard index (HI) were used. Both EDI and HI were calculated using the following formulas from (Lien et al., 2016; Lou, 2017):

$$EDI = \frac{Ci \times IR}{BW}$$

where Ci is the concentration of sulfite in dried fruits (mg/kg). IR represents the food ingestion rate (g/day) which is 18.47 g/day for adult and 12.87 g/day for child while BW is the average of body weight (adult = 56 kg, child = 20 kg).

The HI value was calculated by the following equation:

$$HI = \frac{EDI}{ADI}$$

where ADI is 0.7 mg/kg/BW as set by the Joint Expert Committee on Food Additive (JECFA). HI ratio < 1 indicates the risk of sulfur dioxide residues in dried fruits is acceptable while HI ratio in between 1 to 10 indicates the risk exists, however, it does not require immediate action. The HI ratio > 10 indicates the risk is at unacceptable levels and immediate action is needed (Ling et al, 2015).

RESULT AND DISCUSSION

Figure 1 showed that the mean concentration for both bulk and packaged dried fruits were still under the permissible limit of 2000 mg/kg. There is also significant difference between bulk and packaged dried fruits. The highest sulfites concentration was recorded for bulk apricots while the lowest sulfites concentration was recorded in the dates. Bulk dried fruits showed a higher concentration of sulphites and the packaged dried fruits have much lower sulfites concentration in apricots, raisins and dates.

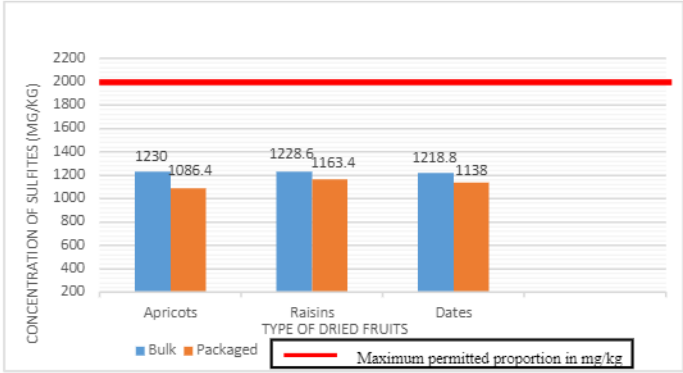

Figure 1: The mean concentration of sulfites in dried fruits

The results may be due to the fact that the surface area of the apricots are bigger than both raisins and dates which contribute to the absorption of sulfur dioxides from the preservation process. Moreover, the percentage of dried substance in apricot is 18-28% (Hojat Ahmadi, 2008). The rate of sulfur dioxide (SO_2) loss also depends on the food product composition as well as storage temperature (Cos et al., 2013). The storage of dried fruits is also a factor as they are very delicate to biochemical changes due to its low water content. Thus, the qualitative changes of colour and sensory characteristics of packaged dried fruits are influenced by the type, combination as well as the barrier features of the packaging materials (Gvozdenoviü et al., 2007). Consumers can also be aware of sulfite content where it should be labelled on packaged dried fruit.

Comparison with Selected Regulations

Table 1 shows the details of the sulfites that were being tested in dried fruits compared with selected regulations and law.

Table 1: Comparison of sulfites concentration and selected regulations.

Types	Concentration of sulfites in dried fruits mg/kg (mean)			Food Regulations 1985 (mg/kg)	CODEX General Standard for Food Additives (mg/kg)	European Directive 95/2/EC (1995) (mg/kg)
	Apricots	Raisins	Dates			
Bulk	1230.0	1228.6	1218.8	2000	1000	2000
Packaged	1086.4	1163.4	1138.0	2000	1000	2000

The results obtained from the laboratory analysis showed that all of dried fruits for both bulk and packaged were still under the permissible limit of Malaysian Food Regulations 1985. However, in comparison with CODEX standard of concentration of sulfites in dried fruits, all the samples exceed the permissible limit of 1000 mg/kg. The sulfites concentrations also were compared with the European Parliament and Council Directive No 95/2/EC under ANNEX III on the Conditionally Permitted Preservatives and Antioxidants. According to this legal standard, the maximum level of SO_2 in dried fruits is 2000 mg/kg which is also within permissible level.

Health Risk Assessment

Health risk assessment was assessed between two population groups which are adults and children to know the risk between these two populations of various ages. The assumed ages of adult population were between 35-65 years while the children population were between 4-18 years.

Table 2: The Estimated Daily Intake (EDI) of dried fruits between two population groups and total Hazard Index (HI)

Types of dried fruits	Groups	Population	EDI	HI
Apricots	Bulk	Adult	378.64	540.91
		Child	791.51	1130.73
	Packaged	Adult	334.43	477.76
		Child	699.10	998.71
Raisins	Bulk	Adult	378.20	540.29
		Child	790.60	1129.43
	Packaged	Adult	358.13	511.62
		Child	748.65	1069.50
Dates	Bulk	Adult	375.19	535.99
		Child	784.30	1120.43
	Packaged	Adult	350.31	500.45
		Child	732.30	1046.15

Both population groups, adults and children showed that the HI ratio are more than 10 which indicates that the risk are at unacceptable level and required immediate actions. It means that there may be a significant potential health effects for the consumers who were eating the dried fruits. A high HI value in dried fruits for adult with 1662.320 and children with 3742.380 was also found in China (Lou, 2017). However, such critical intake events were unlikely where frequent consumption of the highest residues and extreme consumption events must take place. Sulfite exposure is more risky to people with allergy reaction towards sulfur dioxide as sulfites can also result in debility, seizures and death as the effect may be directed to the central nervous system and also detoxified in the liver and lungs (Niknahad & O'Brien, 2008). Sulfites can cause breathing difficulties, asthma, anaphylaxis, sneezing, swelling of the throat, hives and migraine (Bai et. al., 2013).

CONCLUSION

As a conclusion, dried fruits sold in bulk showed a higher mean concentration of sulfites compared to packaged dried fruits. All of dried fruits for both bulk and packaged were within the permissible limit of Malaysian Food Regulations 1985. The Hazard Index (HI) value also stated that children consume in bulk dried fruits are more vulnerable to the sulfites concentration. This group requires more attention on the consumption of dried fruits. Apricots have the highest sulfites concentration compared to raisins and dates. Children must be monitored thoroughly when consuming dried fruits as they are the vulnerable group to adverse health effects. In addition, consumer who have allergies for sulfites must be cautious with the intake of dried fruits.

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