RESEARCH ARTICLE

Food Handling Practices for Fresh-Cut Vegetables at Wet Markets and Supermarkets in Davao City, Philippines

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Abstract

Fresh-cuts, either ready-to-cook (RTC) or ready-to-eat (RTE) fruits and vegetables, are becoming more popular due to consumers' increasing demand for convenient and healthy foods. This paper aimed to document different fresh-cut vegetables available in wet markets and supermarkets in Davao City, Philippines, to differentiate fresh-cut processing practices between the two locations, and to identify some inadequacies in their practices. Overall, the fresh-cuts were available as either monotype (e.g. coconut pith, squash, and immature jackfruit) or mixed (e.g. *pinakbet* and chop suey). With regards to the pre- and post-cutting treatment, water was not always used since consumers were expected to wash them before cooking and/or eating. Water used for washing was also reused, which could be a source of contamination. During processing, inappropriate craft cutter blades were sometimes used in wet markets, which could lead to more produce injury that may result in more browning. Moreover, packaging was mostly used only upon purchase in the wet markets whereas supermarkets had more pre-packed options. Lastly, an evident observation was the temperature abuse (above 5°C) during storage in both locations. This poses a threat of pathogen contamination especially since visual indications of deterioration are not always obvious. Thus, interventions are recommended to educate fresh-cut processors in both wet markets and supermarkets about useful techniques in preserving the quality and safety of fresh-cut vegetables. Additional information on the degree of microbial contamination and shelf-life of these products may also aid in generating applicable food safety strategies.

Keywords: fresh-cut practices • minimal processing • vegetable crops

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Introduction

Consumption of vegetables, including fruits, is regarded as the foundation of a healthy diet (Yousuf et al. 2020). Fortunately, the availability of minimally processed vegetables or fresh-cuts nowadays has aided in attaining consumers' recommended vegetable intake due to their convenience and variety (Yousuf et al. 2020). Fresh-cuts or minimally processed products are defined as any fresh produce that is washed, peeled, and/or cut (International Fresh-cut Produce Association 1996; Cantwell and Suslow 1999; Francis et al. 2012). As these goods are either ready-to-eat (RTE) or ready-to-cook (RTC), they can both save time and decrease waste for the consumers due to pre-weighed packs (James and Ngarmsak 2010). Concepcion (2013) reported that the increased amount of RTC goods available in the public markets and supermarkets in the Philippines come in mixed formats for the preparation of typical Filipino dishes such as *pinakbet* or chop suey. Furthermore, increased education among consumers on the significance of healthy eating habits may have also contributed to their popularity among developing countries (Olivas and Barbosa-Cánovas 2005; Qadri et al. 2005). Indeed, fresh-cut vegetables have acquired heightened attention by fulfilling consumer requirements of nutrition, accessibility, as well as waste reduction at the household level.

However, minimally processed vegetables also come with drawbacks concerning their quality. The rates of respiration and ethylene production are further accelerated due to cutting operations, thereby hastening deterioration and reducing the shelf-life of fresh-cuts (Yousuf et al. 2020). In the context of food safety, minimal processing also presents disadvantages due to two key reasons: (1) the released fluids on the cut surface may provide nutrients to spoilage and pathogenic microorganisms, and (2) post-cutting and decontaminating treatments (e.g. heat- or chemical-based) are typically absent (Berger et al. 2010; Olaimat and Holley 2012; Yousuf et al. 2020; Harris 2003). As a result, microbial contamination is more likely to occur and can come from various sources. Unwanted microorganisms can potentially migrate from the surface of the intact produce to the exposed tissues through fresh-cut operations, such as peeling and slicing (Haris et al. 2003). They may also come from the handlers and equipment. Additionally, storage conditions such as temperature and humidity can also play a role in the occurrence and severity of microbial contamination in fresh-cuts. Harris et al. (2003) compiled incident reports on outbreaks involving minimally processed vegetables (raw lettuce, salads, sprouts, diced tomatoes, shredded carrots, etc.) in various counties in the US. They pointed out that inadequate agricultural (e.g. contaminated irrigation sources) and manufacturing practices (e.g. improper hygiene, contact with contaminated surfaces, etc.) in fresh-cut processing were the culprits of some of the reported outbreaks (Harris et al. 2003).

In a developing country such as the Philippines, the above food safety concerns are even more pressing due to poor sanitation in open-air markets where fresh (-cut) produce is typically sold (Vital et al. 2019). A comprehensive study by Azanza et al. (2019) found that 1.44% of the foodborne disease outbreaks in the Philippines from 2005 to 2018 were due to vegetables. It is important to note, however, that there is likely underreporting of such food poisoning incidents (Azanza et al. 2019). Thus, the food safety risk brought by fresh-cuts should not be underestimated. In Luzon, Philippines, Vital et al. (2014) and Vital et al. (2019) microbiologically assessed fresh vegetables that are typically consumed raw. Vital et al. (2019) reported a high load of *Escherichia coli* in mung bean sprouts and coliphage (fecal indicators) in bell peppers sourced from various regions in Luzon, which

was attributed to contaminated water sources. These bacteria originate from the intestinal tract and fecal material of humans and animals (Harris et al. 2003). Infected consumers may experience diarrhea and vomiting (Harris et al. 2003). Although the above studies gave insights about the consequences of improper sanitation during fresh produce handling, the efforts in monitoring the food safety risk of fresh-cuts in the Philippines are still overall lacking.

Against this background, the objectives of this study were to document the kinds and types of available minimally processed vegetables in wet markets and supermarkets as well as compare the different processing, and storage practices of the two locations. By doing so, it would be possible to identify challenges and gaps in fresh-cut processing in Davao City. The information gathered can then be used to generate food safety strategies that can benefit businesses, handlers, consumers, and policymakers.

Materials and Methods

Four wet markets (Agdao, Bankerohan, Mintal, and Toril) and two supermarkets in Davao City were surveyed for the availability of fresh-cut vegetables from 9 AM to 12 PM on the weekends from November 2017 to January 2018. In wet markets, a total of 67 individual stalls were surveyed. Commodities that were classified as fresh-cuts were enumerated in each stall. The same was done for the vegetable sections of supermarkets.

Products were tallied according to the name of a fresh-cut vegetable or fresh-cut mix, vegetables included, defects (browning, browning and decay, decay, discoloration, and excess liquid), type of packaging, and storage conditions. These were recorded through visual observation of the product. Percentages of each defect and type of packaging used were calculated by dividing the frequency by the number of observations multiplied by 100. The number of observations is the total number of fresh-cut products tallied. No statistical analyses were done, and thus, the numerical data were only used for qualitative evaluation. Moreover, no shelf-life studies were conducted in this study.

Quantitative data collected were product temperature (Digitech InfraRed Thermometer QM7215), storage temperature, and relative humidity (PlatinumS Hygrometer). The temperature was measured once on three different points of the product—on the top, middle, and bottom parts. The mean of these three measurements was considered as the final product temperature. The storage temperature and relative humidity of each location were measured every 15 minutes and were averaged.

Practices in preparing fresh-cuts were determined through person-to-person interviews with vendors and supermarket employees as well as visual observation. Verbal consent was requested from the participants before conducting the interviews. The topics discussed included quality of the source of fresh-cut (good quality or excess stock), time of preparation, materials used, pre-cutting and post-cutting sanitation practice (wash water, others, or none), and duration of the display. These were consolidated and tabulated to determine which practices were commonly observed.

Results and Discussion

Available monotype and mixed fresh-cuts in wet markets and supermarkets

Tables 1 and 2 list the available fresh-cut vegetables in supermarkets and wet markets that are sold as monotypes and RTC or RTE mix, respectively. The data included in the list comprised only of products that were present in both locations. For some of the monotypes, it seems logical to sell them as fresh-cuts, namely, bamboo shoots (*dabong*), coconut pith (*ubod*), and immature jackfruit (Table 1). Their intact forms are typically larger than the other listed vegetables, thus purchasing and processing a whole piece would be excessive and impractical. It was also observed that several slice types can apply to a product, which could be dependent on the dish that these fresh-cut vegetables would be used in.

In the case of fresh-cut mixes, carrot was a common ingredient (Table 2). This might be due to the high number of intact carrot rejects based

on the interviews with the wet market vendors. Moreover, a few of the pre-mixed items contain the same vegetables but are sold in different names. For instance, *giniling* and *menudo* are both Spanish-influenced, tomato-based cuisines (Fernandez 1988) that differ in the consistency, type of meat used, and the ratio of meat and liquid (Miranda 2018).

The distinct differences between products sold in the wet markets and supermarkets in terms of their packaging and storage conditions i.e. temperature and general environment are shown in Figures 1, 2, and 3. More complex packaging systems were used in the supermarkets (Figure 1A and 1C, Figure 2) whereas displaying in open-air either with or without soaking in water (Figure 3C) was common in the wet markets. Furthermore, fresh-cut mixes in the supermarkets contained more ingredients than their wet market counterparts (Table 2). For instance, there were additional cauliflower and broccoli in chop suey mix, and red onion and garlic in *pancit* mix, which were absent for those sold in wet markets. These added ingredients coupled with the chilled temperature storage and plastic packaging could be some of the reasons for their higher prices (data not shown).

Preparation and treatment of fresh-cuts

In wet markets, fresh-cut products were usually prepared early in the morning at the market stall, typically using good vegetable stocks. Wet market vendors would prepare enough that could last until noon, which was about 10–15 kgs or one full basin. Another batch would then be prepared that would be displayed from noon until the end of the day. This practice is similar to Thailand as the handlers in their open-air markets prepare fresh-cuts all day long using good quality produce (Rattanapanone et al. 2000). Nevertheless, excess or reject produce were also used by some vendors such as in processing whole peeled carrots in Bankerohan.

In contrast, supermarkets both outsourced and produced their fresh-cut products. External suppliers would deliver such goods every day. Additionally, employees prepared fresh-cuts at their preparation area before opening hours (i.e. before 9 or 10 AM) and processed both excess and good stock vegetables. These findings thus support the report of Flor et al. (2007) about public markets and supermarkets in the Philippines utilizing raw materials about to reach their limit of saleability.

Table 3 lists a summary of the different processing practices used in wet markets and supermarkets based on visual observations and interviews. Generally, fresh-cut processing in both supermarkets and wet markets involves

TABLE 1 Minimally processed vegetables sold as monotype in supermarkets (S) and wet markets (W) in Davao City (November 2017–January 2018)

Common name[a]	Part of plant prepared as fresh-cut	Cut type	Open display (O) or packed (P)		Mean product temperature °C	
			S	W	S	W
Jackfruit (*Langka*)	Immature fruit (peeled fruit)	Rough chop	P		5.1	
			O	O	4.7	25.7 ± 0.8
Bamboo	Shoot (*Dabong*)	Thin slice	O	O	12.1 ± 6.5	25.4 ± 0.4
Coconut	Pith (*Ubod*)	Julienne	P	O	5.6 ± 1.1	25.4 ± 0.4
Squash	Fruit (sometimes with part of the peel)	Sectioned	P	O	14.8	25.4 ± 0.4
Bitter gourd	Fruit	Slice	O	O	14.5 ± 3.8	25.4 ± 0.4
Corn	Immature cob (baby corn)	Peeled intact	P	P	12.8	25.4 ± 0.4

[a] Scientific names are listed in Appendix 1

Temperature data represent mean and standard deviation of at least three measurements taken from different wet market stalls (two measurements in the case of supermarket temperature data – one per location). Values without a standard deviation pertain to products that were sold in only one supermarket.

TABLE 2 Minimally processed vegetables sold as mixes in supermarkets (S) and wet markets (W) in Davao City (November 2017–January 2018)

Mix	Vegetables included[a] (cut type)	Open display (O) or packaged (P)		Product temperature (°C)	
		S	W	S	W
I. Sautee					
Pinakbet mix	Okra (rough chopped) Squash (rough chopped) Bitter gourd (sliced) Eggplant (slant sliced) Yard long beans (sliced)	O	O	16.2 ± 3.0	26.1 ± 0.3
Sari-sari	Squash (julienne) Carrot (julienne) Chayote (julienne) Yard long beans (slice)	O	O	8.2	25.9 ± 1.3
II. Stir-fry					
Chop suey	Cauliflower[b] (rough chop) Broccoli[b] (rough chop) Chinese cabbage (rough chop) Sweet pepper (julienne) Carrot (thin slice) Leaf lettuce (rough chop) Garden pea (intact) Chayote (julienne)	O, P	O	17.6 ± 2.6	26.1 ± 1.3
Mung bean sprout mix	Carrot (julienne) Snap beans (slant slice) Mung bean sprout (intact)	O	O	20.9	25.6 ± 0.4
Pancit mix	Onion, red[b] (intact) Garlic[b] (peeled) Cabbage (chiffonade) Chinese cabbage (julienne) Carrot (julienne)	O, P	O	11.8 ± 4.8	26.1 ± 0.5
III. Stew					
Giniling	Carrot (brunoise) Potato (brunoise)	O	O	13.7 ± 1.9	25.4 ± 0.8
Menudo	Carrot (dice) Potato (dice)	O	O	15.9 ± 0.1	24.7 ± 1.5
IV. Raw					
Kinilaw	Onion, red (dice) Calamondin (intact) Cucumber (half-disc slice) Radish (rough chop) Ginger (mince)	O	P	3.9	25.9 ± 1.10

[a] Scientific names are listed in Appendix 1
[b] Additional ingredients for the supermarket counterpart
Temperature data represent mean and standard deviation of at least three measurements taken from different wet market stalls (two measurements in the case of supermarket temperature data – one per location). Values without a standard deviation pertain to products that were sold in only one supermarket.

FIGURE 1 Monotype fresh-cuts: A) Packed *ubod* in the supermarket, B) *Ubod* soaked in water in the wet market, C) Sectioned squash wrapped with plastic film in the supermarket, and D) Sectioned squash in open-air the in wet market

FIGURE 2 Mixed fresh-cuts in supermarkets displayed on A) trays over ice flakes (open air), B) regular metal tray (clingwrap over tray), and C) in clamshells in the chiller

FIGURE 3 Mixed fresh-cuts in wet markets: A) Vendor putting *sari-sari* mix inside plastic film upon purchase, B) *pinakbet* mix in plastic film while on display and. C) various mixed fresh-cuts in open-air display exposed to sunlight

washing, cutting, and storing. Before cutting, washing with tap water was typically done in both marketplaces. In the wet markets, water added to a basin was used multiple times to wash different vegetables and was replaced only once or twice a day. As a post-cutting treatment, wash water was not common in the locations surveyed. In supermarkets, processed vegetables were immediately packaged or displayed. Based on the interviews with wet market vendors, some reasons for doing so included "Consumers will wash them anyway" and "*Malata kung hugasan*" (It will soften/rot faster when washed). For some products such as *sari-sari* mix and immature jackfruit (*langka*), they are immersed in wash water before displayed in a dry basin.

These practices are indeed not aligned with food safety principles. Khubber et al. (2020) reported that washing should be done immediately after cutting to remove cell exudates that may support the growth of spoilage and pathogenic microorganisms. However, it is also imperative that the products are free of excess moisture afterwards as this can stimulate microbial activity (Khubber et al. 2020). Additionally, issues can arise from reusing wash water since this can be a source of cross-contamination due to the build-up of microorganisms (Gil et al. 2009). Such wash water related contamination was observed by Vital et al. (2019) in which a high load of *E. coli* in mung bean sprouts and coliphage (fecal indicators) in bell peppers was documented in different wet markets in Luzon (Philippines). As previously mentioned, *E. coli* infection can lead to gastrointestinal-related symptoms. Infection with these bacteria may also become life-threatening especially when such contamination involves the *E. coli* O157:H7 variant. These pathogens have low infection dose (i.e. less than a few hundred cells) and could lead to bloody diarrhea and kidney failure especially in immunocompromised and vulnerable consumers such as children and the elderly (Gilbert et al. 2007). Such microbes have alarmingly been implicated in numerous national outbreaks in Western countries (e.g. England, Scotland) due to consumption of minimally processed salad mixes (Feng et al. 2017; Public Health England 2016).

It is, however, important to consider that washing has economic implications due to the large amounts of water required for washing and/or soaking (Gil et al. 2009). This, including the lack of appropriate moisture removal equipment for post-washing (e.g semi-fluidized beds with forced air) as well as the fact that consumers cook the vegetables, could be some reasons why fresh-cut processors choose not to wash fresh-cuts as a post-cutting treatment. In this regard, government support in providing fresh-cut handlers (especially in open-air markets) access to a clean water source could potentially contribute to improving sanitation during fresh-cut preparation.

TABLE 3 Differences in fresh-cut vegetable processing in wet markets and supermarkets

Parameter	Wet market	Supermarket
Quality of intact produce	Excess and good stock	Excess and good stock
Pre-cutting treatment	Wash with water	Wash with water
Mean storage temperature and relative humidity	31.0°C, 74.6%	Cooler display racks: 14.3°C, 50.7% Vegetable section: 20.5°C, 51.4%
Mode of display	Outdoor (possible exposure to sunlight and flies) Open-air in basins on tabletop Open-air and soaked in water	Indoor Shelf-display in chillers Open-air on trays over ice flakes
Length of time of display, hours	~ 5	~ 24
Packaging during display	Unpacked (open-air display) Plastic film	Unpacked (open-air display) Plastic film Clingwrap over tray Clamshell
Packaging upon purchase	Plastic film	Plastic film Clingwrap over tray Clamshell

Cutting operations

Based on the interviews, handlers in supermarkets typically prepared fresh-cuts in a separate preparation room and wore appropriate clothing (e.g. apron, gloves, hair net, and face mask) during processing. However, this was not the case in wet markets as illustrated in Figure 4. It was also observed that some handlers in wet markets use blade cutters in slicing instead of appropriate knives. The sharpness of cutting materials is an important consideration in fresh-cut processing. Cutting with sharp blades can slow down biochemical reactions and thus have a positive impact on the shelf-life of cut produce. Finnegan et al. (2013) found that fresh-cut pineapples processed using sharp knives had a lower respiration rate compared with those sliced using blunt blades. Similarly, Portela and Cantwell (2001) observed that cantaloupes sliced with sharp borers maintained a marketable visual quality for six days at 5°C while those prepared by a blunt borer were already visually unacceptable by this time. Hence, as craft blade cutters are not made for slicing vegetables, using one instead of an appropriate knife might cause more wounds on the produce thereby potentially reducing its shelf-life at an even faster rate.

FIGURE 4 A handler in a wet market slicing cabbage using a meat cleaver (typically used for cutting meat bones) without apron and gloves

Packaging of fresh-cuts

Figure 5 compares the modes of packaging used in both markets. For most fresh-cuts in wet markets, no packaging was used for the duration of the display. Plastic films were commonly only used upon purchase. Similarly, many fresh-cuts sold in supermarkets were also displayed in open-air placed on trays over ice flakes (Figure 2A, Table 3), and plastic films were also used upon purchase. However, tongs were available for use for the consumers, as opposed to wet markets, where vendors used bare hands when putting products inside plastic films (Figure 3A). Many issues can arise in the open-air storage of fresh-cut produce. Packaging provides a modified atmosphere around the product to decrease the rate of undesirable metabolic reactions as well as protection against microbial contamination (Saltveit 2003). Specifically, low O_2 and elevated CO_2 in packaging systems have been proven to control aerobic respiration, enzymatic browning, firmness, and decay of minimally processed produce (Rojas-Graü et al. 2009). Besides, this modified atmosphere can also delay the growth of aerobic microbes such as *Pseudomonas* (Rojas-Graü et al. 2009). Such species play a key role in the spoilage of minimally processed vegetables since they contain enzymes that contribute to soft rot in these products (Lund 1971; Nguyen-The and Prunier 1989; Pinto et al. 2015). Thus, the shelf-life of fresh-cuts displayed without packaging in the open air could be significantly reduced. However, an open-air storage format allows consumers to grab their desired quantity of fresh-cuts, which could be why vendors preferred to sell them like so. Discussions with vendors also revealed that these goods were displayed for a maximum of one day. Therefore, since pre-packing these goods in certain quantities requires more cost and time, it might not be practical for them to manually cut, weigh, and pack every time.

A few fresh-cuts in wet markets were sold pre-packed in films such as in the case of *pancit* mix and baby corn. In the supermarkets, those that were pre-packed (e.g. clingwrap over tray, plastic film, clamshells) were mostly prepared by external suppliers. Clamshells were only used in ready-to-eat salads as these packages are convenient for the on-the-go type of consumers. The information

available on the packaging was net weight, price, the name of the supplier, and for some, the expiration date. Although these packed versions can give a better barrier against contamination and deterioration, the enclosed pack can lead to the accumulation of unwanted metabolites such as CO_2, which can have adverse effects on product quality. Nevertheless, quality deterioration due to CO_2 accumulation might be less likely to occur given the short display time of these products. Still, the fact that each component in the mix has variable perishability is also an important consideration because the quality of an entire RTC or RTE mix is only as good as its most perishable component (Cantwell and Suslow 1999).

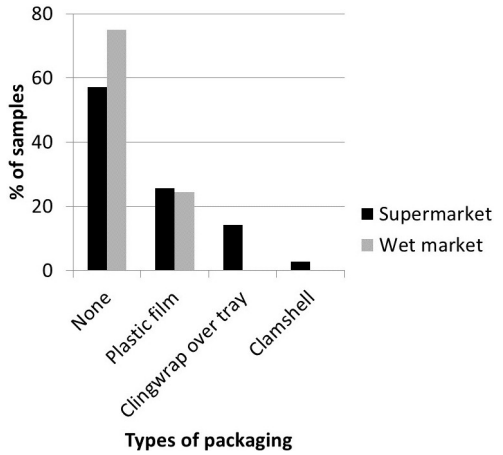

FIGURE 5 Types of packaging used in minimally processed vegetables in wet markets and supermarkets in Davao City, Philippines

Storage of fresh-cuts

One of the most important differences between the fresh-cut processing practices of supermarkets and wet markets was the storage temperature (Table 3). In the supermarkets, the temperatures of the chilled cabinet display and general vegetable section were 14.3°C (50.7% RH) and 20.5°C (51.4% RH), respectively. As a result, the temperatures of fresh-cut vegetables sold in these areas ranged from 3.9 to 20.9°C depending on where they were displayed (Table 1 and 2). In contrast, wet market products were displayed and sold in ambient conditions (31.0°C, 74.6% RH), which led to product temperatures ranging from 24.7°C to 26.4°C (Table 1 and 2). They also had exposure to sunlight, dust, and insects.

Fresh-cut items generally require a storage temperature of 0–5°C to reduce respiration rates, inhibit microbial growth, and retard deterioration such as browning and softening in fresh-cut products (Cantwell and Suslow 1999). The conditions in the wet markets were indeed not ideal. Moreover, in such environments, the growth of pathogens is limited due to competition with spoilage microorganisms (Harris et al. 2003). In other words, spoilage occurs before pathogens could grow and cause infections to consumers.

In the supermarkets, there was also temperature abuse as only two out of the fourteen products listed (Table 1 and 2) were stored below 5°C. However, this could pose a higher threat since some products that may seem fresh could be contaminated by pathogens that may survive in refrigerated environments. In the case of fresh-cut salad containing romaine and iceberg lettuce, storage at 12°C increased the load of *E. coli* O157:H7 even before the product showed signs of quality deterioration (Luo et al. 2010). Additionally, psychrotrophic pathogens (i.e. those that prefer chilled environments) are also a concern. For instance, minimally processed tomato, celery, and lettuce, which were presumably contaminated with *Listeria monocytogenes* (a psychrotroph), were reported as the possible cause of an outbreak in Boston, USA in 1979 (Harris et al. 2003). *L. monocytogenes* causes mild gastroenteritis in healthy adults but could well be deadly for the young, old, pregnant, and immunocompromised group (Meloni et al. 2009). Therefore, respecting the cold chain i.e. 0–5°C throughout transportation and storage as well as in retail displays and in the home of the consumer is paramount in preventing the growth of pathogens (Sousa-Gallagher and Mahajan 2011).

Defects observed in fresh-cuts

Figure 6 illustrates that more than 60% of the fresh-cuts in both locations did not exhibit visual deterioration, which could be mainly due to the short time of display of the products. Moreover, no decay was observed in both locations because the products were displayed for six hours on average in wet markets and about 24 hours in supermarkets. However, in both wet markets and supermarkets,

browning was common in okra, Chinese cabbage, eggplant, and potato. Browning is the consequence of the oxidation of phenols aided by polyphenol oxidase (PPO), thereby producing quinones that are subsequently polymerized to form melanins (Yousuf et al. 2020). These compounds then impart the visually unacceptable browning on the surfaces of fresh-cuts, which are the main causes of their quality deterioration (Yousuf et al. 2020).

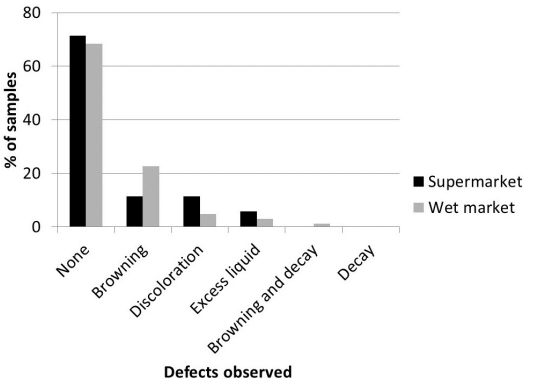

FIGURE 6 Defects observed in minimally processed vegetables in wet markets and supermarkets

Several factors can affect browning, which include the sharpness of the cutting blade and storage conditions. In a study about fresh-cut eggplants, the researchers found that browning was reduced by cutting using a sharp blade (thickness of 0.04 mm), immediate dipping in water for 10 minutes, ambient air-drying, and packaging (Mishra et al. 2012). Additionally, a close look at the surface using scanning electron and fluorescence microscopes revealed that there was less physical injury and cell death when using a sharp blade (Mishra et al. 2012). This led to lesser browning due to a decrease in both leachings of phenols and PPO activity (Mishra et al. 2012). With regards to the shelf-life, fresh-cut eggplant sliced using a sharp blade was overall acceptable up to 16 days at 4°C, 12 days at 10°C, and 5 days at 26°C (Mishra et al. 2012). Conversely, Mishra et al. (2012) showed those that were cut using a conventional knife (thickness of 0.25 mm) were not acceptable even on day 1. Their results suggest that storage in ambient conditions (26°C) can retain the quality of fresh-cut eggplants for more than one day if good cutting equipment, post-cutting treatment, and packaging are applied. Since this entails a relatively lower investment, these show potential shelf-life prolongation applications for wet market vendors and supermarkets e.g. using sharp cutting blades in reducing browning of cut eggplants or other fresh-cut vegetables.

Conclusions and Recommendations

Both wet markets and supermarkets surveyed sold a similar selection of fresh-cut vegetables. A few of the common items found were immature jackfruit (*langka*), coconut pith (*ubod*), bamboo shoot (*dabong*), chop suey mix, and *pinakbet* mix. Having these native vegetables in a convenient and easy-to-cook manner can have a positive impact on the diversity of the Filipino diet for a more balanced source of nutrients. Some practices observed in which issues could arise were reusing of wash water, using inappropriate cutting materials, and absence of post-cutting treatments. More importantly, the fresh-cuts were subjected to temperature abuse in both locations, which could lead to the potential proliferation of pathogens that could lead to life-threatening gastrointestinal-related illnesses. The unnoticeable visual deterioration in some fresh-cuts that could be already highly contaminated with pathogens even poses a greater food safety concern. The results of this study suggest lack of awareness might have caused these unhygienic practices. Therefore, it is recommended that interventions be made by both government and non-government organizations in the education regarding proper handling of fresh-cut products using simple techniques, such as using clean and sharp cutting equipment during processing. Government support in providing access to clean water to open-air market vendors is also a possible solution in improving sanitation during fresh-cut handling. Lastly, microbial assessment on these products can also be performed so that information on the degree of contamination can be used to create strategies in maintaining their quality and safety.

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APPENDIX 1 Common and scientific names of produce sold as fresh-cut vegetables

Common name	Scientific name
Bamboo	*Bambusa vulgaris*
Bitter gourd	*Momordica charantia*
Broccoli	*Brassica oleracea var. italica*
Cabbage	*Brassica oleracea var. capitata*
Calamondin, Calamansi	*Citrofortunella macrocarpa*
Carrots	*Daucus carota*
Cauliflower	*Brassica oleracea var. botrytis*
Chayote	*Sechium edule*
Chinese cabbage	*Brassica rapa subsp. pekinensis*
Coconut	*Cocos nucifera*
Corn	*Zea mays*
Cucumber	*Cucumis sativus*
Eggplant	*Solanum melongena*
Garden pea	*Pisum sativum*
Garlic	*Allium sativum*
Cucumber	*Cucumis sativus*
Jackfruit	*Artocarpus heterophyllus*
Lettuce	*Lactuca sativa*
Mung bean (sprouts)	*Vigna radiata*
Okra	*Abelmoschus esculentus*
Onion	*Allium cepa*
Potato	*Solanum tuberosum*
Radish	*Raphanus sativus*
Snap beans	*Phaseolus vulgaris*
Squash	*Cucurbita maxima*
Sweet pepper	*Capsicum annuum*
Yard long beans	*Vigna unguiculata ssp. sesquipedalis*