Risk Assessment Studies

Report No. 25

MICROBIOLOGICAL QUALITY OF PRE-CUT FRUITS FOR SALE OR SERVING IN RETAIL OUTLETS

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Abstract

Fruit produce is known to carry natural non-pathogenic microflora; however, contamination with pathogens from human and/or animal sources can also occur sporadically at various stages along the production line. Globalisation of fresh fruits potentially increases human exposure to a wider variety of food-borne pathogens and has resulted in a potential increased risk of foodborne illness outbreaks associated with the consumption of these raw commodities. Overseas studies showed that *Salmonella*, *Shigella*, hepatitis A virus and *Cyclospora* might be present on the surface of cantaloupe, strawberries, raspberries, etc. These pathogens might invade the inner surface of the fruits during slicing or peeling. Studies have already confirmed that pre-cut fruits might be contaminated with *Salmonella*, *Listeria monocytogenes* and high counts of *Staphylococcus aureus*. The findings of this study showed that the microbiological quality of all pre-cut fruits taken from the retail outlets were satisfactory, suggesting that food hygiene controls are in place in sampled premises and the risk of pre-cut fruits for foodborne illness is low. However, due to the potential for contamination of fresh fruits occurring prior to their purchase by consumers and the outbreaks of food poisoning in other parts of the world, retailers and consumers are advised to wash fresh fruits before preparation (such as peeling and cutting) and consumption; handle and cut fruits using clean and sanitized utensils and surfaces; store cut fruits at 4 ^{o}C or below until served or sold; and discard cut fruits kept at ambient temperature for more than 2 hours.

Microbiological Quality of Pre-cut Fruits
for Sale or Serving in Retail Outlets

OBJECTIVES

The purpose of the study was to determine the microbiological quality of pre-cut fruits in various retail outlets. The results will be used to assess the risk of pre-cut fruits to public health and to provide scientific information to support the development of hygienic handling guidelines on pre-cut fruits for retail outlets.

INTRODUCTION

2. Over the last several years, the number of foodborne illness outbreaks linked to fresh produce has increased in some developed countries such as the United States [1]. Reasons for the increase, besides improved surveillance, include an increase in the consumption of fresh produce, changing global and domestic distribution systems, lack of a processing step to eliminate pathogens and lack of systematic controls to prevent the presence of pathogens in fruits and vegetables[2].

3. Fruit produce is known to carry a natural non-pathogenic microflora; however, contamination with pathogens from human and/or animal sources can occur at various stages along the food chain [3]. Use of improperly treated manure, contaminated water and poor hygiene practices throughout the fresh produce chain have been reported to be the sources of contamination[4].

4. Outbreaks of salmonellosis have been associated with the consumption of cut watermelon and cantaloupe. Three outbreaks involving watermelons and *Salmonella* occurred in 1954, 1979 and 1991 [2,5,6]. In 1990, cantaloupes from either Mexico or Guatemala were linked to *Salmonella enterica* serotype Chester infection, causing 245 illnesses in 30 states of the US[7]. In 1991, pre-sliced cantaloupes originating from Texas were linked to *Salmonella* serotype Poona infections[8]. In 1998, another outbreak involving 22 cases of *Salmonella* serotype Oranienburg and cantaloupe was reported in Ontario of Canada [9]. During 2000 and 2002 three multistate outbreaks associated with eating cantaloupe imported from Mexico to the US were again linked to *Salmonella* serotype Poona infections[10].

5. Outbreaks involving other types of pre-cut fresh fruits were also reported. In January, 2002, 15 persons in the Hennepia county of Minnesota, after attending a holiday party at a country club, developed gastrointestinal illness[11]. Pre-cut fruits (pineapple, strawberries, honeydew melon, cantaloupe, watermelon, and grapes) were suspected to be contaminated with norovirus. In December 2003, 22 individuals in Wellington, New Zealand sickened after eating fruits salad [12]. Investigation suggested that one of the fruit salad ingredients was contaminated with norovirus. Another outbreak, involving nine states and 429 cases of infections in 2004, was linked to the consumption of pre-sliced Roma tomatoes contaminated with *Salmonella*[13].

6. For most of these outbreaks, it has been assumed that cutting, slicing and peeling remove the protective surfaces of the fruits and expose the edible surface to a range of conditions that may increase the potential for microbial contamination[2], highlighting the need of applying good hygiene practices from farm to fork to prevent contamination and/or bacterial growth.

SCOPE OF STUDY

7. Pre-cut fruits intended for sale or serving in retail outlets were the target samples. For the purposes of this survey, "pre-cut fruits" refer to fruits that have been cut open, sliced into pieces, but remain in the fresh state, and stored/displayed for sale or for serving in retail outlets (e.g. fresh fruit packs in supermarkets, cut fruits in buffets, assorted fruits offered by Chinese restaurants, etc.)

METHODLOGY

Sampling

8. The sampling period was between April and August 2006.

9. A total of 136 pre-cut fruit samples was collected by Health Inspectors from various retail outlets:

- Restaurants in hotels
- General restaurants;
- Light refreshment restaurants;
- Supermarkets;
- Retail outlets with *permits* to sell pre-cut fruits (i.e. fruit shops);

The sampling distribution among these categories is outlined in table 1.

Table 1. Sampling Distribution of Different Regions

Regions	No. of Samples to be taken*					
	RH	GR	LRR	SM	FS	Region Total
Hong Kong	4	26	5	5	5	45
Kowloon	5	25	5	5	5	45
New Territories	9	21	5	6	5	46
Total	18	72	15	16	15	136

* Samples, as far as possible, to be taken from different districts within the region.

RH = Restaurants in hotels

GR = General restaurants

LRR = Light refreshment restaurants

SM = Supermarkets

FS = Fruit shops

10. Health Inspectors were required to note down whether the samples taken were under refrigeration or not at the moment of sampling and were at liberty to pick premises for sampling; however, they should, as far as possible,

(i) take samples from different districts within their region; and

(ii) avoid sampling at different outlets belonging to the same retail chain;

Analyses of samples

11. All samples, being kept at 4 °C or below during transport, were submitted to the Public Health Laboratory Centre for analysis within 4 hours of sampling.

12. *Escherichia coli* count, presence of salmonella and *Staphylococcus aureus* count were used to reflect the microbiological quality of the pre-cut fruits.

Result analysis

13. Data on the microbiological quality of pre-cut fruit samples were analysed by the Risk Assessment Section of the Centre for Food Safety. The microbiological quality of pre-cut fruits was assessed against the criteria listed in Table 2. This is part of the criteria for "Fruits and vegetables (fresh)" extracted from the Microbiological Guidelines for Ready-to-eat Food [14] recommended by the Centre for Food Safety.

Table 2. Microbiological criteria to be used in this survey

Microbiological parameters	Microbiological quality			
	Satisfactory	Acceptable	Unsatisfactory	Unacceptable
E. coli (cfu/g)	< 20	20 - < 100	≥ 100	N/A*
Salmonella	Not detected in 25 g	N/A	N/A	Present in 25 g
Staphylococcus aureus (cfu/g)	< 20	20 - < 100	100 - < 10^4	≥ 10^4

*N/A denotes "Not applicable"

RESULTS

Microbiological parameters

14. The three microbiological parameters (i.e. *E. coli* count, presence of salmonella and *S. aureus* count) examined in this survey reflect different aspects of food hygiene and safety of pre-cut fruits in retail outlets.

15. *E. coli* is commonly found in the gastrointestinal tract and faeces of human beings [15]. Its presence provides ***direct evidence of faecal contamination***, probably resulting from poor personal hygiene (e.g. hands are not washed thoroughly after toileting) during processing and preparation.

16. Humans and animals are the primary reservoirs of *S. aureus*. Staphylococci are present in the nasal passages and throats and on the hair and skin of 50 percent or more of healthy individuals [16,17]. The bacterium is transient and does not usually become part of the resident flora of the skin and numbers of *S. aureus* on normal, undamaged and disease-free skin generally are low. However, the bacterium may become established as part of the resident flora and multiply to high numbers on people who frequently immerse their hands in water resulting in soreness and damage to the skin. This condition has been known to occur on the hands of operatives in food-processing plants[16].

17. Foods that require considerable handling during preparation, particular with bare hands, and that are kept at elevated temperatures after preparation are often involved in staphylococcal food poisoning[17]. If fruits are cut and handled with bare hands, *S. aureus* may be present on the sliced fruits. Unsatisfactory levels of *S. aureus* indicate that ***time/temperature abuse*** of a food is likely to have occurred following ***improper handling of food with bare hands***.

18. *Salmonella* were reported to be responsible for outbreaks involving fresh fruits or pre-cut fruits [1,2,3,4,5,6]. *Salmonella* was found present on the rind, presumably contaminated in the field or during washing in a packinghouse, and that the edible surface became contaminated during cutting or slicing[2]. The presence of this organism in food is hazardous to health and indicates ***poor food preparation and handling practices*** such as cross contamination.

Results

19. All the 136 samples taken from various retail outlets were

considered satisfactory according to the criteria stated in the Microbiological Guidelines for Ready-to-eat Food (Table 3). All samples were reported having *E. coli* count < 10 cfu per gram and *S. aureus* count < 20 cfu per gram. No salmonella was detected in the samples.

Table 3. The microbiological quality of pre-cut fruits sampled from various retail outlets

Number of sample	Plate counts (cfu/g)		
	E. coli	Salmonella	*S. aureus*
136	< 10	Not detected in 25 g	< 20

20. As regards storing temperature of the pre-cut fruits at the retail outlets, all samples were reportedly kept under refrigeration.

DISCUSSION

21. Consumption of fruit and vegetables increased significantly in many countries during the past decade. In the US, from 1982 to 1997, per capita consumption of fresh fruits and vegetables increased from 91.6 to 121.1 kg, an increase of 32% [2]. In Australia, the annual consumption of fruit and vegetables also increased significantly from 1988/89 to 1998/99 when up to 135 kg per person per year of fruit and 162 kg of vegetables were consumed [18]. However, the health of consumers can be adversely affected by consumption of microbiologically unsafe fruit and vegetables.

Contamination of pre-cut fruits

22. Fresh fruits can become contaminated at any point during their growth, harvesting, processing, distribution, retail sale and final preparation.

Some fruits such as melons and strawberries grow in contact with or close to the ground and are often in contact with soil, insects and animals during growing and harvesting in the field. Soil, manure and irrigation water are potential sources of pathogenic micro-organisms such as *E. coli* O157:H7 and *Salmonella*[19,20]. Fruit harvested from trees, such as peaches and plums, can be contaminated with faecal pathogens by pickers and handlers in the fields including harvesting and packaging equipment[21].

23. Overseas studies showed that pathogenic microorganisms might be present on the surface of fresh fruits. In 1990, 11 of 1 440 (0.76%) cantaloupe imported to the US from Mexico were positive for eight different *Salmonella* serotypes. In 1991, 24 of 2 220 (1.08%) cantaloupe were positive with 12 different *Salmonella* serotypes isolated. In another study, *Salmonella* from eight (5.3%) and *Shigella* from three (2.0%) of 151 cantaloupe samples were detected on the surface of the fruit [2]. These results suggest that melons may be naturally contaminated with pathogenic bacteria. Other studies found that *Salmonella* and hepatitis A virus might be isolated from strawberries[22] and *Cyclospora* from raspberries[23].

24. Fruit possesses natural antimicrobial barriers in the form of skin, shell or rind. These barriers protect the fruit from infection and most pathogenic microorganisms are unable to grow on the surface of intact fruit, though they may survive. However, microbial invasion and growth in the underlying tissues of fresh fruit may occur if the antimicrobial barriers are damaged. Unhygienic handling and processing of fresh fruit especially during chopping, slicing or peeling will increase potential for the invasion or growth of pathogenic microorganisms and hence the risk of transmission of foodborne illness. Overseas studies have confirmed that pre-cut fruits might be contaminated with *Salmonella*, *Listeria monocytogenes* and high counts of

Staphylococcus aureus[24,25].

25. In this study, all the 136 samples taken from retail outlets were found satisfactory when comparing with the criteria in the Microbiological Guidelines for Ready-to-eat Food recommended by the Centre for Food Safety, implying that food hygiene controls are in place in sampled premises and the risk of pre-cut fruits for foodborne illness is low.

26. It must, however, be emphasised that transmission of pathogenic bacteria such as *Salmonella*, and others not examined for in this study such as *E. coli* O157, *Shigella* and *Listeria*, remains a risk because of the likelihood of surface contamination of fruits with pathogens. The food industry must not become complacent about the findings of the study as epidemiological data clearly show that food poisoning outbreaks occur if hygiene practices break down. In addition the infective dose of many of these pathogens is low.

Managing the risk

27. Although melon rind provides a natural biological barrier preventing contamination of the edible interior, unwashed rind may contaminate both the flesh and the cutting utensil during slicing, causing food poisoning outbreaks[26]. To manage the risk, the FDA recommends sanitation practices for preparation and serving of melons. The food industry and consumer are advised, *inter alia*, to wash fruits under running water thoroughly just before eating or cutting so as to remove dirt and bacteria[27, 28,29]. Firm-skin fruits such as melons may be rubbed with a clean produce brush while rinsing with running water. Soap and detergent are not recommended because fruits

are porous and can absorb the chemi cals which m ay cause adverse effects on health.

28. Notwithst anding the recommendation from the FDA, a survey conducted in 2002 focussing on consum er handling of fresh fruits and vegetables in the US reve aled that m ore than 35% of consumers did not wash melons before preparation [30]. Consumers thought that the rinds would not be consumed and therefore washing of melons was not necessary. In Hong Kong, although no sim ilar survey was conducted, it is believe d that some consumers would also not wash the skin or rind of fresh frui ts (such as melons, oranges, longans or lychees) before eating due to the same belief. As overseas epidemiological data clearly show th at unwashed rind may contam inate the flesh duri ng slicing and cause food poisoning outbreaks, local consumers should be advised to wash fresh fr uits thoroughly before slicing and consumption.

29. Some studies reported that inclusion of a disinfecting agent such as hypochlorite in the water can im prove the elim ination of m icroorganisms associated with the produce during wash ing but t his does not guarant ee safety. This is because sani tising ef ficiencies depend on a num ber of factors such as water quality, cleaner/sanitizer used, contact time, type of scrubbing action and characteristics of the produce surface [31,32] (e.g. the surface of strawberr y and cantaloupe has many small indentations where m icroorganisms may “hide”). These fact ors are difficult to control at the consumer leve l and hence, many food authorities advise consumers to wash fruits under running water only[28,33,34]. Some authorities such as the FDA state e xplicitly that washing fruits with soap or detergent or using commercial produce washes is not recommended[28].

Effects of chilling and shelf life

30. Decreasing the temperature can prevent or slow the growth of microorganisms depending on the temperature and the microorganisms concerned. Chill temperatures (< 4 ^{o}C) will prevent the growth of mesophilic bacterial pathogens such as *Salmonella, Shigella, E. coli* and *Clostridium perfringens* and psychrotrophs such as *Listeria monocytogenes* will grow only relatively slowly[35].

31. Studies showed that *Salmonella* Montevideo grew on tomatoes stored at 20 and 30 ^{o}C but not at 10 ^{o}C[36] and *E. coli* O157:H7 grew on fresh-cut melon at 12-25 ^{o}C but not at 5 ^{o}C[37]. Hence, consumers are advised to keep pre-cut fruits at or below 4 ^{o}C and consume the product as soon as possible, preferably within one to two days. Pre-cut fruits that are kept at ambient temperature for more than 2 hours should be discarded[27,33]

CONCLUSION

32. Published studies showed that fresh fruits could become contaminated with microorganisms, including human pathogens during their growth, harvesting, processing, distribution, retail sale and final preparation. Globalisation of fresh fruits potentially increases human exposure to a wider variety of food-borne pathogens and has resulted in a potential increased risk for foodborne illness outbreaks associated with the consumption of these raw commodities.

33. The findings of this study showed that the microbiological quality of all pre-cut fruits taken from the retail outlets was satisfactory and the risk of pre-cut fruits for foodborne illness was considered low. However, due to the

potential for contamination of fresh fruit s to occur prior to their purchase by retailers and consumers and the outbreaks of food poisoning in other parts of the world, retailers and consumers are advised to foll ow good hygienic practices when handling fresh fruits.

34. In particular, retailers and consumers ar e advise d to wash fresh fruits before preparation (such as peeling and slicing) and consum ption; handle and cut fruits using clean and sanitized u tensils and surfaces; store cut fruits at 4^{o}C or below until served or sold; an d discard cut fruits kept at am bient temperature for more than 2 hours. The Centre for Food Safety has developed guidelines on the hygienic preparation and handling of pre-cut fruits for the retail food businesses and the consumer (Annex I and II).

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Annex I

A Guide to Foodservice and Retails

Guidelines on hygienic preparation and handling of pre-cut fruits

This guidance is intended for retail businesses (i.e. foodservice and retail establishments) that prepare, sell and/or serve pre-cut fruits on the premises. It helps the businesses implement food safety measures in their operations in order to process and sell safe pre-cut fruits.

2. For the purposes of this guidance, "pre-cut fruits" refer to fruits that have been cut open, but remain in the fresh state, and stored/displayed for sale or for serving in foodservice and retail stores.

3. The basic principles of control include:

I. Avoid contamination of fresh fruits / pre-cut fruits with pathogens
   - during storage;
   - during preparation;
   - during display.

II. Prevent growth of pathogens on pre-cut fruits
   - by keeping them at 4^{o}C or below;
   - by limiting their shelf lives (e.g. limit the shelf lives of pre-cut fruits to one to two days).

<u>Purchase</u>

- Obtained fresh fruits from an identifiable, reputable source.
- Inspect fresh fruits on arrival and accept fresh fruits that are not bruised or damaged. Reject fresh fruits that are grossly contaminated with dirt, soil, or

other organic matter.

Storage of fresh fruits

- Store fresh fruits a way from raw f oods (such as raw meat, poultry and seafood) to avoid cross-contamination.
- Refrigerate fresh fruits if they are not used immediately.

Preparation

- Allocate a work area, together with f acilities and utensils, to pre-cut fruit operations. If it is necess ary to share work space and facilit ies, there mus t be a schedule of operations, including pers onnel traffic, product traffic, and cleaning and sanitising of food contact surfaces t o reduce t he potential for cross contamination of the ready-to-eat pre-cut fruits.
- Use different sets of cutting boards a nd knives to handle fresh ready-to-eat fruits and raw foods (such as raw meat).
- Wash and sanitise cutting boards, knive s and counter tops thoroughly with soap before and after food preparation.
- Wash hands thoroughly before and after handling fresh fruits
- No bare hand contact with the finish ed product, especially cut melons. Single use gloves or an appropriate utensil should be used to prevent cross-contamination.
- Cut away any bruised areas on fresh fru its before preparing. Discard any rotten fresh fruit.

- Wash fresh fruits (including those with skins and rinds that are not eaten) thoroughly under running tap water just before eating, peeling or cutting. Do not use soap or detergent.
- Rub firm-skin fruits under running tap water or scrub with a clean produce brush while rinsing with water.
- Prepare just enough pre-cut fruits for the day needed. It is a good practice to discard any leftover and prepare fresh-cut fruits on the next day.

Storage of pre-cut fruits

- Wrap fresh-cut or peeled fruits tightly in plastic wrap and refrigerate them immediately (i.e. at a temperature of 4°C or below).
- Refrigerate pre-cut fruits within two hours of peeling or cutting.

Serving

- When serving melons, do not let the rind come in contact with the cut melon.
- Leftover cut fruits should be discarded if left at room temperature for more than two hours.

Display

- Clean all display areas on a daily basis. Remove and sanitise any spillages immediately occurring throughout the day.
- Inspect prepackaged cut fruits on a regular basis throughout the day for damage, breakdown and spillages.

- Remove any poor quality prepackaged precut-fruits from sale and be disposed of.

Annex II

A Guide to Consumers

Advice on hygienic preparation and handling of pre-cut fruits

Purchase

- Buy fresh fruit that is not bruised or damaged.
- If buying fresh-cut ready-to-eat fruit, choose only those items that are refrigerated.
- Buy only quantities of fruits that you can use before they begin to spoil.
- Separate fresh fruits from raw foods such as meat, poultry and seafood to avoid cross-contamination when taking fresh fruits home from the market.

Storage after returning from market

- Pre-cut or peeled fruits should be refrigerated immediately to maintain both quality and safety.
- Refrigerate perishable fresh fruits immediately.
- Keep fresh fruits separate from raw meat, poultry or seafood in your refrigerator.

Preparation

- Cut fresh fruits until you are ready to eat it.
- Wash hands thoroughly before and after handling fresh fruits

- Use different cutting boards and knives to handle fresh ready-to-eat fruits and raw foods (such as raw meat).
- Wash cutting boards, knives and counter tops thoroughly with soap before and after food preparation.
- For added protection, saniti se cutti ng boards, knives and counter tops periodically.
- Cut away any bruised areas on fresh fru its before preparing. Discard any rotten fresh fruit.
- Wash fresh fruits (i ncluding t hose with skins and rinds that are not eaten) thoroughly under running tap water just before eating, peeling or cutting. Do not use soap or detergent.
- Rub firm-skin fruits under running tap wa ter or scrub with a clean produce brush while rinsing with water.
- Refrigerate pre-cut fruits within two hours of peeling or cutting.
- When serving melons, do not let the rind come in contact with the cut melon.
- When transporting cut and perishable fruits to a picnic or gathering, put them in a cooler with ice or gel packs

Leftover

- If not consumed, wrap fresh-cut or peel ed fruits tightly in plastic wrap and refrigerate immediately (i.e. at a temperature of 4°C or below).
- Leftover cut fruits should be discarded if left at room tem perature for m ore than two hours.