

Risk Assessment Studies
Report No. 36

Chemical Hazard Evaluation

**The Food Safety of Instant Cup Noodle
Containers**

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Centre for Food Safety
Food and Environmental Hygiene Department
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Table of Contents

	<u>Page</u>
Executive Summary	2
Objectives	5
Background	5
Scope of Study	12
Methods	12
Results	14
Discussion	21
Limitations	22
Conclusion and Recommendation	23
References	24
Annex I	27
Annex II	28

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EXECUTIVE SUMMARY

The Centre for Food Safety (CFS) has conducted a study to assess the safety and suitability of instant cup noodles (ICN) containers commonly available in Hong Kong for holding food.

ICN are commonly consumed in Hong Kong. The safety of ICN containers raised public concern following media reports on unsafe disposable containers. The primary concern of the containers for ICN is the migration of harmful substances from the containers into the food. Also, ICN containers should not leach out into the food an unacceptable quantity of their components because even if they are non-toxic, they may change the composition and affect the quality of the food.

Some chemical residues if present in the ICN containers may lead to health risk if they are migrated to food. Those of most concern are styrene monomer which is used to make polystyrene (PS), heavy metals which are impurities, and diaminotoluene, a contaminant that may remain in lids of ICN made of composite laminated films.

There are other substances such as additives, impurities, reaction products and breakdown products of the contact material of ICN that may migrate into the food. Measuring the specific levels of all these substances in food may not be feasible. However, the total amount of migration of all these substances to food can be reflected by the total migration level.

Study on Containers of ICN and Food Safety

Sampling was carried out from March to May 2008. Laboratory analysis was conducted by the Food Research Laboratory of the CFS. A total of 52 ICN products coming from a number of countries and areas were sampled in local supermarkets, chain stores, department stores, and grocery stores for identification of the contact materials in these cups and lids. Among which, 30 ICN products of most common brands available in supermarkets and chain stores were selected for the testing of safety and suitability. The testing parameters included total migration, heavy metals, styrene monomers and diaminotoluene.

Results

The Identification test revealed that the cups of ICN were made of polyethylene (PE) coated paper, expanded polystyrene (EPS), and polypropylene (PP). As for the lids, they were made of PS, PP, as well as composite laminated films with PE, PS, or co-polymers contact surfaces.

A total of 30 sets of cup and lid from the ICN products were tested for total migration. All levels detected were well below the limit of 0.5 mg/inch² set by the US Food and Drug Administration (FDA). None of the samples were found to contain heavy metals. A total of 11 cups and 5 lids made of PS, EPS, or contain PS coating, were tested for styrene monomer. The levels of styrene monomer ranged from not detected to 1000 mg/kg (0.1% by weight) which were within the limit of 0.5 % by weight of total residual styrene monomer set by the US FDA. No diaminotoluene was detected in any lids made of composite laminated films.

Conclusion and recommendation

Results of this study showed that the containers of ICN complied with the

standards for total migration and styrene monomer set by US FDA as well as heavy metals and diaminotoluene set by the Mainland. Under proper usage, these containers are unlikely to cause food safety problem and are suitable for their intended use.

Advice to consumers

1. Follow instructions on the ICN package properly.
2. Do not microwave cup noodles unless microwave cooking directions are specified on the packaging.
3. Never prepare noodles with boiling water in damaged or deformed containers.

Advice to the trade

1. Obtain containers from manufacturers who follow good manufacturing practice (GMP).
2. Choose containers that are safe and suitable for the intended use.
3. State the instruction and warning for the preparation of the noodles clearly on the package.

The Food Safety of Instant Cup Noodle Containers

OBJECTIVE

This study aims to assess the safety and suitability of instant cup noodles (ICN) containers commonly available in Hong Kong for holding food.

BACKGROUND

2. In recent years, there have been media reports saying that some disposable plastic containers were found to contain toxic substances which might leach out from the containers and be released into the food. These reports aroused public concern in Hong Kong about food safety of the disposable containers. In response, the Centre for food safety (CFS) and the Consumer Council jointly conducted a study on disposable plastic containers for take-away meals to assess the local situation in 2005. The results showed that there was no safety concern on all the containers tested.¹

3. Besides take-away meals, ICN are also packaged with disposable containers. ICN are commonly consumed in Hong Kong and the safety of their containers has also received attention. There have been enquiries from the public to the CFS about the safety of ICN containers

and requesting laboratory tests to be conducted on these products. In view of this, the CFS has conducted a study to examine for the safety and suitability of the ICN containers.

4. The common brands of ICN sold in major supermarkets and chain stores are mainly produced in the Mainland, Taiwan, Thailand or locally. There are also a variety of less common products that are mainly produced in Japan, Korea, and other Asian countries. They are available in certain Japanese-style department stores, Southeast Asia-style grocery stores, or high-end supermarkets.

5. According to the labels, the cups of ICN are mainly made of polyethylene (PE) coated paper, expanded polystyrene (EPS)/foamed PS, and polypropylene (PP) plastic. As for the lids, the majority of them are heat-sealable liddings made of laminated films composed of paper, aluminum foil, and plastics. The rest of the lids are made of PP, PS plastics.

Safety of ICN containers

6. The degree of migration depends on various factors including chemical nature of substances in materials, concentrations of substances, volume of food per unit area of material, the type of food and beverage, the temperature during contact, and the contact time.² Migration into liquid foods will be higher than that into more solid foods, particularly dry food. Studies have shown that migration of styrene monomer was higher with fatty foods than with aqueous foods.³ With all plastic types, migration increases with temperature and time of contact.

7. The standard preparation procedure for ICN is to fill boiling water into the cup and wait for three minutes before serving. As measured, the temperature of the ICN samples dropped to below 85°C within 1 minute at room temperature and to below 60°C within 30 minutes on average. Therefore, the contact temperature of the containers and the noodles will not exceed 100°C. The contact time during preparation and serving for ICN is considered short since it normally takes less than 30 minutes to finish the noodles. After reconstituting with water, the soup in the ICN can be considered as aqueous containing some free oil or fat and it would be slightly acidic or non-acidic depending on its seasonings. Based on the nature of ICN, contact time, temperature, PP, PE or EPS are suitable materials for making the disposable containers.^{3,4,5}

8. However, if the raw materials or finished products were not processed properly, they could contain excessive heavy metals, residual monomers and other chemicals, such as additives for the production of plastics. The primary concern about the disposable containers of ICN is the migration of these harmful substances from the contact materials into the food. Other than harmful substances, if an ICN container leaches out an unacceptable quantity of its components when contacting food, it may change the composition and affect the quality of the food, and therefore is not suitable for food contact.

Chemicals of concern

9. Some of the chemical residues of the ICN containers may lead to health risk. Among them, there are styrene monomer which is the raw material for making PS, heavy metals which are impurities, and diaminotoulene which is a contaminant that may remain in the lids of ICN made of composite laminated films.

Styrene monomer

10. PS is made by polymerization of styrene. It is a hard, brittle, low-strength material with a relatively low melting point and poor impact resistance. PS can be foamed by adding foaming agents such as pentane or butane, during polymerization. The foamed PS is a very low density material but still rigid enough to be widely used for egg cartons, meal containers, and trays for meat, poultry, and other products. Products made of polystyrene are generally not suitable for use above 100°C.¹

11. Polystyrene is non-toxic, however, during the polymerization process, a small amount of the styrene monomer may remain unpolymerised and find their way into the finished products. Styrene monomers may migrate into food causing contamination. This may present a health risk after prolonged exposure.

12. Chronic exposure to styrene in human may have depressive effects on the central nervous system (CNS) and is an irritant to epithelial surfaces. Human studies are inconclusive on the reproductive and developmental effects of styrene. An increased rate of spontaneous

abortions was reported in a study of styrene workers, however, another study of occupationally exposed women failed to establish a link between the incidence of spontaneous abortions and styrene exposure. There are studies that suggest there may be an association between styrene exposure and hepatic dysfunction as well as an increased risk of leukemia and lymphoma. However, the evidence is inconclusive.⁶

13. The International Agency for Research on Cancer (IARC) of the World Health Organization (WHO) has evaluated styrene and considered it as possibly carcinogenic to humans (Group 2B).⁷ According to the Joint FAO/WHO Expert Committee on Food Additives (JEFCA), a provisional maximum tolerable daily intake (PMTDI) of 0.04 mg/kg body weight has been established. Its presence in food should be kept to its minimum as technologically achievable.⁸

Heavy metals

14. When the plastic material comes into contact with food, heavy metal impurities may migrate into the food and affect food safety. For example, excessive exposure to lead may cause damages to the kidney, cardiovascular system, immune system, blood forming organs, central nervous system and reproductive system. IARC has evaluated lead compounds and considered that inorganic lead compounds as probably carcinogenic to humans (Group 2A).⁹ JECFA has established a provisional tolerable weekly intake (PTWI) of 0.025 mg/kg body weight for lead.¹⁰

Diaminotoluene

15. The primary use of diaminotoluene (or diaminomethylbenzene) is as an intermediate of the production of toluene diisocyanate, which is used to produce polyurethane.¹¹ Polyurethane is an adhesive that can be used in composite laminated films, the heat-sealable liddings of the ICN. The unreacted diaminotoluene if not removed from polyurethane may remain in the film.

16. Renal toxicity after oral administration of one of the diaminotoluene isomers, 2,4-diaminotoluene, has been reported in experimental animals. 2,4-diaminotoluene has been shown to be carcinogenic for animals, but there is inadequate evidence to evaluate the carcinogenic potential of two other isomers 2,5- and 2,6-diaminotoluene. All three isomers have been shown to be mutagenic in several experimental systems but the results in several *in vivo* mammalian assays were negative. They are reproductive toxins in experimental animals but human reproduction data are limited.¹¹ IARC has classified 2,4-diaminotoluene as possible carcinogenic to human (Group 2B).¹²

Other substances

17. The monomers, propylene and ethylene, used to manufacture PP and PE respectively, and 1-butene used to manufacture some co-polymers, have low toxic potential. They are volatile gases and therefore unlikely to exist in the finished product. The European Commission's Scientific Committee on Food (SCF) opined that migration of these residues into

food will be toxicologically negligible.⁵

18. Other than plastics, aluminium foil is used as a component of ICN packaging. They are covered by a polymeric film (surface coating or laminated plastic film). Therefore migration of aluminum into the food in such a concentration that may cause any adverse health effect is not likely to occur.¹³

19. It is possible that other substances such as additives, impurities, reaction products and breakdown products could migrate into the food from both the food contact layer and non-food contact layer of the ICN containers. It is not feasible to specifically measure all these substances. Nevertheless, the total amount of substances that may be transferred from the container material into the food can be determined in terms of total (overall) migration.

Regulatory Control

20. Currently, no comprehensive standard for food contact materials is available internationally, and the degree of control varies from country to country. Nevertheless, the regulation of food contact materials falls mainly into three aspects, (i) the food contact materials, (ii) the selection of contact materials for food use in food establishment, and (iii) levels of specific chemicals in the food or food simulants migrated from contact materials.

21. There is no specific local legislation governing the use of food packaging materials. However, the Public Health and Municipal Services Ordinance (Cap.132) stipulates that all food offered for sale in Hong Kong must be fit for human consumption. Should the food be rendered unfit for human consumption due to a problematic container, it would be an offence to offer such food for sale.

SCOPE OF STUDY

22. Instant cup noodles available in Hong Kong were selected for the study. The contact materials of the ICN containers were identified and depending on the types of materials being used, they were tested for total overall migrations, heavy metals, styrene monomer residues and/or diaminotoluene, respectively. The reference standards were listed in Annex I.

METHODS

Sampling

23. A total of 52 ICN products of various countries and regions were sampled in local supermarkets, chain stores, department stores, and grocery stores for identification of the contact materials of their cups and lids. Among which, 30 ICN products of most common brands available in supermarkets and chain stores were selected for the testing of safety

and suitability. In order to accurately assess the samples, clean and empty cup and lid of each product were obtained from their corresponding traders. For samples that could not be obtained from the traders, the testing was conducted using purchased samples from the market.

Laboratory analysis

24. Laboratory analysis was conducted by in the Food Research Laboratory of the CFS. The materials of the food contact surface of the cups and lids were identified by Fourier transform infrared (FTIR) spectroscopy techniques.

25. Total migration test was carried out with reference to the Code of Federal Regulation, 21 CFR 175.300 Resinous and polymeric coatings, stipulated by the U.S. Food and Drug Administration (FDA).¹⁴ All samples were tested according to their intended use and the testing conditions were listed in Annex II.

26. Since PS cups deformed when filled with 49°C n-heptane and the lids were flat, they cannot be tested by means of article filling as described by the US FDA. The test was then performed by virtue of a tailor-made cell, single face immersion cell according to the British Standards, BS EN 1186-1.¹⁵ Two cells with different sizes were made and the use of either one depended on the size of the test specimen. The surface area for the big cell and the small cell was 15.0 sq. inch and 4.4 sq. inch, respectively. The volume for the big cell and small cell

was 94 ml and 28 ml, respectively. The limit of detection for total migration was 0.05 mg/ inch².

27. Heavy metals in all samples were tested according to the National Standard, GB/T 5009.60-2003 Method for analysis of hygienic standard of products of polyethylene, polystyrene and polypropylene for food packaging, of the People's Republic of China.¹⁶

28. Styrene monomer of PS cups and lids was tested according to 21 CFR 177.1640 Polystyrene and rubber-modified polystyrene by the US FDA.¹⁷ The limit of detection was 50 mg/kg.

29. Diaminotoluene in composite laminated film lids was tested according to GB/T 5009.119-2003, "Determination of diaminomethylbenzene of complex food packaging material".¹⁸ The limit for detection was 0.0004 mg/L.

RESULTS

Identification of the contact materials of the containers

30. Our screening test of 52 samples collected revealed that ICN containers were made of EPS, PE coated paper, and PP. As for the lids, majority were made of composite laminated films with PE, PS, or co-polymer contact surfaces. The rest were made of PS and PP. The results are listed in Table 1 and 2.

Table 1: The contact materials of cups of the ICN samples

Materials	Number (%)
EPS	25 (48%)
Paper coated with PE	21 (40%)
PP	6 (12%)

Table 2: The contact materials of lids of the ICN samples

Materials	Number (%)
PE film	22 (42%)
Co-polymer film	18 (35%)
PS	7 (13%)
PP	4 (8%)
PS film	1 (2%)

Total migration

31. A total of 30 sets of cup and lid of ICN products were tested for total migration. One EPS cup had migration level detected at 0.06 mg/inch² and 0.14 mg/inch² in water and n-heptane simulants, respectively. Four EPS cup had migration detected only in n-heptane and the levels ranged from 0.08 to 0.24 mg/inch². As for the lids, the total migration levels of one copolymer and one PE coated samples were 0.05 mg/inch² and 0.09 mg/inch², respectively. All levels detected were well below the limit of 0.5 mg/inch² as stipulated in the US FDA requirement. Migration was not detected in other container and lid samples (see Table 3).

Heavy metals

32. The level of heavy metals of all samples was below 1ppm which complied with the GB standard (see Table 3) ^{19, 20,21,22}.

Table 3 : The levels of total migration (mg/inch²) and heavy metal (ppm) of the cups and lids of the ICN samples

Sample code	Articles	ID (FT-IR result)	Total migration (mg/inch ²)		Heavy metals (as Pb) (ppm)
			H ₂ O	n-Heptane	
ICN01	Cup	Paper coated with PE PE film	ND	ND	< 1
	Lid		ND	-	< 1
ICN02	Cup	Paper coated with PE Copolymer film	ND	ND	< 1
	Lid		ND	-	< 1
ICN03	Cup	EPS PE film	ND	ND	< 1
	Lid		ND	-	< 1
ICN04	Cup	PP Copolymer film	ND	ND	< 1
	Lid		ND	-	< 1
ICN05	Cup	EPS PS	ND	ND	< 1
	Lid		ND	-	< 1
ICN06	Cup	EPS PS	ND	ND	< 1
	Lid		ND	-	< 1
ICN07	Cup	EPS Copolymer film	ND	ND	< 1
	Lid		ND	-	< 1
ICN08	Cup	Paper coated with PE PE film	ND	ND	< 1
	Lid		ND	-	< 1
ICN09	Cup	EPS Copolymer film	0.06	0.14	< 1
	Lid		ND	-	< 1
ICN10	Cup	Paper coated with PE PE film	ND	ND	< 1
	Lid		ND	-	< 1
ICN11	Cup	EPS Copolymer film	ND	ND	< 1
	Lid		0.05	-	< 1
ICN12	Cup	Paper coated with PE PP	ND	ND	< 1
	Lid		ND	-	< 1
ICN13	Cup	Paper coated with PE PE film	ND	ND	< 1
	Lid		ND	-	< 1
ICN14	Cup	Paper coated with PE PP	ND	ND	< 1
	Lid		ND	-	< 1
ICN15	Cup	PP PS	ND	ND	< 1
	Lid		ND	-	< 1
ICN16	Cup	Paper coated with PE Copolymer film	ND	ND	< 1
	Lid		ND	-	< 1

Table 3 continued.

Sample code	Articles	ID (FT-IR result)	Total migration (mg/inch ²)		Heavy metals (as Pb) ppm
			H ₂ O	n-Heptane	
ICN17	Cup	Paper coated with PE	ND	ND	< 1
	Lid	Copolymer film	ND	-	< 1
ICN18	Cup	EPS	ND	ND	< 1
	Lid	Copolymer film	ND	-	< 1
ICN19	Cup	EPS	ND	0.10	< 1
	Lid	Copolymer film	ND	-	< 1
ICN20	Cup	Paper coated with PE	ND	ND	< 1
	Lid	Copolymer film	ND	-	< 1
ICN21	Cup	EPS	ND	0.08	< 1
	Lid	Copolymer film	ND	-	< 1
ICN22	Cup	EPS	ND*	0.10*	< 1*
	Lid	PS film	ND*	-	< 1*
ICN23	Cup	EPS	ND	0.24*	< 1
	Lid	Copolymer film	ND*	-	< 1
ICN24	Cup	Paper coated with PE	ND*	ND*	< 1*
	Lid	PE film	ND*	-	< 1*
ICN25	Cup	Paper coated with PE	ND	ND	< 1
	Lid	PE film	ND	-	< 1
ICN26	Cup	Paper coated with PE	ND	ND	< 1
	Lid	PP	ND	-	< 1
ICN27	Cup	PP	ND	ND	< 1
	Lid	Copolymer film	ND	-	< 1
ICN28	Cup	Paper coated with PE	ND*	ND*	< 1*
	Lid	PS	ND*	-	< 1*
ICN29	Cup	Paper coated with PE	ND	ND	< 1
	Lid	PE film	ND	-	< 1
ICN30	Cup	PP	ND	ND	< 1
	Lid	PE film	0.09	-	< 1

* Testing was done on samples purchased from market

“ND” denotes “Not Detected”

“-” denotes test was not performed

The US FDA standard for total migration is not exceed 0.5 mg/inch²

The GB standard for heavy metal is ≤ 1 mg/L (1 ppm)

The limit of detection for total migration is 0.05mg/ inch²

Styrene monomer

33. A total of 16 samples made of PS, EPS, or contained PS contact surface which included 11 containers and 5 lids, were tested for styrene monomer. The levels of residual styrene monomer ranged from not detected to 1000 mg/kg (0.1 % by weight) which were within the limit, 0.5 % by weight of total residual styrene monomer, as stipulated by the US FDA (see Table 4).

Table 4: The level of residual styrene monomer (mg/kg) in cups and lids with contact surface made of PS.

Sample code	Article with PS	Styrene monomer
ICN03	Cup	ND
ICN05	Cup	360
	Lid	340
ICN06	Cup	350
	Lid	280
ICN07	Cup	ND
ICN09	Cup	390
ICN11	Cup	ND
ICN15	Lid	600
ICN18	Cup	420
ICN19	Cup	420
ICN21	Cup	1000
ICN 22	Cup	160
	Lid	ND
ICN23	Cup	130
ICN28	Lid	270

“ND” denotes “Not detected”

The limit of detection is 50 mg/kg

The US FDA standard for residual styrene monomer is not more than 0.5 % by weight (5000 mg/kg) for container for fatty food

Diaminotoluene

34. Of 30 lid samples, 23 were heat-sealable liddings made of laminated films composed of paper, aluminum foil, and plastics. They were tested for diaminotoluene. Results showed diaminotoluene were not detected in these samples.

DISCUSSION

35. For protection of public health, the ICN containers were tested under more severe conditions in terms of temperature, time, and the strength of the extractant than that of real situation. The results of the study showed that among 30 sets of cup and lid samples, only five EPS cups and two heat-sealable liddings had migration detected and the levels were well below the limits set by the US FDA. This showed that the contact surfaces of the noodle containers would not transfer their components to food in unacceptable quantities.

36. The levels of styrene monomer detected in EPS cups, PS lids and heat-sealable liddings with PS contact surface were within the limit set by the US FDA. The amount of residual styrene monomer in these samples is not likely to cause any food safety problems.

37. Heavy metals in all containers and diaminotoluene in all heat-sealable liddings were not detected. There is no concern for exposure to these contaminants due to the usage of the samples.

LIMITATIONS

38. Although the study provided an overview on the safety and suitability of ICN containers, it did not cover all of the ICN containers available in the market due to resource constraints. Ideally, more samples would better reflect the safety and quality of the containers sold locally.

39. There were samples namely, ICN22, ICN23, ICN24 and ICN28 for which clean and empty containers could not be obtained from the traders so the testing was therefore conducted using purchased samples from the market. Since some purchased samples had been in contact with the noodles and, as a result, the testing result might overestimate the total migration level of these samples.

40. Due to the limited reference regulatory standards and testing methods available, not all substances that might migrate into the food could be specifically measured in the study. The amounts of all substances that might be leached out from the containers were reflected by the total migration levels.

CONCLUSION AND RECOMMENDATIONS

41. This study showed that the containers of ICN complied with the standards the standards for total migration and styrene monomer set by US FDA as well as heavy metals and diaminotoluene set by the Mainland. Under proper usage, these containers are unlikely to cause food safety problem and are suitable for their intended use.

Advice to consumers

1. Follow instructions on the ICN package properly.
2. Do not microwave cup noodles unless microwave cooking directions are specified on the packaging.
3. Never prepare noodles with boiling water in damaged or deformed containers.

Advice to the trade

1. Obtain containers from manufacturers who follow good manufacturing practice (GMP).
2. Choose containers that are safe and suitable for the intended use.
3. State the instructions and warning for the preparation of the noodles clearly on the package.

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ANNEX I. Reference standards for different materials used in instant cup noodles containers.

Test	Sample	Contact material	Limit	Reference Standard
Total migration	Cups and lids	EPS, PS, PP, PE, and co-polymers	0.5 mg/inch ²	21CFR175.300 Resinous and polymeric coating
Heavy metals	Cups and lids	EPS, PS	1mg/L	GB 9689-88:Hygienic standard for polystyrene products used as food containers and tablewares
		PP	1mg/L	GB 9688-88:Hygienic standard for polypropylene products used as food containers and tablewares
		PE	1mg/L	GB 9687-88:Hygienic standard for polyethylene products used as food containers and tablewares
		Co-polymers	1mg/L	GB 9683-88:Hygienic standard for composite laminated food packaging bag
Styrene monomer	Cups and lids	PS, EPS	0.5% (by weight) for container for fatty food	21CFR177.1640 Polystyrene and rubber-modified polystyrene
Diaminotoluene	Lids	PS, PE, and co-polymers	0.002 mg/L	GB 9683-88:Hygienic standard for composite laminated food packaging bag

ANNEX II. Testing conditions Chosen for the total migration test with reference to 21CFR175.300.

Sample	Conditions of intended use during preparation and serving of ICN	Testing conditions	
		Extractant	Time and Temperature
Cups	Holding noodle and soup at or below 100°C for less than 30 minutes	Water	100°C, 30 minutes
		n-Heptane	49°C, 30 minutes
Lids	Contact with steam from the reconstituted noodle at or below 100°C for about 3 minutes	Water	100°C, 30 minutes

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