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ORIGINAL

Health Risk Assessment of Adolescence and Children Consuming Commercial Fish Contaminated with Formaldehyde

Siti Aminah A[1], Zailina H[1,2], Fatimah AB[3]

[1]Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Malaysia
[2]Centre of Excellence EOH, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Malaysia
[3]Department of Food Science, Faculty of Food and Technology, Universiti Putra Malaysia, 43400, Malaysia

* Corresponding author: Tel: +60389472406 Email: zailina@upm.edu.my

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Abstract The health benefits of consuming fish as a source of omega-3 fatty acids have been established. It can reduce cholesterol levels and the incidence of stroke and can protect against cardiovascular disease, improve cognitive development in children and slow cognitive decline in the elderly. Formaldehyde was used as antibacterial agent and preservative in food processing such as dried food, fish, certain oil and fats and disinfectants for container. Formaldehyde classified by the International Agency for Research on Cancer (IARC) in the Group 1 as carcinogenic to humans. If the amount of formaldehyde is small, it does not harm health. However, it can cause minor to serious problems such as pain, vomiting, coma and possible death when with large doses of formaldehyde is taken. Survey was conducted for adults, teenagers and children to identify the commercial fish consumption pattern in order to assess the risks of consuming different commercial fish contaminated with formaldehyde. Seven types of commercial fish species based on the survey were analysed. All the samples were purchased in different wet market and analysed under different circumstances; fresh, boiled and fried. Formldehyde were determined in all fish circumstances analysed. Formaldehyde content was in range 2.38 to 2.95 µg/g for fresh, 2.08 to 2.35 µg/g for boiled and 2.28 to 2.49 µg/g for fried. This study showed that there is formaldehyde content in fish sample analysis. However, formaldehyde content among all fish species and fish circumstances were still lower than amount that set by Malaysian Food Act (1985) and Malaysian Food Regulation (1985) that the maximum limit value for formaldehyde in fish and fish products are 5mg/kg. The effect of cooking shows a reduction of the formaldehyde content. There is no adverse health effects on human related to the fish consumption contaminated with formaldehyde have to be supposed by the risk assessment calculation. Thus, the fish from wet market can be considered safe to consume because of lower amount of formaldehyde content. Furthermore, some methods have suggested reducing formaldehyde content in fish such as cooking and washing.

Keywords: risk assessment, formaldehyde, fish

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1. Introduction

The health benefits of consuming fish are well documented such as a source of omega-3 fatty acids that can reduce cholestrol level, the incidence of stroke and protect against cardiovascular disease (Kris et al., 2002), (Mozaffarian et al., 2006), improve cognitive development in children (Daniels et al., 2004) and slow cognitive decline in the elderly (Morris et al., 2005).

Fish also can cause harm to human health. The most significant sources of foodborne diseases are related to the micrological and chemical hazards. Contamination of chemical in food may include natural toxicants such as mycotoxins (Melchert et al., 2005) and marine toxin (Vale et al., 1999) environmental contaminants such as mercury and lead (Hui et al., 2005) and naturally occuring substances. Among the contaminants, attention has been paid to volatile toxic aldehydes such as formaldehyde classified by the International Agency for Research on Cancer (IARC) in the Group 1 as carcinogenic to humans (IARC, 2004).

Formaldehyde is metabolised naturally in our bodies by normal metabolism and can also be found in the air, natural food, some skin-care products as well as preservatives in processed food, especially in dried and frozen food. If the amount of formaldehyde is small, it does not harm health. However, it can cause minor to serious problems such as pain, vomiting, coma and possible death when with large doses of formaldehyde is taken.

Formaldehyde an acceptable daily intake (ADI) of 0.2 mg/kg body weight has been set by the United States Environmental Protection Agency (Xuang et al., 2009).

In the food industry, formaldehyde is used as anti bacterial agent and preservative in food processing. It widely used in food processing for its bleaching effect and also as a preservative in order to prevent spoilage by microbial contamination. Formaldehyde is also used as a preservative in dried foods, fish, certain oil and fats and disinfectants for containers (Wang et al., 2007).

In seafood and crustaceans, formaldehyde is known to form post-mortem from the enzymatic reduction of trimethylamine-N-oxide (TMAO) to formaldehyde and dimethylamine (Sotelo et al., 1995), (Badii et al., 2005). This compound acccumulates during frozen storage, reacts with protein and subsequently causes protein denaturizing and muscle toughness (Sotelo et al., 1995).

Protein sources in the Malaysian diet were mainly provided by fish and seafood (Malaysian Adult Nutri en Survey 2003) Fish and seafood are an important part of a healthy diet and considered as the biggest protein sources (Ashie et al., 1996). Fish contain fat, free amino acids and water by composition which is susceptible to spoilage by microorganisms and biochemical reactions during post mortem process (Ismail et a., 2005) Unfortunately, commercial fish consumed by population maybe contaminated with formaldehyde in order to keep the freshness of fish and seafood because fish and seafood are very perishable and can only kept fresh in ice for 8 to 14 days depending on the species (Noordiana et al., 2011).

Risk assessment is the scientific evaluation of known or potential adverse health effects resulting from human exposure to food borne hazards. It is structured process for determining the risk associated with any type of hazard for biological, chemical or physical in food. It has as its objective a characterization of the nature and likelihood of harm resulting from human exposure to agents in food. The characterization of risk typically contains both qualitative and quantitative information and is associated with a certain degree of scientific uncertainty (WHO. 2012).

As formaldehyde is carcinogenic to human, it is important to investigate the formaldehyde content in fish since it is claimed to be the major contaminant and to better understand the risks of fish consumption, to manage risk and the need for additional information in providing production of safe food.

2. Materials and Methods

The survey location is around 1 kilometer radius from the wholesale wet market. There were 3 wholesale market selected which were Pasar Borong Selayang, Pasar Harian Selayang and Pasar Borong Klang. The calculation of the required sample size for Adults will be calculated based on the formula [18] as follow:

$$N = Z^2 \frac{P\,(1-P)}{d^2}$$

Where;

N = Sample size needed

Z = Z statistic for a level of confidence (level of confidence of 95%, Z value is 1.96)

P = Prevalence of the marine fish consumed in the central zone (28.9%) - According to Malaysian Adult Nutrition Survey 2003.

d = precision (In proportion of one; if 5%, d = 0.05).

From the calculation, minimum sample size needed for adults are 316 respondents. For the adolescence and children, the sample size calculation will refer to the study by (Pamela et al., 2017) which is 84% of their (households) children ate fish and the frequency of fish consumption was similar among all age group. Therefore, 265 subject each adolescence and children.

Primary schools were used as the sampling frame to select a representative sample of children below 12 years old and secondary schools will be used as the sampling frame to select a representative sample of adolescence aged between 13 to 17 years old. The age for primary and secondary school were 11 years old, 14 years old and 16 years old that Ministry of Education restricted.

2.1. Survey Form

The form used The form used in the survey consisted of 16 questions and was administered by face to face interview, where subject was asked on the frequency commercial fish intake either per day, per week, per month. Subjects were also requested to respond on the number of servings consumed each time they ate the fish and duration of storage the fish before cook. Questionnaires also consist on socio-demographic variables which included gender, body weight, ethnicity, age group, family members, how much they buy fish per week from market, type of fish they consume, how often they consume the fish.

2.2. Sample Preparation

All four species belonging to sea fish (commercial) based on the survey as most consumed fish from the adults and children weighing 500g were purchased from the different wet markets. Each sample was put into sterile plastic bag and stored in ice boxes. Each fish species were analysed under different circumstances; fresh, fried and boiled. Flesh was separated from skin and bones without damaging the gut by using sterile scalpel. For the boiled and fried fish, each sample were boiled in hot water or cooked at 180 ˚C for 20 min. 30 g of each sample are then minced and homogenized with 60 ml (6% TCA). A calibration curve in the 0–5 mg/L range is used for the analysis of the samples. Six concentration levels are analyzed using 3 measurements at each concentration level.

2.3 Chemicals

Nash's Reagent (Nash et al., 1953) was used as an indicator by diluting 15g ammonium acetate with an addition of 0.3 ml of acetylacetone and 0.2 ml of acetic acid. Nash's Reagent was kept in dark-glass reagent bottle at all times because the reagent is light sensitive. Trichloroacetic acid, TCA was used to adjust pH of fish flesh appropriately. A 0.1 N potassium hydroxide, KOH and 0.1 N hydrochloric acid, HCl have been used to adjust the pH of the distillate to be in rage 6.0 to 6.5. The range of used of working standard which was 0 – 5 mg/l was prepared from intermediate standard solution of 10 µg/g for calibrate the graph.

2.4 Determination of Formaldehyde

The fish samples were cut into small pieces and 30 g samples were homogenised with 60 ml of 6% w/w TCA. The mixture was filtrate was adjusted to pH 7.0 with 30% w/w KOH and stored in ice for 1 h. the test was performed by mixing 5 ml of the standard solution, TCA, fish extracts, 2ml Nash's Reagent and was heated in water bath at 60˚C for 30 min. the absorption at 415 nm was measured immediately by UV/vis spectrophotometer (Thermo Fisher Scientific, Waltham, MA).

2.5 Statistical Analysis

All experiments were done triplicate. The data were recorded as mean (standard deviations) and were analyzed using the statistical computer software 'Statistical Package for Social Science' (SPSS Windows Version 17.0). Based on data collected, some statistical analysis made to formaldehyde content in fish study which is descriptive analysis to seek average content of formaldehyde in fish. ANOVA one-way will be used to make comparison mean formaldehyde content in fish based on fish species and fresh, fried and boiled fish. Multiple regressions will be used to determine the exposure assessment of consuming commercial fish contaminated with formaldehyde.

3. Results and Discussions

The distribution of response rate for teenagers and children were 307 and 298 which is more than 15.98% and 12.45% of the sample size. The exposure was obtained through calculation on amount of formaldehyde in fish in order to identify the hazard quotient (HQ).

3.1. Socio-demographic Characteristics of Subjects

More than half of teenagers were female (57.33%) as compared to male (44.67%). For adolescence, the mean age of was 15 years old and the mean body weight was 51.2 kg. The subjects comprised 63.84% Malay, 23.45% Chinese, 12.33% Indian and the other

0.33%. Favourite fish part for adolescence is meat (52.1 %), tail (8.1 %) and head (1.0 %). About 38.8 % of them like to eat all part or some of the part. Same as adults, fried (23.5 %) is the highest cooking style between boiled (13.4 %) and roasted (3.6 %). More than half of subjects (59.5 %) like to eat all of cooking style or some of the cooking style including steamed.

For children, the mean age was 11 years old and the mean body weight was 30.24 kg. More than half of subjects were female (52.35%) as compared to male (47.65%). Subjects comprised 78.86% Malay, 16.44% Chinese and 4.70% Indian. Favourite fish part for children is meat (53.0 %), tail (4.7 %) and head (1.3 %). About 41.0 % of them like to eat all part or some of the part. Same as adults and adolescence, fried (21.1 %) is the highest cooking style between boiled (11.1 %) and roasted (4.0 %). More than half of subjects (63.8 %) like to eat all of cooking style or some of the cooking style including steamed. Most of the subjects (adolescence and children) consume fish for once to twice a week range between 23.2 % and 60.5 % for all types of commercial fish.

3.2. The Consumption Pattern of Commercial Fish

The four commercial fish frequently consumed by adolescence were Kembong (75.9%), Bawal (61.9%), Selayang (53.7%), and Merah (50.2%). In children, the commercial fish frequently consumed was Kembong (73.8%), Bawal (53.4%), Merah (49.3%) and Siakap (47.3%) respectively.

According to ethnicity, Kembong fish had the highest rating among Malay (82.7 %) followed by Bawal (48.9 %), Siakap (44.3 %) and Merah (42.0 %). Among the Chinese, the highest fish species consumed was in Kembong (60.7 %) followed by Bawal (60.3 %), Merah (46.2 %) and Selayang (45.3 %). Among the Indian, the highest fish species consumed was in Kembong that was 64.2 % followed by Merah (58.0 %), Bawal (46.9 %) and Selayang (40.7 %). The consumptions pattern of commercial fish contaminated with formaldehyde (Kembong, Merah, Bawal and Siakap) were shown to be significantly different ($p < 0.05$) between the ethnics. Thus, the study showed that the most familiar fish consumed was Kembong fish. According to Fisheries Development Authority of Malaysia (LKIM, 2005), Kembong fish have high consumption rate because of the price is inexpensive.
Fish has been the main supply of healthy and cheap protein to a large percentage of the world's population. In the most Asian countries, fish is a main protein of the diet especially those in Southeast Asia. It is particularly valuable for providing proteins of high quality comparable with those meat, milk or eggs. Fish also a good source of *n*-3 fatty acids, calcium, phosphorus, iron, trace elements like copper and a fair proportion of the B-vitamins (Tucker, 1997). Consumption of fish most probably because of the fish oils contain in fish. It is beneficial to the developing fetal and infant brain and perhaps to the aging brain (Anthony J. Mc Michael, 2005). For most children, the fish in their diets provides a healthy source of low-fat protein and nutrients (Nash. 1953).

3.3. Formaldehyde Content in Fish

Since fish products are generally eaten after cooking, some of the samples were analysed just after boiling and frying in order to evaluate the possible decrease in the formaldehyde content. As reported in Table 1, a decrease in a formaldehyde concentration was generally observed in all fish species analysed.

Comparisons the mean formaldehyde concentration between fish sample is presented in Table 1. The comparison showed that there were significant difference ($p < 0.05$) in formaldehyde concentration between fish samples for Kembong, Kerisi, Selar, Selayang, Merah and Bawal fish. Post Hoc comparisons using Tukeys test indicated that the mean formaldehyde concentration were significantly different ($p < 0.05$) between fish samples of Kembong fresh and boiled, Kerisi fresh and boiled, Selar fresh and boiled, Merah fresh and boiled, Bawal fresh and boiled and Selayang fresh, boiled and fried. However there was no statistically significant difference ($F = 1.736$, $p = 0.198$) in the mean formaldehyde concentration of Siakap fish samples.

The comparisons of the amount formaldehyde content in the whole fish of commercial fish species are shown in the Table 1. Generally results showed that all the fresh, boiled and fried samples had low formaldehyde concentration. Data obtained found that the amount of formaldehyde in all fish species and fish circumstances were still lower than the permissible level set by the Malaysian Food Act (1983) and Malaysian Food Regulation (1985) which stated maximum limit value for formaldehyde in fish and fish products are 5mg/kg (MFR. 2006).

Table 1. Amount of Formaldehyde in Commercial Fish Species Consumed by subjects

Fish Type	Mean (SD)				
	Fresh	Boiled	Fried	*F*	*p*
Kembong *(Mackerel)*	2.557(0.219)	2.233(0.341)	2.407(0.114)	3.968	0.032*
Kerisi *(Red sea beam)*	2.381(0.162)	2.082(0.235)	2.283(0.190)	5.272	0.013*
Selar *(Scad)*	2.447(0.204)	2.118(0.357)	2.327(0.227)	3.995	0.032*
Selayang *(Sardine)*	2.946(0.431)	2.357(0.178)	2.495(0.156)	10.558	0.001***
Merah *(Red snapper)*	2.498(0.158)	2.292(0.210)	2.403(0.124)	3.403	0.050*
Siakap *(Golden snapper)*	2.409(0.157)	2.237(0.247)	2.327(0.172)	1.736	0.198
Bawal *(Black pomfret)*	2.615(0.316)	2.108(0.386)	2.427(0.226)	5.887	0.008**

*Significant at p<0.005

** Significant at p<0.01

***Significant at p<0.0001

According to Swiss (2001), Danish (2002) and Sweedish Products Registers (2000), formaldehyde is found in a large number of products and available for consumer. In addition, formaldehyde is used in fish farming as preservative agents. Formaldehyde formed in fish reacts with protein and subsequently causes muscle toughness (Yasuhara et al., 1995).

Based on the result, there were significant differences in amount formaldehyde content between fish samples. The formaldehyde content generally decreased in the all fish species analysed after cooking. The decrease in levels occurred when the samples were cooked in open pots, thus allowing the evaporation of formaldehyde during the cooking process since the formaldehyde is soluble in water at 20 ºC**.** In addition, the boiling point for formaldehyde is 101 ºC, so the volatility of formaldehyde occurred (Leslie et al., 1994). In addition, fish products are eaten after cooking. Thus, the results showed that exposure to formaldehyde will decrease if the fish was cooked.

Again, the differences in the formaldehyde levels among fish could be explained on the basis of the different trimetyhilamine-oxide (TMAO) levels usually found in these products. In seafood, formaldehyde is present naturally. It is formed from the post-mortem of enzymatic reduction of TMAO to equimolar amounts of formaldehyde and dimetylamine (DMA) (Bianchi et al., 2005). The amount of formaldehyde formed depends mainly on the time and temperature of the storage which causes muscle toughening and water loss in fish, leading to lower acceptability as well as functionality (Sotelo et al., 1995). Different levels of formaldehyde in fish species depend on the level of TMAO and reaction to reduce TMAO to formaldehyde and DMA obtained from the frozen seafood (Bianchi et al., 2005). The reduction of TMAO process also caused the bacteria activity to increase (Sotelo et al., 1995).

3.4. Risk Assessment

The average daily dose (ADD) was used for carcinogenic risk assessment. Data analysis for this survey had taken into account the respondent body weight to estimate the average daily dose (ADD) – expressed as mg per kg of body weight (BW) per day. The average daily dose used for carcinogenic risk assessment (EPA, 1997).

$$ADD = \frac{C \times IR \times ED}{BW}$$

C = concentration of the chemical (ppm)
IR = intake rate (for food/ingestion; how many grams/day)
ED= exposure duration (how many years)
BW = body weight

Because the exposure route is via ingestion of food, divide the ADD value for formaldehyde by its oral RfD (oral RfD for formaldehyde = 0.2 mg/kg-day) to determine the hazard quotient (HQ) for formaldehyde. If the HQ less than or equal 1.0, so that there is no known adverse effect from the exposure.

The choice of fish consumed may vary considerably from one individual to another. The daily intake of formaldehyde concentration from food consumption is dependent on the fish and amount of fish consumed. The survey made by Malaysian Adults Nutrition Survey through their survey on Habitual Food Intake of Adults Aged 18 to 59 years showed that one medium size fish particularly marine fish are eaten daily. Protein sources in the Malaysian diet were mainly obtained from fish and seafood.

Malaysian adult consume similar food when compared to various zone, in rural and urban areas among men, women and various age groups. The mean intake of the fish daily was 60.7 g/day for medium size fish (Malaysian Adults Nutrition Survey .Therefore, estimation for intake rate in teenagers and children will follow intake rate from Malaysian Adult Nutrition Survey and assuming 50 kg of body weight as follow the average body weight of Southeast Asian people (Agusa et al., 2007) because the data for Malaysian adolescence and children were limited.

Since seafood is one of the most important food sources in Southest Asia, intake of formaldehyde from fish is of great concern for human health risk. Assessment of human health risk from ingestion of fish contaminated with formaldehyde required information on the quantities of fish consumed. The choice of fish consumed may vary considerably from one individual to another. The daily intake of formaldehyde concentration from food consumption is dependent on the fish and amount of fish consumed. The ADD values in adolescence were calculated by assuming that 50 kg individual (Agusa et al., 2007) will consume 60.7 g/day fish serving (MOHM, 2003) while for children, body weight will assume 30.24 kg.

Eating fish may be good for health but eating to many fish is bad for human health (Anthony et al., 2005). Because the exposure route is via ingestion of food, the ADD value for formaldehyde was divided by its oral RfD (oral RfD for formaldehyde = 0.2mg/kg-day) to determine the hazard quotient (HQ) for formaldehyde.

The estimation of risk assessment was shown in

Table 2 and Table 3. Generally, the findings showed that the risks are computed as a hazard quotient (HQ, the ratio of ingested formaldehyde to the reference dose, or RFD). Since the value of HQ is less than 1, it is unlikely that concentrations of formaldehyde in fish caused adverse effects on human the fish are consumed. In fact, the ADI value (0.2mg/kg-day) is sufficiently high to guarantee consumer safety. Fish is usually eaten after cooking. Boiling point of formaldehyde is 101 ºC and while being cooked at high temperature, the formaldehyde content will be decrease. Fish cooked in the

Table 2. The Value of Average Daily Dose (ADD)

Group	Fish types	C (mg/kg)	IR (mg/day)	EF	CF (10^{-6}) kg/mg)	BW (kg)	ADD (mg/k
Adolescence	Selayang fresh	2.946	60700*	1	10^{-6}	50**	0.0357
	Selayang boiled	2.357	60700*	1	10^{-6}	50**	0.0286
	Selayang fried	2.495	60700*	1	10^{-6}	50**	0.0302
Children	Selayang fresh	2.946	60700*	1	10^{-6}	30.24	0.0591
	Selayang boiled	2.357	60700*	1	10^{-6}	30.24	0.0473
	Selayang fried	2.495	60700*	1	10^{-6}	30.24	0.0500

Note : *Intake rate according to Malaysian Adult Nutrition Survey 2003

****Body weight according to average age of Southeast Asian people**

Table 3. Hazard Quotient for Formaldehyde

Group	Fish types	ADD (mg/kg/day)	Oral RfD (mg/kg/day)	HQ (≤ 1)	Conclusion
Adolescence	Selayang fresh	0.03576	0.2	0.1788	No adverse effect
	Selayang boiled	0.02861	0.2	0.1431	No adverse effect
	Selayang fried	0.03029	0.2	0.1514	No adverse effect
Children	Selayang fresh	0.05913	0.2	0.2957	No adverse effect
	Selayang boiled	0.04731	0.2	0.2366	No adverse effect
	Selayang fried	0.05008	0.2	0.2504	No adverse effect

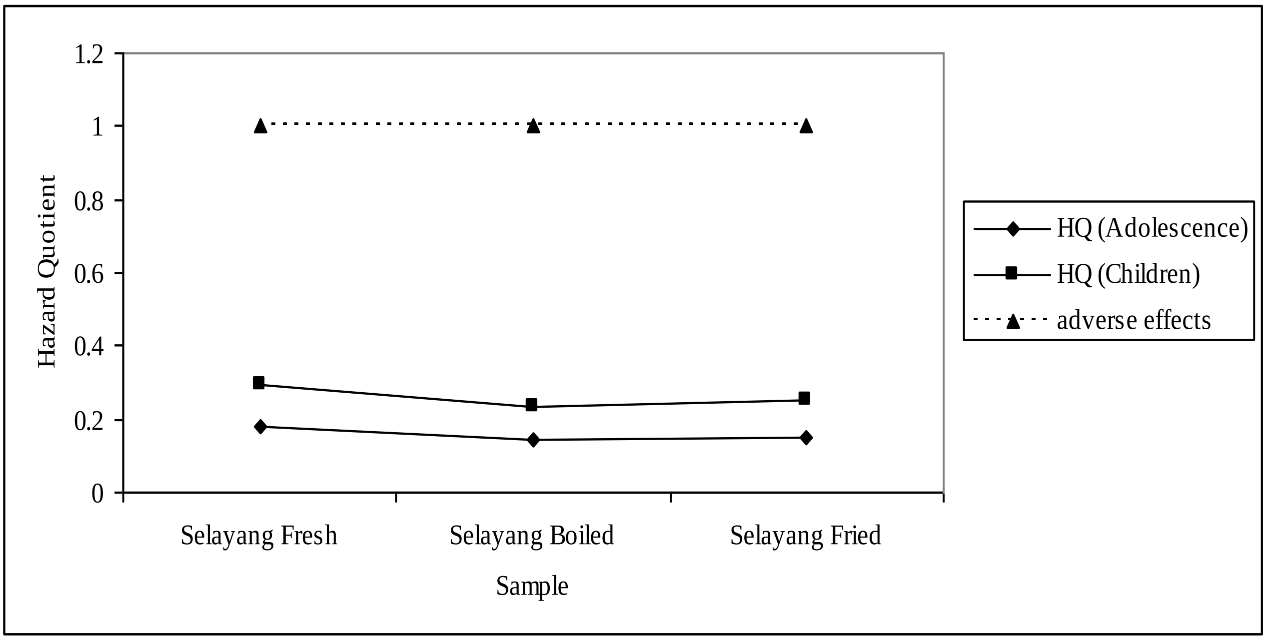

Figure 1. The Range of HQs for a Fish Sample Contaminated with Formaldehyde

open pot causes formaldehyde to evaporate easily (Benchmann, 1998). However, the study showed that the consumption of commercial fish influences the risk of formaldehyde.

Studies on human acute toxicity showed that serious ulceration and damage of the gastrointestinal tract have been observed after ingestion of formaldehyde (Kochhar et al., 1986). Formaldehyde can also cause allergic reaction in human. Systemic or localised allergic reactions have been associated with formaldehyde exposure (Benchmann, 1998). For patch testing of product containing formaldehyde, the threshold for elicitation of allergic contact dermatitis in sensitised subjects range from 30 ppm to 60 ppm aqueous solution. A threshold for induction is estimated to be less than 5 % aqueous solution (Cronin E, 1991).

Formaldehyde is weakly genotoxic and was able to induce gene mutations and chromosomal aberrations in mammalian cells. DNA-protein crosslinks are a sensitive measure of DNA modification by formaldehyde. However, the genotoxic effects were limited to those cells, which are in direct contact with formaldehyde, and no effects could be observed in distant-site tissues. In conclusion, formaldehyde is a direct acting locally effective mutagen (SIAR, 2002).

Epidemiological studies of potential carcinogenic hazards associated with the ingestion of formaldehyde were not identified. However, consistent with the known reactivity of this substance with biological mocromolecules in the tissue or organ of first contact, histopathological and cytogenetic changes within the aerodigestive tract, including oral and gastrointestinal mucosa, have been observed in rate administered formaldehyde orally. These observations and additional consideration of the mode of induction of tumours by formaldehyde lead to the conclusion that under certain conditions of exposure, potential carcinogenic hazard associated with the ingestion of formaldehyde cannot be eliminated (WHO, 2002).

There are no indications of a specific toxicity of formaldehyde to fetal development and no effects on reproductive organs were observed after chronic oral administration of formaldehyde to male and female rats. Amounts of formaldehyde which produce marked toxic effects at the portal of entry do not lead to an appreciable systemic dose and thus do not produce systemic toxicity. This is consistent with formaldehyde's high reactivity with many cellular nucleophiles and its rapid metabolic degradation (WHO, 2002).

Although species –specific meal rate were not evaluated, it would appear that the majority of children in this study were not at high risk of formaldehyde exposure as a result of commercial fish consumed. Depending on the risk calculation on fish selected (Table 3), most of the children may exceed safe exposure limit for formaldehyde (Figure 1) because of their rapid growth and developing organ systems. Children are considered to be more sensitive to many environmental contaminants than adult and older children (Pamela et al., 2007).

3.5 Methods and Procedure to Control Formaldehyde in Fish

There are a few suggestions that can be considered to overcome the formaldehyde content in fish. Several methods and procedures has been taken and proposed in order to control or reduces formaldehyde content in fish. In Hong Kong, government advised to the public to choose only fish that are fresh and avoid those with unusual smell and also avoid buying noodle fish that are stiff (formaldehyde could stiffen flesh of fish). Freshness is a property of fish that has a considerable influence on its quality (Bianchi et al., 2007).

Besides, public also advised to wash and cook the fish thoroughly as formaldehyde is water soluble and could dissipate upon heating. When formaldehyde is released into water, it does not move into other media but is broken down because formaldehyde is readily soluble in water, alcohols and other polar solvent (Connel, 1995). The report noted from USEPA's Exposure Factors Handbook (EPA, 1997), cooking fish results in weight (moisture and fat) loss which results decrease formaldehyde concentration in cooked fish. The formaldehyde concentration was decrease after roasting and boiling. The decrease of formaldehyde content was due to the evaporation of the sample during cooking process (Bianchi et al, 2007).

4. Conclusions

This study showed that there is formaldehyde content in fish sample analysis. However, formaldehyde content among all fish species and fish circumstances were still lower than amount that set by Malaysian Food Act (1985) and Malaysian Food Regulation (1985) that the maximum limit value for formaldehyde in fish and fish products are 5mg/kg. The effect of cooking shows a reduction of the formaldehyde content. There is no adverse health effects on human related to the fish consumption contaminated with formaldehyde have to be supposed by the risk assessment calculation. Thus, the fish from wet market can be considered safe to consume because of lower amount of formaldehyde content. Furthermore, some methods have suggested reducing formaldehyde content in fish such as cooking and washing.

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