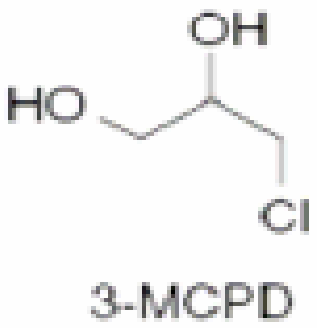
Fatty Acid Esters of 3-MCPD in Food

7 Nov 2012

3-Monochloropropane-1,2-diol (3-MCPD)

- 3-MCPD
  - is a type of ***process contaminant***
    - produced naturally in foods during food manufacturing, cooking, and other processing activities such as deep frying and roasting
    - It occurs in foods in its free form as well as in the bound form (fatty acid esters)
    - **Much of the 3-MCPD found in foods is present as 3-MCPD fatty acid esters (3-MCPD esters) and 3-MCPD esters are found in a wide range of food**



3-MCPD

3-MCPD fatty acid esters is a source of previously not recognized 3-MCPD

3-Monochloropropane-1,2-diol (3-MCPD)

free 3-MCPD

- Two joint projects with Consumer Council
  - 3-MCPD in Soy Sauce Products; conducted in 2002/03
  - 3-MCPD in Condiments and Sauces; conducted in 2003/04
- A RA study conducted in 2007
  - "Dietary Exposure to Chloropropanols of Secondary School Students"

Determine the level of the **bound 3-MCPD**

(3-MCPD fatty acid esters) instead in this study

Occurrence of 3-MCPD esters

- The exact mechanism on the formation of 3-MCPD fatty acid esters is still unknown
- There is currently lack of data about 3-MCPD fatty acid esters in foodstuffs at international scene
- Formed when **fat**- and **salt**-containing foods are processed at **high temperatures** during production
- High concentrations found in **refined vegetable oils and fats**, and in milk powder for infants in some overseas studies

Occurrence of 3-MCPD esters

- **ILSI Europe Workshop in 2009**

  - *" Although there is a **lack of data** about 3-MCPD esters for many foodstuffs, it is obvious that **thermally processed foods** and **refined fats and oils** (as such or as a component of other foodstuffs) are the most significant sources of 3-MCPD esters for consumers. In particular, **refined palm oil** in different kinds of foodstuffs is responsible for a significant part of the exposure."*

* Workshop on 5-6 February 2009

Toxicology of 3-MCPD esters

- There is currently an information gap on 3-MCPD fatty acid esters internationally
  - the metabolic pathways and toxicological properties of the intact 3-MCPD esters

- The Joint Food and Agriculture Organization (FAO) / World Health Organization (WHO) Expert Committee on Food Additives (JECFA)
  - noted that 3-MCPD esters had been reported in foods, but there were **insufficient data** to evaluate their intake or toxicological significance

Toxicology of 3-MCPD esters

- In 2010, the Codex Committee on Contaminants in Foods (CCCF)
  - included 3-MCPD fatty acid esters in the priority list for evaluation by JECFA for toxicological assessment and exposure assessment

Toxicology of 3-MCPD esters

- The primary toxicological concern is the **potential release of the toxic 3-MCPD** *in vivo* during digestion in the gastrointestinal tract

- Adverse effects of 3-MCPD
  - affect the kidney, the central nervous system and the male reproductive system of rats

  - The International Agency for Research on Cancer (IARC) classified 3-MCPD as Group 2B agent (Possibly carcinogenic to humans)
    - there is sufficient evidence showing that 3-MCPD is carcinogenic to experimental animals
    - no data is currently available for the carcinogenicity of 3-MCPD in humans.

Objectives

- The Centre for Food Safety (CFS), as a World Health Organization (WHO) Collaborating Centre for Risk Analysis of Chemicals in Food , conducted the study with a view to
  - giving WHO an overview of the level of fatty acid esters of 3-MCPD in foods in Hong Kong
  - assessing the potential health risk posed to the local population

Scope

- Ranges of products which reported having higher level of fatty acid esters of 3-MCPD
  - Refined oils and fat & fat and salt containing products
  - foodstuffs involving thermal processing e.g. baking, roasting, frying, deep frying etc.
  - Sample: 300 individual samples

Laboratory analysis

- Laboratory analyses were conducted by the Food Research Laboratory (FRL) of the CFS
- The concentration of 3-MCPD fatty acid esters in samples are *expressed as 3-MCPD*
- The limits of detection (LOD) varied among different food categories (ranged **1 – 20** µg/kg)

Data analysis

- Safety reference value
  - JECFA established a provisional maximum tolerable daily intake (PMTDI) of 2 µg/kg bw in 2001 for 3-MCPD
  - No safety reference value for its esters

Data analysis

- Assumption:
  - Since primary toxicological concern is the potential release of the toxic 3-MCPD *in vivo* during digestion in the gastrointestinal tract
  - Assumed 100% of 3-MCPD was released from its fatty acid esters by hydrolysis in the digestive system in adults, (having noted that this assumption may overestimate the actual 3-MCPD exposures)
  - this approach was agreed by European Food Safety Authority (EFSA)

Data analysis

- **Estimate dietary exposure**
  - **Substance Level X Food Consumption Amount**
  - 1/2 LOD was assigned to the ND samples for the calculation of mean levels of 3-MCPD fatty acid esters

- **Food Consumption data**
  - Hong Kong Population-based Food Consumption Survey 2005-2007 (the Survey)
  - For fats and oils consumption data
    - The survey
    - HK Edible Oil Association (2007)

3-MCPD fatty acid esters levels in different food groups

Food Group	Number of Samples	3-MCPD fatty acid esters level (µg/kg), expressed as 3-MCPD	
		Mean*	Minimum – Maximum
Breakfast cereal	20	7	ND# - 43
Noodles	20	53	ND - 210
Biscuit	25	440	50-860
Meat, and its products	30	19	ND-280
Poultry, and its products	15	23	ND-160
Fish, and its products	15	77	ND-280
Nuts and seeds	15	5	ND for all samples
Fats and oils	20	390	ND - 2500
Condiments and sauces	15	75	ND - 490
Snacks	25	270	9 - 1000
Bakery wares	35	120	ND - 410
Chinese pastry	20	270	ND - 1200
Dairy products	15	17	ND - 230
Soup and non-alcoholic beverages	20	12	ND - 61
Infant formula	10	100	26 -290

3-MCPD fatty acid esters levels in different vegetable oils

Oils	Number of Samples	3-MCPD fatty acid esters level (μg/kg), expressed as 3-MCPD	
		Mean	Minimum – Maximum
Peanut oil	3	570	500 - 650
Canola oil	3	110	100 - 130
Corn oil	3	280	120 - 470
Olive oil	3	390	250 - 640
Grape seed oil	3	1180	390 - 2500
Extra virgin olive oil	1	10	ND

- Local levels ranged 100 - 2500 μg/kg (except extra virgin olive oil)
- Reported levels in other countries <200 – 21500 μg/kg

Adult's dietary exposure to 3-MCPD fatty acid esters

- The estimated dietary exposure to 3-MCPD from its fatty acid esters
  - average adult consumers
    - 0.20 μg/kg bw/day
    - (10% of the PMTDI of 3-MCPD)
  - high (95th percentile) adult consumers
    - 0.53 μg/kg bw/day
    - (26 % of the PMTDI of 3-MCPD)

Assuming that 100% of 3-MCPD was released from its fatty acid esters, the results suggested that both average and high consumers were unlikely to experience major toxicological effects of 3-MCPD.

Adult's dietary exposure to 3-MCPD fatty acid esters from different food groups

Food Group	Average exposure (ng/kg bw/day)*	Percentage of PMTDI of 3-MCPD (%)*
Breakfast cereal	0.3	0.01
Noodles	48	2
Biscuit	29	1
Meat, and its products	7	0.4
Poultry, and its products	9	0.4
Fish, and its products	19	0.9
Nuts and seeds	0.1	0
Fats and oils	13	0.7
Condiments and sauces	3	0.1
Snacks	9	0.5
Bakery wares	48	2
Chinese pastry	6	0.3
Dairy products	3	0.1
Soup and non-alcoholic beverages	9	0.4
Total	200	10

*average exposure and percentage of PMTDI values below 10 have been rounded to one significant figure and values equal to or above 10 have been rounded to two significant figures

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食物安全中心 Centre for Food Safety

Consumption amount of fats and oils

- Local Fats and Oils consumption data for food items in this study (all respondents)
  - Average consumer: 2.67 grams per day

- Data from the HK Edible Oil Association in 2007
  - consumption per capita was 11.22 kg per annum (about 30.74 grams per day)

- about **11.5**-folds higher

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Comparison on dietary exposure to free 3-MCPD and its esters

- Previous CFS study results on **free** 3-MCPD
  - Average consumer (secondary school student)
    - 0.063 – 0.150 μg/kg bw/day
    - (3- 8% PMTDI of 3-MCPD)
  - High consumer (secondary school student)
    - 0.152 – 0.300 μg/kg bw/day
    - (8 – 15% PMTDI of 3-MCPD)

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Limitation

- Limited laboratory resources
  - Focused on local food items reported more likely to contain higher amount of 3-MCPD fatty acid esters
- Information gaps on 3-MCPD fatty acid esters
  - Formation mechanism
  - Occurrence in food
  - Analytical method
  - Potential toxicological properties of intact 3-MCPD esters
  - Metabolic pathway such as degree of hydrolysis during digestion etc.

Conclusion

- Average and high consumers were unlikely to experience major toxicological effects of 3-MCPD

Recommendation

- By virtue of the dietary exposure to 3-MCPD fatty acid esters in adults alone,
  - the findings of the current study did not provide sufficient justifications to warrant changes to the basic dietary advice on healthy eating
  - to maintain a balanced and varied diet which includes a wide variety of fruits and vegetables

- Refined oil is one of the major sources of 3-MCPD fatty acid esters
  - may reduce consumption of fats and oils to further reduce the exposure to 3-MCPD fatty acid esters

Recommendation

- Members of the food trade are
  - advised to find ways to reduce the levels of 3-MCPD fatty acid esters in refined fats and oils while not impairing the quality of their products
  - The methods may include
    - removal of precursors from the raw material e.g. remove chloride by washing,
    - optimisation of the oil refining process and
    - removal of 3-MCPD-esters from the product

All these possibilities needed to be assessed in the future

End