Risk Assessment Studies

Report No. 42

Chemical Hazard Evaluation

Safety of Melamine-ware Available for Use on Local Food Premises

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EXECUTIVE SUMMARY

The safety of food contact materials is a matter of public concern. Tableware products made of melamine-formaldehyde resins, generally described as melamine-ware, are widely used around the world due to their strong durability, good chemical and heat resistance and low cost. The major food safety concern of melamine-ware is the possible migration of excessive melamine and formaldehyde to food. The Centre for Food Safety (CFS) has conducted a study to examine the level of melamine and formaldehyde migration from melamine-ware available for use on local food premises, and to assess the safety of these products.

In this study, sampling and testing of melamine-ware was carried out from May 2009 to February 2010. Samples of melamine-ware commonly available for use on local food premises were obtained either from the local food premises direct or from manufacturer/suppliers known to supply melamine-ware to local food premises. Laboratory analysis of the level of melamine and formaldehyde migration was conducted by the Food Research Laboratory of the CFS according to the GB test method (GB 9690-2009) and the European Committee for Standardisation method (CEN method EN 13130-1:2004).

Results

A total of 61 melamine-ware samples covering 7 melamine-ware categories and 9 brands were collected and analysed. The overall mean level of melamine migration from melamine-ware (LOQ = 0.003 mg/dm^2) was 0.027 mg/dm^2 (range: not-detected (ND) - 0.190 mg/dm^2) under the GB test and 0.050 mg/dm^2 (range: ND - 0.280 mg/dm^2) under the EU test. The overall mean level of formaldehyde migration from melamine-ware (LOQ = 0.044 mg/dm^2) was 0.090 mg/dm^2 (range: ND - 0.407 mg/dm^2) under the GB test and 0.217 mg/dm^2 (range: ND - 0.750 mg/dm^2) under the EU test. These levels, for both melamine and

formaldehyde, were all below the respective GB and EU limits. No overt difference in the concentration range of melamine and formaldehyde migration was noted between the various categories, brands or sources of the melamine-ware samples.

Conclusion and Recommendations

This study investigated the levels of migration of melamine and formaldehyde from commonly used melamine-ware categories of brands available for use on local food premises. The study results show that even under experimental conditions that simulate the worse-case scenario, all melamine-ware tested had low levels of migration of melamine and formaldehyde which were well below the GB and EU specified migration limits, indicating that all melamine-ware samples tested were of the quality suitable for food use. Based on the satisfactory analytical results, the melamine-ware samples tested are not expected to pose health concern to consumers under normal food use. There is no cause for alarm.

General Advice for Using Melamine-ware

1. Use melamine-ware according to product specifications and instructions.
2. Do not use melamine-ware that is broken or damaged on its surface.
3. Do not heat or cook foods in melamine-ware.
4. Do not use melamine-ware in microwave oven or conventional oven.
5. Do not use melamine-ware to hold hot oil or highly acidic foods.
6. If melamine-ware is to be used for holding hot deep-fried foods, cool the foods down before putting in the melamine-ware.
7. For cleaning, do not use abrasive detergent and cleaning tools or strong chemicals which will damage the surface.

Advice to Food Businesses

1. Restaurants and food businesses should obtain melamine-ware from reliable manufacturers and suppliers and use melamine-ware of suitable quality to serve food to customers.
2. Use melamine-ware according to the product specifications and instructions.

Advice to Manufacturers and Suppliers

1. Manufacturers should adopt good manufacturing practices in making melamine-ware for food use.
2. Manufacturers are advised to provide instructions on its intended use.
3. Suppliers should obtain melamine-ware products from reliable manufacturers and ensure the products are of suitable quality for food use.

Risk Assessment Studies –

Safety of Melamine-ware Available for Use on Local Food Premises

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OBJECTIVES

The study aims to

(i) examine the level of melamine and formaldehyde migration from melamine-ware available for use on local food premises, and

(ii) assess the safety of these melamine-ware.

INTRODUCTION

2. The safety of food contact materials is a matter of public concern. Since the melamine-milk incident, the public has become more aware of the safety of melamine-made tableware and the Centre for Food Safety (CFS) received some public enquiries concerning the safety of this type of products.

3. Tableware products made of melamine-formaldehyde resins are generally described as melamine-ware. Due to their strong durability, good chemical and heat resistance and low cost, melamine-ware are widely used around the world. Melamine-ware are made by compression-moulding melamine-formaldehyde resin from powder or granular form. The heat and the pressure of the moulding process cures the resin to provide a thermoset plastic. Residual monomer, however, can remain in the plastic after the manufacture and may migrate into foodstuffs coming into contact with the melamine-ware surface.

4. Previously, the media reported that a survey on melamine tableware in the Mainland revealed some products had problems of decolouration and leaching out excessive amount of formaldehyde. It was suggested that improper use of tableware might also lead to migration of melamine into the foodstuff. In December 2008, General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China conducted a country-wide survey on all types of melamine-ware sold in major shops and supermarkets in the Mainland and reported that all melamine-ware produced by certified manufacturers were tested satisfactory.

5. In the UK, a study on melamine-ware conducted by the UK Food Standards Agency (FSA) in 2004 revealed that in all 50 samples tested for migration of melamine from the melamine-ware was within the European Union (EU)'s legal limit of 30 mg/kg. However, the migration of formaldehyde were found to be 8 – 76 times above the EU legal maximum (15 mg/kg) in 5 samples.[1,2] The UK FSA stated that consumers' health might have been at risk. A follow-up study released in August 2008 again reported that in 8 out of 50 samples of melamine-ware tested, the level of formaldehyde migration was 6 – 65 times the EU specified legal maximum migration limit.[3]

6. In Hong Kong, the Customs and Excise Department has sampled melamine tableware from the market for testing by the Government Laboratory. The results of the safety test, which was released in February 2009, revealed that the level of formaldehyde migration from one model of melamine ladle was 4.3 times the GB permissible hygienic standard (30 mg per litre) for melamine products used as food containers and tableware in the Mainland China (GB9690-88).[4] It was not known whether the migration of formaldehyde and melamine from the melamine-ware available for use on local food premises would be a cause of potential safety concern to consumers.

HAZARD IDENTIFICATION

Potential hazard of melamine-ware

7. The migration of impurities and excessive heavy metals could be a problem for any type of food contact materials. However, the major safety concern of tableware made of melamine-formaldehyde resins is the possible migration of excessive melamine and formaldehyde to food.

8. Melamine is of low acute toxicity. Data from animal studies show that high levels of melamine would cause bladder and kidney stones. In 2008, high levels of melamine in infant milk and other milk products have led to kidney damage in Chinese children.

9. Formaldehyde occurs naturally in the environment and can be found naturally in small amounts in a wide range of raw foods, including fruit and vegetables, meat, fish, crustacean, dairy products, etc. Ingestion of a small amount of formaldehyde is unlikely to cause any acute toxicity. However, ingestion of a large amount of formaldehyde can cause severe abdominal pain, vomiting, coma, renal injury and possible death. Animal studies have shown that long-term exposure to formaldehyde in drinking-water might lead to pathological changes in the stomach and increase in kidney weight. Formaldehyde is a carcinogen by inhalation although sustained exposure to a high concentration of formaldehyde would probably be necessary to cause a potential risk to health.

Regulatory control of melamine food contact materials

10. In Mainland China, according to the new GB standard established in September 2009 (GB 9690-2009) "Hygienic standard for melamine-formaldehyde

products used as food containers and packaging materials", the migration limit for melamine and formaldehyde is 0.2 mg/dm^2 and 2.5 mg/dm^2, respectively. [5]

11. In the EU, according to the Commission Directive EC No 2002/72, melamine and formaldehyde are approved for use as monomers or additives in plastics with a specific migration limit of 30 mg/kg (5.0 mg/dm^2) food for melamine and 15 mg/kg (2.5 mg/dm^2) food for formaldehyde.[6]

12. In the USA, it is specified that the molded melamine-formaldehyde food-contacting articles when extracted with the solvent(s) characterising the type of food in contact and under the conditions as specified in 21 CFR 177, shall yield net chloroform-soluble extracts not to exceed 0.5 mg/in^2 (~7.8 mg/dm^2) of food-contact surface.[7] However, no specific standards for migration limits of melamine or formaldehyde have been established.

Local situation

13. Food containers normally supplied for private use or consumption in Hong Kong is controlled under the Consumer Goods Safety Ordinance (CGSO), Cap 456, which is enforced by the Customs and Excise Department while the safety use of utensils/tableware in restaurants is under the ambit of FEHD.

14. There is no specific regulation governing the safety of utensils /tableware. However, Section 6 of Food Business Regulation, Cap. 132 stipulated that every person who carries on any food business shall at all times ensure that all furniture, articles, equipment and utensils used are kept clean and free from noxious matters and in proper repair and free from cracks or chipping. Furthermore, according to the Preservatives in Food Regulations, Cap. 132 a maximum level of 5 mg formaldehyde per kg of food is allowed, provided that the chemical is from the

packaging or containers that are manufactured with formaldehyde-based resins and plastics.

15. Due to the lack of local data on the level of migration of melamine and formaldehyde from melamine-made tableware available for use on the local food premises, the associated health risk to the local population cannot be assessed. A study is therefore needed to examine the situation in the local scene.

HAZARD CHARACTERISATION

I. MELAMINE

Nature of melamine

16. Melamine (also known as tripolycyanamide, or 2,4,6-triamino-1,3,5-triazine) is an industrial chemical used for the production of melamine resins, typically by reaction with formaldehyde. Melamine resins or other melamine compounds are used in laminates (e.g. for tabletops), glues, adhesives, molding compounds, coatings, paper (to obtain wet strength), textiles (to obtain shrink resistance, water repellence, stain repellence, fire retardance), flame retardants or superplastisizer for concrete. The end products include countertops, dry erase boards, fabrics, glues, houseware (including kitchen utensils and tableware) and flame retardants.

17. Melamine is also a major component of pigment yellow 150 (colorant for inks and plastics), fertilizers, derivatives of arsenical drugs for the treatment of African Sleeping Sickness (trypanosomiasis), and a metabolite of the pesticide cyromazine.[8,9,10]

18. Melamine is not allowed in food in any quantity. However, melamine has been found to be illegally used to boost nitrogen levels of food products during protein test. Recent examples include the 2008 melamine milk products incident in Mainland China and the 2004 and 2007 melamine pet foods incident in the USA, Canada and South Africa, causing pathological effects in humans and in pets, respectively. [15]

19. The structurally related compounds of melamine, namely cyanuric acid, ammelide and ammeline, have raised toxicological concern in the international arena, particularly the possibility of their enhanced toxicity in combination with melamine. Cyanuric acid is a structural analogue of melamine. It may be found as an impurity of melamine. Cyanuric acid is an FDA-accepted component of feed-grade biuret, a ruminant feed additive. It can also be found in swimming pool water as the dissociation product of dichloroisocyanurates used for water disinfection.[11]

Toxicity of melamine and its structural analogues

20. The Joint Food and Agriculture Organization (FAO) / World Health Organization (WHO) Expert Committee on Food Additives (JECFA) has not evaluated the safety of melamine and its structural analogues. Little human data on oral exposure to melamine were available before the 2008 outbreak of the infant kidney stone cases in the Mainland. WHO convened an expert meeting in December 2008 to review the toxicological aspects of melamine and cyanuric acid. A tolerable daily intake of 0.2 mg/ kg body weight was established for melamine.

Kinetics and metabolism

21. Melamine can be degraded by hydrolysis by three successive deamination reactions to ammeline, ammelide and cyanuric acid in bacteria.[10] After oral administration of a single dose of melamine labelled by isotope, 90% of the administered dose was excreted within the first 24 hours into urine in rats. Only slight differences in levels of radioactivity between blood, liver or plasma were observed, suggesting that melamine is distributed in the body water. Radioactivity levels were much higher in the kidney and the bladder compared to plasma. It is considered that bladder levels were highest, probably due to either back diffusion from urine or a contamination of the bladder tissue with urine.[10] However, a study with oral application in rats indicates that melamine is not metabolised and is rapidly eliminated via urine, with an elimination half-life in plasma of about 3 hours.

22. The rapid clearance from the body shows that melamine and its analogues do not accumulate in mammalian tissues. The US Food and Drug Administration (FDA) in 2007 also considers that melamine is metabolically inactive or inert (i.e. it does not readily undergo any type of metabolic change) and there is a reasonable probability that all monogastric species eliminate the originally ingested substance, melamine or its analogues, and not a metabolite.

23. A US patent for the use of melamine as a source of non-protein nitrogen for cattle (melamine may be utilizable by the rumen microorganisms) was filed in 1970.[6] However, a study to determine the effectiveness of melamine as a non-protein nitrogen source for ruminants published in 1978 concluded that melamine may not be an acceptable non-protein nitrogen source for ruminants because melamine may not be hydrolysed in the rumen at a rate sufficient to promote maximum ruminal protein synthesis and the incompletely hydrolysed fractions may be absorbed and voided in

the urine.[12] There is no official information to-date that melamine is currently approved for use in animal feed.

Acute toxicity

24. Melamine is of low acute toxicity. The reported oral median lethal dose (LD_{50}) values were 3100 - 3300 mg/kg of body weight (bw) in rodents.[8,10,11] Melamine produced diuresis and crystalluria (i.e. excretion of crystals in the urine) in rats and dogs given a single oral dose of 2400 mg/kg. Signs of toxicity following lethal doses to mice included lacrimation, dyspnea, intermittent tremors and coma preceding death.

Genotoxicity and carcinogenicity

25. The International Agency for Research on Cancer (IARC) of the WHO (1999) evaluated the carcinogenicity of melamine and considered that there was inadequate evidence in humans for the carcinogenicity of melamine and there was sufficient evidence in experimental animals for the carcinogenicity of melamine under conditions in which it produces bladder calculi (i.e. stones). IARC classified melamine as Group 3 agent, i.e. not classifiable as to its carcinogenicity to humans.[13]

26. IARC also noted that melamine was not genotoxic in experimental system and the non-DNA-reactive mechanism by which melamine produced urinary bladder tumours in male rats occurred only under conditions in which calculi were produced.[13]

27. The European Food Safety Authority (EFSA) in 2007 also considered that melamine is not genotoxic or carcinogenic.[10]

Chronic toxicity

28. The most commonly observed effects in animal experiments where melamine was administered orally include reduced food consumption, body weight loss, bladder stones, crystalluria, epithelial hyperplasia of urinary bladder and lowered survival rate. However, no kidney failure or clinical symptoms of kidney failure were observed. The lowest no-observed-adverse-effect-level (NOAEL) noted in published literature was 63 mg/kg bw/day for stone formation in a 13-week rat study.[14] EFSA considered that melamine is not teratogenic.[10]

Observation in Human

29. With reference to the data from the 2008 Chinese incident, it showed that infant formula contaminated mainly with melamine can result in stone formation if sufficient concentrations are present. Limited data indicate that stones are composed of uric acid and melamine at a molar ratio ranging from 1.2:1 to 2.1:1, without evidence of the presence of cyanuric acid or other melamine analogues.

30. Most children with stones developed in the urinary tract did not have clinical signs of illness. Overt clinical symptoms only occurred in severe cases of renal failure and/or blockage.

II. FORMALDEHYDE

Nature of formaldehyde

31. For industrial uses, formaldehyde is produced by catalytic, vapour-phase oxidation of methanol. Formaldehyde is used mainly in the production of phenolic,

urea, melamine and polyacetal resins. These materials have wide uses as adhesives and binders for the wood products, pulp and paper, and synthetic vitreous fibre industries and in the production of plastics and coatings as well as in textile finishing. Formaldehyde is often used as preservative in cosmetics. In addition, formaldehyde has been used as a fumigant in wheat and oats, as well as in some other plants and vegetables.[16,17,18]

Routes of human exposure

32. The general population is exposed to formaldehyde during release from combustion (e.g. from cigarettes and cooking) and emission from some building materials. They may also get exposed via the application of consumer products containing formaldehyde as a preservative and the consumption of food containing formaldehyde either naturally or as a preservative. A survey conducted in Canada indicated that daily intake of formaldehyde via ingestion of foodstuffs was consistently higher than via inhalation. Nevertheless, the focus of human health assessment is airborne exposure, due primarily to the lack of representative data on concentration in media other than air and limited data on effects following ingestion.[16]

Kinetics and metabolism

33. Following ingestion, formaldehyde is readily absorbed from the gastrointestinal tract and converted to formate, which is further oxidised to carbon dioxide or incorporated into nucleic acids and amino acids.[17,19] Excretion of formate in the urine is the other major route of elimination of formaldehyde.[16] Formaldehyde also shows dose-dependent toxicity in cell cultures.[18] However, the bioavailability of formaldehyde in various foods following ingestion is not known.[16]

Acute toxicity

34. It has been reported that oral LD_{50} s of 800 and 260 mg/kg body weight for rats and guinea pigs.[16] Also, there is evidence that formaldehyde can induce irritation to the forestomach in experimental animals after high-dose oral exposure.[18] Human deaths have also been reported after ingestion of 517-624 mg/kg body weight of formaldehyde (in form of formalin containing 37% formaldehyde).[19] Generally speaking, ingestion of large amounts of formaldehyde can cause severe abdominal pain, vomiting, coma, renal injury and possible death.[17,19]

Carcinogenicity

35. The International Agency for Research on Cancer (IARC) re-evaluated the carcinogenicity of formaldehyde in 2004 and considered that there was sufficient evidence for carcinogenicity in both humans and experimental animals. IARC re-classified formaldehyde from Group 2A (probably carcinogenic to humans) to Group 1 (carcinogenic to humans). After reviewing the epidemiological data in humans upon occupational exposure, IARC concluded that:[18]

(i) there is *sufficient* epidemiological evidence that formaldehyde causes nasopharyngeal cancer in humans;

(ii) there is *strong but not sufficient* evidence for a causal association between leukaemia and occupational exposure to formaldehyde;

(iii) there is *limited* epidemiological evidence that formaldehyde causes sinonasal cancer in humans; and

(iv) there is *insufficient* epidemiological evidence for a causal role for formaldehyde in relation to other cancers including the oral cavity, oro- and hyophayrynx, pancreas, larynx, lung and brain.

36. However, it should be noted that IARC's consideration was mainly based on studies of occupational exposures in workers.[18] In establishing the guideline value for formaldehyde in drinking water, the World Health Organization (WHO) in 2005 considered that the weight of evidence indicates that formaldehyde is not carcinogenic upon ingestion.[20]

Genotoxicity

37. In its evaluation in 2004, IARC considered that formaldehyde is genotoxic in multiple *in vitro* models and in exposed humans and experimental animals.[18]

Chronic toxicity

38. Animal studies showed that long-term exposure to formaldehyde in drinking-water might lead to pathological changes in the stomach and increase in kidney weights.[20] There have been epidemiological studies examining the reproductive effects upon occupational exposures to formaldehyde but the results are inconsistent.[18]

Safe reference intakes

39. The Joint Food and Agriculture Organization / World Health Organization Expert Committee on Food Additives (JECFA) has not evaluated the safety of formaldehyde in foods.

40. The US Agency for Toxic Substances and Disease Registry has established the intermediate and chronic oral minimal risk level for formaldehyde at 0.3 mg/kg/day and 0.2 mg/kg/day, respectively.[21] Minimal risk level is an estimate of the daily human exposure to a hazardous substance that is likely to be without

appreciable risk of adverse noncancer health effects over a specified duration of exposure, intermediate being14 - 364 days and chronic being 365 days and longer.

Formaldehyde in Foods

41. Formaldehyde may be present in various foodstuffs due to natural metabolism, post-mortem decomposition, food processing or in animal products which are derived from animals feeding on formaldehyde containing feeds, migration from formaldehyde containing food contact materials, therapeutic use in aquaculture and illegal use as food preservative. [16,19,22,23]

RISK ASSESSMENT

Scope of study

42. This study covered repeated-use melamine-made tableware available for use on food premises in Hong Kong. Melamine-ware samples of the same kinds used to serve customers were obtained via two channels (i) from food premises direct, and (ii) from manufacturers/ suppliers of melamine-ware to food premises. Seven different types of melamine-ware commonly used by consumers were sampled and analysed, namely, (i) regular bowls (ii) large bowls (iii) cups (iv) dishes/ plates (v) spoons (vi) ladles and (vii) chopsticks. For interpretation of results with respect to testing standards, only new unused samples were collected and analysed for migration of melamine and formaldehyde. Details of the types, brands and sources of the melamine-ware samples analysed in this study are presented in Annex II and III.

Methodology

Sampling

43. The sampling consisted of two phases. Phase I sampling was conducted to collect samples from local food premises direct and Phase II from manufacturers/ suppliers of melamine-ware to local food premises. Eight to twenty-four new, unused pieces of each product were sent to the Food Research Laboratory (FRL) for material identification and analysis for migration of melamine and formaldehyde. If available, an extra piece of the product was collected for sample record. The final number of melamine-ware collected and analysed was determined by the number of new melamine-ware provided by the food premises and/or the stock availability of the manufacturer/ supplier.

44. A total of 73 melamine-ware samples were collected in Phase I and Phase II. Of these, 61 were found suitable for testing by the Food Research Laboratory. They were obtained from one fast food chain (5 samples), two local "tea-restaurant" chains (10 samples), one Chinese restaurant chain (6 samples), two Japanese restaurant chains (5 samples), one manufacturer (3 samples) and three suppliers (32 samples) of melamine-ware to local food premises and consisted of seven melamine-ware categories and covered nine brands. The seven melamine-ware categories were regular bowls (15 samples), large bowls (14 samples), cups (10 samples), plates (10 samples), spoons (3 samples), ladles (6 samples) and chopsticks (3 samples). The nine brands included Dynasty (3 samples), Ever Unison (9 samples), Moreware (4 samples), Shun Ta (5 samples), Smile (1 sample), Swan (9 samples), Tong Ya (12 samples), Uli (10 samples) and WK (6 samples).

45. Twelve of the melamine-ware samples collected were found not suitable for

testing either because they were identified as non-melamine-ware by infrared spectroscopy or they were shallow plates with inadequate holding volume for standard test extraction and judged unlikely to be used for serving liquid foods (e.g. sushi plates).

Phase I Study (May – October 2009)

46. In the Phase I study, new, unused melamine-ware samples were collected from local food premises for the analysis of specific migration of melamine and formaldehyde from the food-ware into the contacting medium. Assistance from food trade associations was sought in collecting the necessary samples from their trade members.

47. The study was commenced in May 2009. Samples were collected during June-September 2009 from various local food premises via the Hong Kong Federation of Restaurants & Related Trades Limited (HKFORT) under an anonymous arrangement. The source of melamine-ware samples obtained covered four main types of food premises, namely, (i) fast food chains, (ii) local "tea restaurant" chains , (iii) Chinese restaurant chains and (iv) Japanese restaurant chains. The samples were analysed by the FRL during the period July-October 2009.

48. A total of 35 samples were collected and 26 samples were found suitable for testing. These samples were obtained from one fast food chain (5 samples), two local "tea-restaurant" chains (10 samples), one Chinese restaurant chain (6 samples) and two Japanese restaurant chains (5 samples). They consisted of seven melamine-ware categories, namely, (i) regular bowls (4 samples), (ii) large bowls (7 samples), (iii) cups (3 samples), (iv) plates (6 samples), (v) spoons (3 samples), (vi) ladles (2 samples) and (vii) chopsticks (1 sample). They covered six brands of

melamine-ware make, including Moreware (4 samples), Shun Ta (3 samples), Smile (1 samples), Swan (3 samples), Tong Ya (3 samples) and Uli (10 samples) while the brands for two samples were not known.

Phase II Study (October 2009 – February 2010)

49. Phase II study commenced in October 2009 and was completed in February 2010. Samples were collected during November-December 2009 by purchasing new, unused melamine-ware directly from manufacturers/wholesalers known to be suppliers of melamine-ware to local food premises. The purchased melamine-ware samples were analysed by the FRL during the period November 2009 – February 2010.

50. An initial list of relevant local/regional suppliers/manufacturers of melamine-ware was compiled. Sources of information included contacts provided by the trade associations and internet search. From this list, manufacturers/suppliers that were known or claimed to routinely supply melamine-ware to food premises in Hong Kong were further identified and counter-checked to the best of our ability prior to purchase of melamine-ware samples.

51. A total of 38 samples were purchased from one manufacturer and three suppliers of melamine-ware to local food premises. Thirty-five samples were found suitable for testing, of which 3 samples were purchased from the manufacturer and 32 samples were purchased from the suppliers of melamine-ware. These samples consisted of six melamine-ware categories, namely, (i) regular bowls (11 samples), (ii) large bowls (7 samples), (iii) cups (7 samples), (iv) plates (4 samples), (v) ladles (4 samples) and (vi) chopsticks (2 samples). They covered six brands of melamine-ware make, including three new brands not covered by Phase I study,

namely, Dynasty (3 samples), Ever Unison (9 samples) and WK (6 samples). The other three brands were Shun Ta (2 samples), Swan (6 samples) and Tong Ya (9 samples).

Laboratory analysis

52. Sixty-one repeated-use tableware products made by melamine-formaldehyde resins known to be commonly available for use on food premises in Hong Kong were collected and analysed for migration of melamine and formaldehyde.

53. All samples were sent to the Food Research Laboratory of the CFS for analyses of melamine and formaldehyde migration, and for material identification by Infrared Spectroscopy when required. For laboratory analysis of melamine and formaldehyde migration, both the European Committee for Standardisation method (CEN method EN 13130-1:2004) and the GB test method (GB 9690-2009) were used.[5, 24, 25]

54. The EU testing method specifies different testing conditions for simulation by different food contact uses. In this study, the food simulant and test condition reflecting the greatest migration (i.e. worst case) was used, i.e. specimen was exposed to 3% aqueous acetic acid (as simulant) for 2 hours at 70 °C. In accordance with the EU testing method specified for a material or article intended to come into repeated contact with foodstuffs, the migration test was repeated three times on the same test specimen, (using a fresh sample of simulant each time) and the level of migration was determined using the simulant from the third test. For the GB testing, specimen was exposed to 4% aqueous acetic acid (as simulant) for 2 hours at 60 °C according to GB 9690-2009. Only one migration test was carried out. The reference standards are

listed in Annex I.

55. Wherever possible, three specimens of the same sample were tested under the EU and the GB testing conditions, respectively. For sample size fewer than eight pieces, three specimens were tested under EU testing conditions (as per specified requirement) and 1 specimen was tested under the GB testing conditions. The limit of quantification (LOQ) for melamine was 0.003 mg/dm^2 and that for formaldehyde was 0.044 mg/dm^2.

RESULTS

56. A total of 61 samples from 7 categories of melamine-made tableware covering 9 brands were sampled and analysed. Detailed records of the individual results of melamine migration and formaldehyde migration are presented in Annex II and Annex III, respectively. Tables 1, 2, and 3 summarize the study results according to various categories, brands and sources of melamine-ware samples obtained, respectively. The overall mean level of melamine migration from melamine-ware (LOQ = 0.003 mg/dm^2) was 0.027 mg/dm^2 (range: ND – 0.190 mg/dm^2) under the GB test and 0.050 mg/dm^2 (range: ND – 0.280 mg/dm^2) under the EU test. The overall mean level of formaldehyde migration from melamine-ware (LOQ = 0.044 mg/dm^2) was 0.090 mg/dm^2 (range: ND – 0.407 mg/dm^2) under the GB test and 0.217 mg/dm^2 (range: ND – 0.750 mg/dm^2) under the EU test.

57. Table 1 shows the level of melamine and formaldehyde migration from different categories of melamine-ware samples tested. The mean level of melamine migration ranged from 0.014–0.053 mg/dm^2 for GB test and 0.037–0.112 mg/dm^2 for EU test, while the mean level of formaldehyde migration ranged from 0.066–0.209 mg/dm^2 for GB test and 0.192–0.386 mg/dm^2 for EU test. Table 2 shows the level

of melamine and formaldehyde migration from different brands of melamine-ware samples tested. The mean level of melamine migration ranged from 0.003–0.068 mg/dm^2 for GB test and 0.002–0.100 mg/dm^2 for EU test, while the mean level of formaldehyde migration ranged from 0.022–0.188 mg/dm^2 for GB test and 0.022–0.346 mg/dm^2 for EU test. Table 3 shows the melamine and formaldehyde migration levels from melamine-ware samples obtained from different sources. The mean level of melamine migration ranged from 0.009–0.065 mg/dm^2 for GB test and 0.014–0.080 mg/dm^2 for EU test, while the mean level of formaldehyde migration ranged from 0.062–0.140 mg/dm^2 for GB test and 0.138–0.238 mg/dm^2 for EU test.

Table 1: Migration of melamine and formaldehyde from various categories of melamine-ware samples

Melamine-ware samples	Melamine migration (mg/dm^2)		Formaldehyde migration (mg/dm^2)	
	Mean	**Range**	**Mean**	**Range**
Results of testing conducted under conditions specified by GB standard:				
Regular Bowl (15)	0.017	0.004 - 0.049	0.074	ND - 0.167
Large Bowl (14)	0.038	0.003 - 0.140	0.094	ND - 0.407
Cup (10)	0.014	0.003 - 0.029	0.084	ND - 0.200
Plate (10)	0.029	ND - 0.190	0.066	ND - 0.230
Spoon (3)	0.035	0.019 - 0.062	0.138	0.073 - 0.220
Ladle (6)	0.029	0.006 - 0.031	0.081	ND - 0.147
Chopsticks (3)	0.053	0.023 - 0.087	0.209	0.117 - 0.260
Total (61)	**0.027**	**ND – 0.190**	**0.090**	**ND – 0.407**
Results of testing conducted under conditions specified by EU standard:				
Regular Bowl (15)	0.037	0.008 - 0.076	0.207	0.071 - 0.390
Large Bowl (14)	0.042	ND - 0.167	0.195	ND - 0.750
Cup (10)	0.041	0.007 - 0.062	0.230	0.092 - 0.390
Plate (10)	0.071	0.003 – 0.280	0.199	0.061 - 0.513
Spoon (3)	0.066	0.054 - 0.076	0.268	0.230 - 0.287
Ladle (6)	0.043	0.025 - 0.074	0.192	0.147 - 0.270
Chopsticks (3)	0.112	0.052 - 0.193	0.386	0.257 - 0.557
Total (61)	**0.050**	**ND – 0.280**	**0.217**	**ND – 0.750**

Number in bracket ( ) denotes the number of melamine-ware samples.

ND: not detected; i.e. level of melamine < 0.003 mg/dm^2 or level of formaldehyde < 0.044 mg/dm^2.

The value of 1/2 LOQ was assigned to non-detects (results below LOQ) for the calculation of mean levels.

Table 2: Migration of melamine and formaldehyde from various brands of melamine-ware samples

Melamine-ware brands	Melamine migration (mg/dm^2)		Formaldehyde migration (mg/dm^2)	
	Mean	**Range**	**Mean**	**Range**
Results of testing conducted under conditions specified by GB standard:				
Dynasty (3)	0.025	0.015 – 0.041	0.112	0.062 – 0.167
Ever-Unison (9)	0.019	0.004 – 0.080	0.045	ND – 0.124
Moreware (4)	0.018	0.009 – 0.024	0.072	0.043 – 0.120
Shun Ta (5)	0.068	0.010 – 0.190	0.188	0.085 – 0.260
Smile (1)	0.003	0.003	0.022	ND
Swan (9)	0.031	0.003 – 0.101	0.086	ND – 0.207
Tong Ya (12)	0.036	0.006 – 0.140	0.092	ND – 0.407
Uli (10)	0.010	ND – 0.019	0.081	ND – 0.200
WK(6)	0.013	0.004 – 0.033	0.083	ND – 0.137
Unknown (2)	0.047	0.007 – 0.087	0.163	0.075 – 0.250
Total (61)	**0.027**	**ND – 0.190**	**0.090**	**ND – 0.407**
Results of testing conducted under conditions specified by EU standard:				
Dynasty (3)	0.056	0.043 – 0.075	0.346	0.280 – 0.390
Ever-Unison (9)	0.048	0.024 – 0.092	0.184	0.090 – 0.343
Moreware (4)	0.035	0.004 – 0.061	0.218	0.117 – 0.390
Shun Ta (5)	0.100	0.035 – 0.280	0.324	0.257 – 0.513
Smile (1)	0.002	ND	0.022	ND
Swan (9)	0.034	0.007 – 0.087	0.169	0.071 – 0.320
Tong Ya (12)	0.069	0.011 – 0.179	0.242	0.095 – 0.750
Uli (10)	0.024	0.003 – 0.068	0.153	0.061 – 0.290
WK(6)	0.037	0.017 – 0.076	0.242	0.101 – 0.380
Unknown (2)	0.100	0.006 – 0.193	0.313	0.069 – 0.557
Total (61)	**0.050**	**ND – 0.280**	**0.217**	**ND – 0.750**

Number in bracket ( ) denotes the number of melamine-ware samples.

ND: not detected; level of melamine < 0.003 mg/dm^2 or level of formaldehyde < 0.044 mg/dm^2.

The value of 1/2 LOQ was assigned to non-detects (results below LOQ) for the calculation of mean levels.

Table 3: Migration of melamine and formaldehyde from melamine-ware samples obtained from various sources

Source	Melamine migration (mg/dm^2)		Formaldehyde migration (mg/dm^2)	
	Mean	**Range**	**Mean**	**Range**
Results of testing conducted under conditions specified by GB standard:				
Fast food chains (5)	0.020	0.009 – 0.029	0.072	0.043 – 0.120
Local "tea-restaurant" chains (10)	0.065	0.003 – 0.190	0.140	ND – 0.250
Chinese restaurant chains (6)	0.010	ND – 0.019	0.097	0.051 – 0.200
Japanese restaurant chains (5)	0.009	0.003 – 0.018	0.062	ND – 0.180
Manufacturers/ suppliers (35)	0.023	0.003 – 0.140	0.081	ND – 0.407
Total (61)	**0.027**	**ND – 0.190**	**0.090**	**ND – 0.407**
Results of testing conducted under conditions specified by EU standard:				
Fast food chains (5)	0.036	0.004 – 0.061	0.204	0.117 – 0.390
Local "tea-restaurant" chains (10)	0.080	ND – 0.280	0.238	ND – 0.557
Chinese restaurant chains (6)	0.029	0.003 – 0.068	0.152	0.061 – 0.287
Japanese restaurant chains (5)	0.014	0.004 – 0.025	0.138	0.068 – 0.290
Manufacturers/ suppliers (35)	0.052	0.007 – 0.179	0.229	0.085 – 0.750
Total (61)	**0.050**	**ND – 0.280**	**0.217**	**ND – 0.750**

Number in bracket ( ) denotes the number of melamine-ware samples.

ND: not detected; i.e. level of melamine < 0.003 mg/dm^2 or level of formaldehyde < 0.044 mg/dm^2.

The value of 1/2 LOQ was assigned to non-detects (results below LOQ) for the calculation of mean levels.

DISCUSSION

58. In this study, according to the GB and EU testing methods, sample analysis needs to be carried out on new unused melamine-ware for the purpose of standardisation which would best reflect the quality of the melamine-ware under test.

59. Since melamine-ware may come into contact with all types of foods, the food simulant and test condition simulating the greatest migration (i.e. worst-case scenario) was adopted in the present study, an approach similar to the UKFSA surveys conducted in 2004 and 2008. [1,2,3]

60. Results indicate that all melamine-ware samples tested had low levels of migration of both melamine and formaldehyde under experimental conditions that simulated the worse-case scenario. For the GB test, all samples showed melamine migration level of < 0.2 mg/dm^2 and formaldehyde migration level of < 0.5 mg/dm^2. For the EU test, all samples showed melamine migration level of < 0.3 mg/dm^2 and formaldehyde migration level of < 0.8 mg/dm^2. These levels were below the respective GB/ EU specified limits for migration of melamine and formaldehyde (see Table 4). No overt difference in the concentration range of melamine and formaldehyde migration was noted between the various categories, brands or sources of the melamine-ware samples.

Table 4: GB and EU limits for migration of melamine and formaldehyde

Migration test	GB 9690-2009	EU limit
Melamine	0.2 mg/dm^2	30 mg/kg (equivalent to 5 mg/dm^2)
Formaldehyde	2.5 mg/dm^2	15 mg/kg (equivalent to 2.5 mg/dm^2)

61. The low levels of migration of melamine and formaldehyde detected in all melamine-ware samples tested in this study under the worst-case scenario indicate that these melamine-ware samples are not expected to pose health concern to consumers under normal food use.

62. The levels of migration of melamine and formaldehyde measured in this study (melamine migration: ND – 0.280 mg/dm^2; formaldehyde migration: ND – 0.750 mg/dm^2, under the EU test) were much lower compared to those reported in the UKFSA studies conducted in 2004 and 2008. In the 2004 UKFSA study, the reported melamine and formaldehyde migration ranged from 0.051 – 0.90 mg/dm^2 and 0.055 – 190 mg/dm^2, respectively. In the UK studies, for the 13 samples that showed formaldehyde migration level exceeding the EU limit (5/50 samples in 2004 study and 8/50 in 2008 study), Turkey was the country of origin for one sample, China for two samples and the country of origin was not given for the remaining 10 samples. No samples of the brands of the non-compliant samples in the UK studies were available for this study.

LIMITATIONS

63. In this study, a total of 61 samples from 7 categories of melamine-made tableware covering 9 brands and 4 main types of local food premises were analysed. The types of melamine-ware studied were not exhaustive and coverage of local food premises was limited. Increasing the types of melamine-ware, the number of brands, the number of local food premises and the sample number in each would provide a more comprehensive coverage of melamine-ware used on local food premises for a better estimate of melamine and formaldehyde migration.

64. The number and types of food premises where melamine-ware samples were obtained under an anonymous arrangement were limited due to the voluntary basis of sample provision by food premises.

65. The sample number was also limited by availability since only new unused melamine-ware samples could be used for analysis and those melamine-ware used on food premises were not readily available in the market.

66. The number of manufacturer/suppliers were limited since melamine-ware samples were obtained only from those manufacturers/ suppliers verified to be suppliers of melamine-ware to local food premises and those that were locally accessible or were able to arrange freight of the purchased samples within the sampling period.

CONCLUSION AND RECOMMENDATIONS

67. This study investigated the levels of migration of melamine and formaldehyde from commonly used melamine-ware categories of brands available for use on local food premises. The study results show that even under experimental conditions that simulate the worse-case scenario, all melamine-ware samples tested had low levels of migration of melamine and formaldehyde which were well below the GB and EU specified migration limits, indicating that all melamine-ware samples tested were of the quality suitable for food use. Based on the satisfactory analytical results, the melamine-ware samples tested are not expected to pose health concern to consumers under normal food use. There is no cause for alarm.

68. It is noted that instructions on the recommended conditions of use of the melamine-ware are often specified on the package or provided at the manufacturer's

company website. Most manufacturers specify a temperature of -30 ^{o}C to +120 ^{o}C while some specify a temperature of up to +140 ^{o}C. General instructions for safe use include not to use the melamine-ware for cooking, holding hot oil or highly acidic foods, and in particular, not to use melamine-ware for heating in microwave or conventional oven. Based on the product information provided by the manufacturers, the following recommendations on the safe use of melamine-ware are formulated.

General Advice for Using Melamine-ware

- ◆ Use melamine-ware according to product specifications and instructions.
- ◆ Do not use melamine-ware that is broken or damaged on its surface.
- ◆ Do not heat or cook foods in melamine-ware.
- ◆ Do not use melamine-ware in microwave oven or conventional oven.
- ◆ Do not use melamine-ware to hold hot oil or highly acidic foods.
- ◆ If melamine-ware is to be used for holding hot deep-fried foods, cool the foods down before putting in the melamine-ware.
- ◆ For cleaning, do not use abrasive detergent and cleaning tools or strong chemicals which will damage the surface.

Advice to Food Businesses

- Restaurants and food businesses should obtain melamine-ware from reliable manufacturers and suppliers and use melamine-ware of suitable quality to serve food to customers.

- Use melamine-ware according to the product specifications and instructions.

Advice to Manufacturers and Suppliers

- Manufacturers should adopt good manufacturing practices in making melamine-ware for food use.

- Manufacturers are advised to provide instructions on its intended use.

- Suppliers should obtain melamine-ware products from reliable manufacturers and ensure the products are of suitable quality for food use.

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Annex I

Reference standards

Test	Reference Standards
1. Melamine 2. Formaldehyde	Limit: EC Directive 2002/72 Testing conditions: Directive 82/711/EEC EN 13130-1:2004 Materials and articles in contact with foodstuffs - Plastics substances subject to limitation - Part 1: Guide to test methods for the specific migration of substances from plastics to foods and food simulants and the determination of substances in plastics and the selection of conditions of exposure to food simulants
3. Melamine 4. Formaldehyde	GB 9690-2009: Hygienic standard for melamine-formaldehyde products used as food containers and packaging materials. 中華人民共和國國家標準 GB9690 – 2009《食品容器、包裝材料用三聚氰胺-甲醛成型品衛生標準》

Annex II

Level of melamine migration from melamine-ware samples

Category and brand	Source	No. of samples	Melamine migration (mg/dm²)	
			Mean (Range) (GB test)	Mean (Range) (EU test)
Regular Bowl		**15**	**0.017 (0.004 – 0.049)**	**0.037 (0.008 – 0.076)**
Dynasty	Manufacturer	2	0.028 (0.015 – 0.041)	0.063 (0.050 – 0.075)
Ever Unison	Supplier	3	0.009 (0.006 – 0.010)	0.033 (0.024 – 0.043)
Moreware	Fast food chain	1	0.016	0.021
Swan	Local tea restaurant chain Supplier	1 1	0.027 (0.006 – 0.049)	0.018 (0.013 – 0.023)
Tong Ya	Supplier	2	0.015 (0.010 – 0.019)	0.047 (0.033 – 0.061)
Uli	Chinese restaurant chain Japanese restaurant chain	1 1	0.011 (0.011 – 0.011)	0.019 (0.008 – 0.030)
WK	Supplier	3	0.014 (0.004 – 0.033)	0.046 (0.030 – 0.076)
Large Bowl		**14**	**0.038 (0.003 – 0.140)**	**0.042 (ND – 0.167)**
Dynasty	Manufacturer	1	0.018	0.043
Ever-Unison	Supplier	1	0.009	0.052
Moreware	Fast food chain	1	0.009	0.004
Smile	Local tea restaurant chain	1	0.003	0.002
Swan	Local tea restaurant chain	2	0.091 (0.101 – 0.082)	0.045 (0.018 – 0.071)
Tong Ya	Supplier	4	0.070 (0.007 – 0.140)	0.083 (0.011 – 0.167)
Uli	Japanese restaurant chain	2	0.004 (0.003 – 0.006)	0.012 (0.020 – 0.004)
WK	Supplier	1	0.020	0.030
Unknown	Chinese restaurant chain	1	0.007	0.006
Cup		**10**	**0.014 (0.003 – 0.029)**	**0.041 (0.007 – 0.062)**
Ever-Unison	Supplier	2	0.010 (0.004 – 0.016)	0.040 (0.033 – 0.048)
Moreware	Fast food chain	1	0.024	0.061
Shun Ta	Supplier	1	0.010	0.058
Swan	Supplier	2	0.004 (0.003 – 0.005)	0.013 (0.007 – 0.019)
Tong Ya	Supplier	1	0.029	0.055
Uli	Chinese restaurant chain Japanese restaurant chain	1 1	0.019 (0.018 – 0.019)	0.044 (0.025 – 0.062)
WK	Supplier	1	0.013	0.040
Plate		**10**	**0.029 (ND – 0.190)**	**0.071 (0.003 – 0.280)**
Shun Ta	Local tea restaurant chain	1	0.190	0.280
Swan	Local tea restaurant chain Supplier	1 1	0.012 (0.008 – 0.016)	0.066 (0.044 – 0.087)
Tong Ya	Local tea restaurant chain Supplier	1 2	0.022 (0.011 – 0.046)	0.087 (0.035 – 0.179)
Uli	Chinese restaurant chain Japanese restaurant chain	2 1	0.003 (0.002– 0.005)	0.007 (0.003 – 0.014)
WK	Supplier	1	0.005	0.017

Spoon		**3**	**0.035 (0.019 – 0.062)**	**0.066 (0.054 – 0.076)**
Moreware	Fast food chain	1	0.024	0.054
Shun Ta	Local tea restaurant chain	1	0.062	0.076
Uli	Chinese restaurant chain	1	0.019	0.068
Ladle		**6**	**0.029 (0.006 – 0.031)**	**0.043 (0.025 – 0.074)**
Ever-Unison	Supplier	2	0.047 (0.080 – 0.014)	0.054 (0.035 – 0.074)
Shun Ta	Supplier	1	0.031	0.035
Swan	Local tea restaurant chain	1	0.013	0.025
Tong Ya	Fast food chain Supplier	1 1	0.018 (0.006 – 0.029)	0.044 (0.041 – 0.046)
Chopsticks		**3**	**0.053 (0.023 – 0.087)**	**0.112 (0.052 – 0.193)**
Ever-Unison	Supplier	1	0.023	0.092
Shun Ta	Supplier	1	0.048	0.052
Unknown	Local tea restaurant chain	1	0.087	0.193
Total		**61**	**0.027 (ND – 0.190)**	**0.050 (ND – 0.280)**

Note:

ND: not detected; i.e. level of melamine < 0.003 mg/dm^2 or level of formaldehyde < 0.044 mg/dm^2.

The value of 1/2 LOQ was assigned to non-detects (results below LOQ) for the calculation of mean levels.

Annex III

Level of formaldehyde migration from melamine-ware samples

Category and brand	Source	No. of samples	Formaldehyde migration (mg/dm^2)	
			Mean (Range) (GB test)	Mean (Range) (EU test)
Regular Bowl		**15**	**0.074 (ND – 0.167)**	**0.207 (0.071 – 0.390)**
Dynasty	Manufacturer	2	0.136 (0.106 – 0.167)	0.378 (0.367 – 0.390)
Ever Unison	Supplier	3	0.022 (ND)	0.133 (0.090 – 0.170)
Moreware	Fast food chain	1	0.043	0.137
Swan	Local tea restaurant chain	1	0.079 (0.052 – 0.106)	0.126 (0.071 – 0.180)
	Supplier	1		
Tong Ya	Supplier	2	0.114 (0.085 – 0.143)	0.303 (0.297 – 0.310)
Uli	Chinese restaurant chain	1	0.083 (0.064 – 0.102)	0.115 (0.080 – 0.150)
	Japanese restaurant chain	1		
WK	Supplier	3	0.057 (ND – 0.080)	0.239 (0.101 – 0.380)
Large Bowl		**14**	**0.098 (ND – 0.407)**	**0.195 (ND – 0.750)**
Dynasty	Manufacturer	1	0.062	0.280
Ever-Unison	Supplier	1	0.033	0.213
Moreware	Fast food chain	1	0.060	0.117
Smile	Local tea restaurant chain	1	0.022 (ND)	0.022 (ND)
Swan	Local tea restaurant chain	2	0.188 (0.170 – 0.207)	0.165 (0.094 – 0.237)
Tong Ya	Supplier	4	0.140 (0.049 – 0.407)	0.311 (0.111 – 0.750)
Uli	Japanese restaurant chain	2	0.022 (0.022 – 0.022)	0.096 (0.068 – 0.123)
WK	Supplier	1	0.137	0.260
Unknown	Chinese restaurant chain	1	0.075	0.069
Cup		**10**	**0.084 (ND – 0.200)**	**0.230 (0.092 – 0.390)**
Ever-Unison	Supplier	2	0.022 (ND)	0.142 (0.130 – 0.153)
Moreware	Fast food chain	1	0.063	0.390
Shun Ta	Supplier	1	0.085	0.303
Swan	Supplier	2	0.029 (0.022 – 0.035)	0.123 (0.092 – 0.153)
Tong Ya	Supplier	1	0.077	0.213
Uli	Chinese restaurant chain	1	0.190 (0.180 – 0.200)	0.272 (0.253 – 0.290)
	Japanese restaurant chain	1		
WK	Supplier	1	0.137	0.323
Plate		**10**	**0.066 (ND – 0.230)**	**0.199 (0.061 – 0.513)**
Shun Ta	Local tea restaurant chain	1	0.230	0.513
Swan	Local tea restaurant chain	1	0.056 (0.046 – 0.066)	0.255 (0.190 – 0.320)
	Supplier	1		
Tong Ya	Local tea restaurant chain	1	0.037 (ND – 0.067)	0.179 (0.095 – 0.313)
	Supplier	2		
Uli	Chinese restaurant chain	2	0.050 (ND– 0.078)	0.093 (0.090 – 0.127)
	Japanese restaurant chain	1		
WK	Supplier	1	0.056	0.150

Spoon		**3**	**0.138 (0.073 – 0.220)**	**0.268 (0.230 – 0.287)**
Moreware	Fast food chain	1	0.120	0.230
Shun Ta	Local tea restaurant chain	1	0.220	0.287
Uli	Chinese restaurant chain	1	0.073	0.287
Ladle		**6**	**0.029 (0.006 – 0.080)**	**0.192 (0.147 – 0.270)**
Ever-Unison	Supplier	2	0.047 (0.014 – 0.080)	0.208 (0.147 – 0.270)
Shun Ta	Supplier	1	0.031	0.260
Swan	Local tea restaurant chain	1	0.013	0.180
Tong Ya	Fast food chain	1	0.018 (0.006 – 0.029)	0.148 (0.147 – 0.150)
	Supplier	1		
Chopsticks		**3**	**0.053 (0.023 – 0.087)**	**0.386 (0.257 – 0.557)**
Ever-Unison	Supplier	1	0.023	0.343
Shun Ta	Supplier	1	0.048	0.257
Unknown	Local tea restaurant chain	1	0.087	0.557
Total		**61**	**0.090 (ND – 0.407)**	**0.217 (ND – 0.750)**

Note:

ND: not detected; i.e. level of melamine < 0.003 mg/dm^2 or level of formaldehyde < 0.044 mg/dm^2.

The value of 1/2 LOQ was assigned to non-detects (results below LOQ) for the calculation of mean levels.