

## Knowledge and Practices in the Utilization of Banana (*Musa* sp.) Leaf as Food Contact Material in the Metropolitan Manila Foodservice Industry

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Banana (*Musa* sp.) leaf is widely used as a food contact material (FCM) in the Philippine foodservice industry. In spite of its usage in serving and wrapping various raw and cooked foods, the Association of Southeast Asian Nations (ASEAN) general guidelines on FCMs exempted its application to banana leaf (BL) and other natural materials that have not undergone chemical modification. This study documented the knowledge and practices in the utilization of BL in foodservice establishments within the top five local government units (LGUs) in Metropolitan Manila, Philippines. Key informant interviews using a semi-structured questionnaire and participant observation were employed in data collection. Data were analyzed using the constant comparison method. Results showed that despite technological and scientific advancement, the BL has remained a functional FCM in the foodservice industry due to its perceived ethnic, sensory, and environmental impacts. The BL specifications – including leaf maturity, dimensions, integrity, cleanliness, and varietal source – are related to its functionalities as FCM. Generally, preparation methods employed by foodservice establishments include wiping, washing, and heating. These methods of preparation were found to be significantly associated with types of food products. The efficacy of these preparation methods needs to be evaluated due to possible leaf contamination and deterioration due to improper handling and storage prior to usage. Furthermore, the foodservice industry identified BL supply, price, and quality issues that should be properly addressed. As an FCM, BL influences final food product quality and safety. Thus, the utilization of BL by other actors within the foodservice supply chain should be further studied to provide baseline information for the establishment of Philippine standards for BL as an FCM.

Keywords: banana leaf utilization, food contact material, food quality and safety, foodservice, key informant, knowledge and practices

### INTRODUCTION

The BL is widely used in Philippine cuisine (Besa and Dorotan 2006). The leaf is traditionally used as a serving plate or liner for boodle service, cooked viands, and rice meals. Moreover, it is traditionally used as a wrapper for

various foods during cooking. The use of BL in foods has not only been limited to households. More recently, even the foodservice (Planters Bank Inc.; Olchondra 2010) and food processing industries (Luna 2018) utilize it as a food packaging material. Its functionality in foodservice and processing industries may be attributed to its availability (Faylon *et al.* 2004), fast regeneration (Arvanitoyannis

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and Mavromatis 2009), and biodegradability (Kora 2019). Also, its inherent chemical components (Yanagida *et al.* 2005; Kuo *et al.* 2006) and structure (Yanagida *et al.* 2005; Angeles *et al.* 2013; Luna 2018) may contribute to its suitability as packaging material enhancing the sensory properties and shelf life of food it encloses. The BL utilization as food packaging has provided a source of income and livelihood for all stakeholders, including the harvesters, distributors, and foodservice and processing industries. Additionally, compared to synthetic food packaging materials like plastics which are derived from fossil fuel, BL – which is a renewable resource – can contribute to the reduction of carbon footprint (Gautam *et al.* 2020).

The FCMs are “all materials and articles intended to come into contact with food including packaging materials but also cutlery, dishes, processing machines, containers, *etc.*” (Enguix *et al.* 2008). Based on the local utilization of BL as a food packaging, wrapper, and liner, it can be considered as an FCM.

The FCM can contaminate the food it is in contact with. Leaf contaminants may be classified as physical, chemical, or biological that can compromise food quality and safety. These may come from the various stages of the supply chain: primary production, processing, and trade or distribution (Kirezieva *et al.* 2013). Therefore, the practices involved throughout the BL supply chain need to be documented. As an FCM, there is a paucity of documented information regarding knowledge and practices in the utilization of BL as an FCM in the foodservice supply chain. Moreover, the safety and quality properties of BL as an FCM are not yet established. These are crucial in the foodservice industry since food is directly cooked and served in BL. Thus, this study mainly aimed to document knowledge and practices of foodservice establishments in the utilization of BL as an FCM. This will provide initial baseline information for the establishment of Philippine standards for BL as a liner or wrapper to ensure food quality and safety.

## MATERIALS AND METHODS

Knowledge and practices in the selection, handling, preparation, and utilization of BL as an FCM in foodservice establishments were documented using key informant technique (Tremblay 1957; Marshall 1996) and participant observation (Delamont 2004).

In this study, foodservice is defined as “the serviced provision of food and beverages (meals) purchased out of the home but which may be consumed both in and out of the home” (Edwards and Overstreet 2009). In 2016,

Euromonitor classified foodservice into six categories that were defined by Martin-Rios and his co-authors (2018) as follows: “full-service provider (offers full table service of different food products), café and bar (focus on beverage variations; some offer a variety of snacks), fast food (offers convenient food products that are paid and served at the counter; has standard food menus served quickly), self-service or cafeteria (offers food at low prices and often has a wide range of menu; typically located near companies, schools, and the community to cater consumers around the area), take-away or delivery (offers food products that could be eaten at home or elsewhere; eating on site is not possible due to lack of proper area), and kiosk or stall (small outdoor or indoor outlets that offer specific food products at a low price).”

### Study Site Selection

The foodservice establishments in Metropolitan Manila were identified as the target population for this study. Based on the 2018 Census of Philippine Business and Industry (PSA 2021), Metropolitan Manila has the highest number of foodservice establishments and total revenue among all the regions in the Philippines.

Request letters to participate in the study were sent to the top five performing LGUs, which were identified based on total local revenue sources (Blgf.gov.ph) in Metropolitan Manila. Also, assistance from the National Nutrition Council NCR for endorsement from health offices of LGUs was sought. Only the cities of Makati, Quezon, and Pasig offered support in data collection and were, hence, considered as the study sites. A master list of foodservice establishments utilizing BL as an FCM in the identified study sites was generated by consolidating different lists available from the internet and government institutions.

### Participant Recruitment

Key informants who served as participants in this study are local experts who have the pertinent knowledge and practices about the selection, handling, preparation, and utilization of BL as an FCM in the foodservice industry. The criteria for selecting key informants were modified from Tremblay (1957). They were chosen based on their role in the utilization of BL in foodservice, level of knowledge, willingness to cooperate, communicability, and impartiality.

The study was discussed with potential participants. For those willing to participate, a written consent form was secured prior to the interview. Convenience sampling was used to recruit key informants who were readily available (Sekaran 2003). Likewise, the snowball technique (Biernacki and Waldorf 1981) whereby chain referrals from government and private institutions, survey

respondents, and individuals from the academe were obtained. Participant recruitment and data analysis were continued until theoretical saturation was reached (Corbin and Strauss 2008).

### Questionnaire Development and Pre-testing

A semi-structured questionnaire was prepared and pre-tested using five foodservice establishments drawn from the identified prioritized study sites. Based on pre-test results, the questionnaire was revised and validated. Key questions for the survey include demographics, foodservice industry profile, specifications and functionality of BL as an FCM, BL storage and preparation methods, issues in the utilization of BL as an FCM, and foodservice respondents' aspirations for BL utilization.

### Data Collection and Analysis

Audio-recorded interviews were conducted within the natural work settings of key informants. Also, video-recording of BL preparation and utilization was done upon their consent. Responses of key informants were summarized immediately after completion of the interview and observation. Interviews were transcribed *verbatim* by the research assistant, and the accuracy of the transcription was evaluated by the project leader. Data were collated and analyzed as the collection progressed. Data collection was terminated upon reaching theoretical saturation (Corbin and Strauss 2008). Content analysis (Graneheim and Lundman 2004) was used to analyze data. Additionally, data obtained from interviews were validated by on-site observation of processes, and summarized responses were verified with the respondents. Follow-up questions to supplement the interviews were also made *via* email, calls, and face-to-face meetings.

### Statistical Analyses

To determine the association between the type of food products and methods of BL preparation, the chi-squared test of independence was used at a 5% level of significance. When results showed a significant association between variables, correspondence analysis was done. All statistical analyses were conducted using Stata IC 15.0.

### Ethical Considerations

Prior to the conduct of the study, ethical clearance of the study protocol was obtained from the National Ethics Board of the Department of Science and Technology (NEC Code: 2019-008-Luna-Banana Leaf).

## RESULTS AND DISCUSSION

### Foodservice Establishment Participants in the Study

The demographic characteristics of the 27 foodservice key informants for the survey are presented in Table 1. Overall, 62 potential participants from foodservice establishments were approached. However, most foodservice establishments did not show support to the study because of a lack of interest, confidentiality, and privacy concerns.

A majority (70%) of key informants who participated in this study were females with ages ranging from 19–64 yr old. Demographic data observed in foodservice establishments utilizing BL in Metropolitan Manila follow the typical labor trend relative to gender in the services sector, including hotels and restaurants (ILO 2010) and age of the working class (PSA 2020). The educational background and age groups of the participants are widely distributed because of the diversity of their ranks and involvement in the management of operations. Some key informants are involved in the preparation of BL as workers or supervision and management of operations. There are small business owners or workers with little educational background, while others are supervisors, managers, or owners of large enterprises with at least a college diploma.

Knowledge on BL preparation and utilization of key informants in more established foodservice institutions is transmitted through work-related affiliation. Particularly, knowledge is formally shared through the mother company's established training program. On the other hand, for those employed in smaller, less established businesses, knowledge on BL preparation, and utilization of key informants is acquired through familial affiliation.

Knowledge transmission is achieved by observation of practices by family members. This modality is consistent with African food processors (Oniang'o *et al.* 2004) and *suman sa lihiya* (lye treated boiled rice cake) processors (Luna 2018). Some owners of foodservice establishments acquired their knowledge while growing up, imbibing the culture and tradition of BL usage as liner or wrapper in food products. Some also applied their personal knowledge in their business ventures.

### Foodservice Industry Profile

The rank order of the participating foodservice establishments in terms of categories is take-away or delivery > full-service > cafeteria or self-service > bar or café, fast food. Generally, 67% of foodservice establishments employ one to nine workers and are classified as small-scale business units (SEPO 2012). A majority (70%) has been operational for 2–10 yr, with a

**Table 1.** Demographics of foodservice key informants for the survey on knowledge and practices in the utilization of BL as FCM in Metropolitan Manila.

Parameters	Details	Foodservice key informants (n = 27)	
		Frequency	% distribution
Gender	Male	8	30
	Female	19	70
Age	19–30	6	22
	31–40	7	26
	41–50	8	30
	≥ 51–64	6	22
No. of years involved in the foodservice establishment	< 2	4	15
	2–5	11	41
	6–10	4	15
	11–20	6	22
	21–50	2	7
Highest educational level	Primary school undergraduate	1	4
	Primary	3	11
	Secondary	8	30
	Tertiary	12	44
	Vocational	2	7
	Postgraduate	1	4
Source of knowledge	Work-related affiliation	17	63
	Familial affiliation	6	23
	Cultural environment/ media	2	7
	Personal or own knowledge	2	7
Position or occupation	Owner	9	33
	Manager	7	26
	Supervisor	2	8
	Worker	9	33

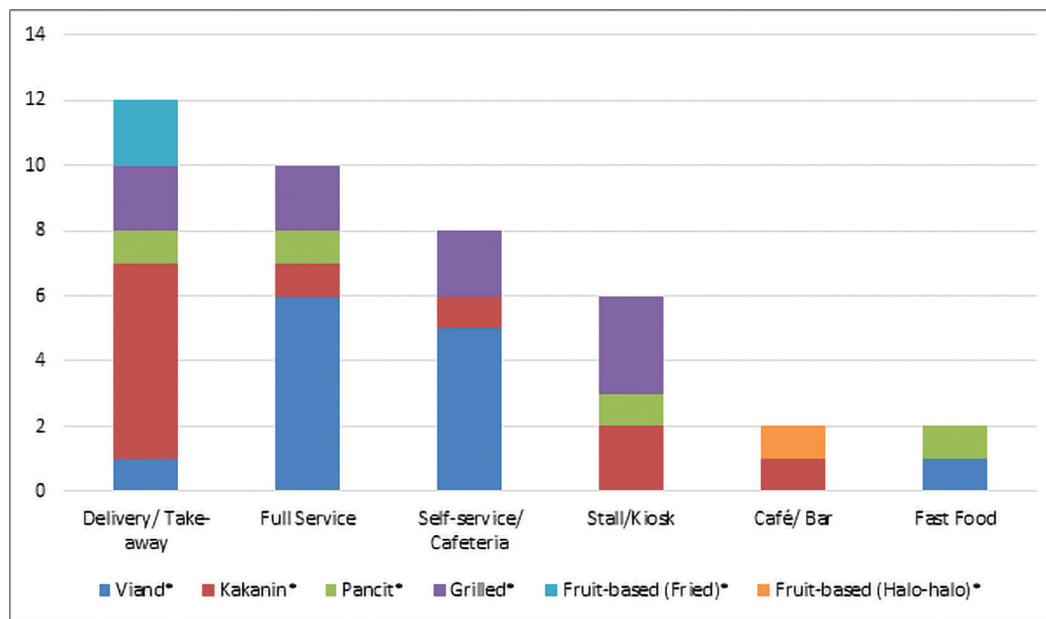
few for 11–50 yr. These establishments primarily obtain their BL supply by bundle from wholesalers and retailers within the Metropolitan Manila and CALABARZON (Region IV-A), although a few of them purchase directly from BL harvesters. The overall BL volume ordered by foodservice establishments is 4,458 half leaves/wk. As shown in Figure 1, BL is widely used in various products.

### Packaging Functions and Specifications of BL Identified by Foodservice Establishments

Interestingly, all packaging functions – including containment, communication, convenience, and protection – conventionally ascribed to food packaging materials (Robertson 2013) are also attributed to BL utilized as FCM in the foodservice industry. Additionally, new functional properties such as sensory enhancement and environmental features were identified by key informants.

Specifications of BL as an FCM and the corresponding functionalities are presented in Table 2.

Notably, most of the packaging functions for BL as an FCM are ascribed to leaf maturity, which is further qualified with the most number of descriptors. Color is used to mainly describe maturity: yellow-green for the young leaf and light to dark green for the mature. A similar result for BL used for *suman sa lihiya* was reported, wherein processors defined maturity in terms of increasing intensity of green color for the young to mature leaves. This was also validated with leaf instrumental color analysis (Luna 2018). However, in botany, BL maturity is defined based on the position relative to the newly emerged (sword) leaf at the apex of the plant. The first four leaves surrounding the sword leaf are classified as young. The rigid leaves surrounding the young are old (Ekanayake *et al.* 1994; Okolle *et al.* 2009). Aside



\*Multiple responses provided by foodservice respondents

**Figure 1.** Types of participating foodservice establishments (n = 27) and food products utilizing BL as FCM in Metropolitan Manila, Philippines.

**Table 2.** Specifications and packaging functions of BL considered by foodservice establishments (n = 27) for using it as an FCM.

Specifications for BL of FSEs			Packaging functions of BL	
Leaf attributes	Primary descriptor	Secondary descriptor	Category	Interpretation of primary functions as an FCM
Maturity	Mature	a) Light green	Aesthetic appeal	Sensory enhancement
		b) Medium green	Aesthetic appeal	Sensory enhancement
		Strong	Resistance to tearing	Containment; protection
		Thick	Resistance to tearing	Containment; protection
		c) Dark green	Aesthetic appeal	Sensory enhancement
		Strong	Resistance to tearing	Containment
	Young	Thick	Resistance to tearing	Containment
		Yellow-green	Aesthetic appeal	Sensory enhancement
		Pliable	Foldability	Containment
		Texture	Soft	Containment
Dimension	Thickness	Thick	Ease of preparation	Containment; protection
	Length	Long	Ease of preparation	Containment
	Width	Wide	Versatility of package format	Containment
			Greater yield in numbers produced	Containment
	Area	Broad	Versatility of package format	Containment
Integrity	Whole	Absence or with minimal tears	Versatility of package format	Containment
			Greater yield in numbers produced	Containment
			Aesthetic appeal	Sensory enhancement
			Ease of preparation	Containment
Cleanliness	Clean	Absence of visible dirt and insects	Indicator of product cleanliness	Protection
			Consumer acceptability	Protection; communication
			Prevention of foodborne illnesses	Protection

Leaf attributes	Specifications for BL of FSEs		Packaging functions of BL	
	Primary descriptor	Secondary descriptor	Category	Interpretation of primary functions as an FCM
Varietal source: <i>saba</i> (as being compared to <i>latundan</i> )	Width	Wide	Versatility of package format	Containment
			Wide compared to other variety ( <i>latundan</i> )	Containment
	Thickness	Thick	Resistance to tearing	Protection; containment
	Color	Green	Darker in color compared to other variety ( <i>latundan</i> )	Sensory enhancement
	Texture	Brittle	Not pliable compared to other variety ( <i>latundan</i> )	Containment
	Aroma and flavor impact on food	More aromatic and enhanced flavor	Appetizing food	Sensory enhancement

from color, leaf maturity is also qualified in terms of strength, thickness, pliability, and texture – which are also associated with specific packaging functions.

#### Containment Functions of BL in the Foodservice Industry

The BL serves to contain food when used as a liner for raw and cooked foods like *pancit* (Filipino stir-fried noodles), grilled products, viands, fried-fruit-based products, and *kakanin* (rice cakes). Aside from serving as a food container, BL used as a wrapper also facilitates distribution. Consistent with the containment food packaging function stated by Robertson (2013), to a certain extent, BL also reduces product spillage and spoilage by creating closures. As a wrapper, it accommodates a substantial amount of food when BL is cut and folded into different formats as practiced in packing take-away of *pancit* and cooking foods like *suman* (rice-based cake), *pinais na isda* (Filipino native fish dish), *pinaputok na isda* (deep-fried stuffed fish), *pepes ikan* (Indonesian grilled curry fish), and *lontong* (Indonesian rice cake).

The BL maturity is also associated with containment. Foodservice respondents noted that the young leaf is pliable and soft facilitating folding without breaking when used as a food wrapper. The foldability of the young leaf is responsible for forming an assortment of packaging formats. On the other hand, the mature leaf is described as durable and thick, making the leaf resistant to tearing and puncture when used as a food liner. According to Tomlinson (1957), *Musa* is one of the plants that taxonomically assimilates silicates from the soil (Prychild *et al.* 2004). Silicates may contribute to the mechanical strength of leaves (Tomlinson 1957). The BL strength associated with mature leaves may be attributed to its acid insoluble ash, which is primarily silicates (Prychild *et al.* 2004).

The BL attributes related to its containment function are dimension and integrity. Specifically, BL thickness and width are important attributes for wrapping *suman*. In this food product, leaves are pre-cut according to specified measurements prior to use. The large size and pliability of BL allow it to be formed into various package designs without tearing (Kora 2019). Additionally, in *pancit sa bilao* (circular wooden basket), width is important to ensure that the whole basket is covered with the leaf. A respondent stated, “If the banana leaf is wide, you do not need to double the layer in covering the whole *bilao*” – thus saving time, effort, and money. Chua and Dykes (2013) and Luna (2018) reported that BL is used as a food wrapper due to its large surface area. However, in the industry – when BL received are of bad quality – torn leaves are overlapped to properly contain and avoid product spillage. This practice, however, increases material cost.

For its containment function, the integrity of BL is also important to some foodservice establishments. The BL should be whole to ensure ease of preparation, the versatility of package format, and the production of a greater number of FCM.

Aside from BL dimension and integrity, its containment function is enhanced because of its natural waxy cuticle (Yanagida *et al.* 2005) that serves as a hydrophobic barrier protecting the wrapped food from external contamination. This leaf wax integument may also confer the required pliability responsible for retaining BL integrity as it is folded to the desired package format.

#### Communication Functions of BL in the Foodservice Industry

Foodservice key informants articulated that BL usage in foods is linked to tradition. According to them, ancestors have utilized BL in rice-based cakes, including *suman* and *bibingka*. Also, viands like fried, stewed, roasted, grilled,

and steamed products served in a boodle fight – which is a modality of eating together using bare hands – are traditionally served on overlapping layers of BL (Salcedo 2019). As such, BL has become part of the vital formula in producing and serving different types of food. A key informant mentioned that “We should never run out of a banana leaf. If paper linen will be used, it will not be considered a *bibingka* anymore but a cupcake only.” Thus, the visual impact offered by BL is associated with the authenticity of the food. Lee and co-authors (2020) noted that in local cuisine, the plating style – including BL as a garnish – is one of the factors that could influence consumer’s positive perception of its authenticity.

Foodservice key informants also relate BL with native appeal in *maja blanca*, *suman*, and other *kakanin* used as liner or wrapper; and *halo-halo* and *con yelo* products (Filipino mixed fruit preserve in shaved ice) as a garnish. It was mentioned that “*Bibingka* is a Filipino product and the normal way to prepare it is to use banana leaf to maintain the original version.” Specifically, in *suman sa lihiya*, processors mentioned that BL confers a distinctive Filipino identity (Luna 2018). The BL usage has been an essential part of Filipino food culture, conferring Filipino ethnicity. Besa and Dorotan (2006) stated that BL is still used with various Filipino food preparations in foodservice. Also, BL is considered an FCM in various foods of other Southeast Asian countries to showcase their own culture (Chua and Dykes 2013).

Presently, several foodservice establishments use BL as an FCM to primarily promote Filipino culture and tradition. A key informant noted that “Banana leaf is already our trademark.” Furthermore, informants stated that BL usage helps establish their brand soul or image by providing a unique ambiance and environment depicting a Filipino home. This is further supported by Ardianto and Hardjana (2016), emphasizing that modern packaging cannot replace traditional leaf packaging because it provides a brand soul to food products and companies.

### **Convenience Functions of BL in the Foodservice Industry**

Convenience as a food packaging function is related to apportionment, resealability, and portability for consumers in a fast-moving environment (Robertson 2013). In foods like *suman* and *pancit*, wherein BL is used as a wrapper, these functions are evident. As a liner, foodservice respondents noted its convenience function from an industrial perspective. They associate its convenience function with ease of BL usage compared to porcelain and plastic plates, articulating that “The use of banana leaf is not labor-intensive since it can be disposed-off easily. There’s no problem in washing.” Thus, time and labor are saved (Kora 2019). They added that other costs

related to breakages and dishwashing are not incurred. Since the use of phosphate-containing dishwashing liquid is eliminated, it does not contribute to eutrophication that causes disproportionate microbial growth and oxygen depletion that kill fishes and other marine life (Kundu *et al.* 2015).

### **Protection Functions of BL in the Foodservice Industry**

The protection function of BL may be ascribed to leaf maturity. Foodservice respondents described mature leaves as resistant to tearing and puncture. This helps maintain the packaging format intact, protecting the food from further contamination. Leaf thickness of sword leaf is significantly thinner than the younger leaves (Luna 2018).

Also, foodservice respondents claimed that BL could prolong food product shelf-life. This may be attributed to bioactive compounds inherent in BL (Yanagida *et al.* 2005). Specifically, acidic and phenolic extracts of BL showed antibacterial activity against *Bacillus subtilis* NBRC 3134 and *Staphylococcus aureus* NRC14462. Moreover, these BL extracts demonstrated antioxidant activity based on DPPH (1,1-diphenyl-2-picrylhydrazyl) Radical Scavenging Ability.

### **Sensory Enhancement Functions of BL in the Foodservice Industry**

Foodservice establishments claimed that BL enhances the sensory attributes of food products. A respondent said, “It is aromatic (*mabango*), and it adds flavor in a newly cooked *bibingka*.” Other informants observed sensory enhancement of foods like grilled fish wrapped in BL, grilled viands served in BL, *suman*, and steamed rice. Possibly, cooking food in BL extracts its natural aromatic compounds that permeate into the food. Luna (2018) reported that processors observe the same sensory impact in *suman sa lihiya*. Kuo and co-authors (2006) isolated 9-lipoxygenase from BL responsible for generating compounds from the extract. They reported that after pickling BL extract, an oolong tea-like odor is observed. Other treatments mixed with soybean oil and lipase and linoleic acid formed a green, melon-like odor whereas with linolenic acid, a sweet, fruity cucumber-like aroma is noted. Foodservice respondents further pointed out that bitterness, naturally associated with plants, is not observed in BL products.

Additionally, one key informant stated that “The food is pleasant and enticing to look at. It looks delicious because of the banana leaf.” This enhanced aesthetic appeal could be explained by the traditional BL folding providing a unique identity that increases product value. The leaf also enhances its aroma and taste (Ardianto and Hardjana

2016). Furthermore, BL maturity enhances the aesthetic appeal of food products. Foodservice respondents have varying preferences for leaf color ranging from yellow-green to dark green. Generally, they associated the green-colored BL packaging with freshness. However, in color perception, green is associated with naturalness and eco-friendliness, provoking emotions (Hartmann *et al.* 2005; Evans *et al.* 2010). Among the sensory perceptions affecting the overall food experience, they recognized that the sensory enhancement function of BL as an FCM is associated with its visual, odor, and taste attributes.

Notably, foodservice respondents associate sensory enhancement function with specific BL varietal sources. They noted that *saba* leaves impart a delectable aroma that enhances the taste of the food it encloses. Some respondents mentioned that *saba* (*Musa x paradisiaca* L.) and *latundan* (*Musa x paradisiaca* L.) are the common leaf varieties sold in the market. However, most respondents are unfamiliar with BL varietal sources and only use what is available in the market. According to Valmayor and co-authors (2000), *latundan* leaves are used as a wrapper in cooking. Contrary, in another study, it was reported that *latundan* is not used for food packaging since it imparts bitterness in *suman sa lihiya*. The leaf varietal sources *saba*, *butuan* (*Musa acuminata* sbsp. *errans*), and *lagkitan* (*Musa x paradisiaca* L.) are used for the said product (Luna 2018). Nonetheless, actual field observation should be done to determine the veracity of the foodservice respondents' claim.

### Environmental Functions of BL in the Foodservice Industry

The BL is also used as an eco-friendly FCM; as noted by a key informant, "Banana leaf is non-destructive to the environment, unlike plastic." With the widespread issue regarding environmental sustainability associated with plastic, BL is a good alternative as a food liner or wrapper due to its biodegradability. This was also reported by Kora (2019), in which BL is commonly used as a single leaf plate that can be composted after use.

Foodservice respondents stated that "Banana leaf has no chemicals, so it's safe to use in food." They noted that BL is free of toxic chemicals and is, thus, safe to use as an FCM. However, banana plantations in Mindanao are heavily treated with pesticides, fungicides, and other chemicals for pest management (Nikol and Jansen 2018). Thus, BL sourcing should be traced to determine potential chemical contamination.

As a natural resource, respondents perceived that BL – unlike plastic – does not impart toxic compounds into foods. A respondent stated that "Plastic has toxic materials, whereas banana leaf is native, natural, and clean." According to Meeker and co-authors (2009), the

plastic used as FCM could transfer bisphenol A, melamine, vinyl chloride, phthalates, and others to food. Some of the complications these substances could cause are cancers, kidney damage, thyroid hormone imbalance, male fertility problem, and congenital disabilities (Meeker *et al.* 2009). Thus, there is the increased promotion of shifting to plant leaf usage as FCM (Kora 2019). It is also claimed that BL is inexpensive compared to plastic because BL is widely propagated in the country and is, hence, readily available and accessible. Availability of BL is ensured because of the rapid propagation of banana as a plant through its corm, thus confirming its perennial nature (Arvanitoyannis and Mavromatis 2009). In the Philippines, banana is a known cash crop; hence, it is widely propagated and can be easily accessed. There are more than 90 Philippine cultivars of bananas (Faylon *et al.* 2004).

### The BL Preparation Practices by Foodservice Establishments

The preparation procedures for BL used as FCM in foodservice establishments in the study are presented in Table 3. Generally, the most commonly used method is wiping, followed by washing and lastly heating. Convenience and service speed are the primary reasons cited for wiping the leaf, as these influence consumer satisfaction. Furthermore, foodservice establishments solely using the wiping method mentioned that heating complicates the process, thus incurring unnecessary expenses (*i.e.* overhead and labor costs). Similarly, Luna (2018) reported these reasons in *suman sa lihiya* processors.

Inherent BL cleanliness was also cited as one of the reasons for wiping. They added that if dirt particles are found on BL, these contaminants can easily be removed by wiping alone. Besa and Dorotan (2006) and Luna (2018) also reported the same preparation method for BL intended for FCM.

The BL is viewed by foodservice establishments as inherently clean. Luna (2018) also reported that *suman sa lihiya* processors have similar perceptions regarding BL cleanliness. However, contamination may occur at various stages of the BL supply chain. Furthermore, Chua and Dykes (2013) reported that potential pathogens like *Staphylococcus aureus*, *Salmonella enterica*, and *Escherichia coli* could adhere to the BL surface and possibly affect product safety. Thus, wiping alone might not be enough in cleaning BL.

Cleanliness is one of the attributes considered by most foodservice establishments for BL. Specifically, the leaf should be free from dirt, dust, insects, and other extraneous matter. Similar specifications for BL used as packaging for *suman sa lihiya* were reported by Luna (2018). Cleanliness is a crucial attribute specified by the United



**Table 3.** Common BL preparation procedures implemented by foodservice establishments (n= 27) according to product type.

Type of product preparation	Type of food product	Frequency of foodservice establishments implementing BL preparation procedures*				
		Wiping		Washing	Heating	
		Wet wiping	Dry wiping		Oven-heating	Singeing
Cooked food served on BL liner or wrapper	Viand and grilled products	3	13	6		6
	<i>Pancit</i>	1	3			
	Fried fruit-based products		3			
Raw food assembled on BL liner then cooked and served without BL	<i>Kakanin</i>	1	8	3		2
	Grilled products		3	1		1
Food garnished with BL	Fruit-based <i>halo-halo</i> products		1			
Food assembled and cooked with BL wrapper or liner	<i>Kakanin (bibingka, suman)</i>		1		2	
	Viand		3	2		2
<b>Total</b>		5	35	12	2	11

BL – banana leaf

FCM – food contact material

\*Multiple responses provided by foodservice key informants in Metropolitan Manila

States Code of Federal Regulations for food packaging materials (Robertson 2013). However, the ASEAN general guidelines on FCMs exempted its application to BL and other natural materials (The ASEAN Secretariat 2018). The BL used as FCM for the foodservice industry should first be evaluated for microbial and extraneous material contamination and further studied for guideline reconsideration.

Wet and dry modes of wiping are practiced by foodservice establishments. The BL visibly contaminated with filth is often wiped with using a wet cloth, while extremely contaminated BL is soaked or washed in tap water. On the other hand, BL dry wiping is done when no visible dirt particle is observed. This is also done to facilitate the drying of wet leaves using tissue paper or clean cloth to prevent microbial growth and rapid deterioration. Regardless of the wiping method, the same material is used for the whole production batch. A similar wet-wiping procedure was observed for BL intended for *suman sa lihiya* (Luna 2018). Dish towels are potential fomites in kitchens and can harbor foodborne pathogens, as well as free-living protozoa (Chavatte *et al.* 2014).

Ideally, washing eliminates soil residues, plant debris, nutrient-rich cellular fluids, and pesticide residues in leaves (Simons 2001) and reduces the microbial load of vegetables

by < 1 log cycle (Nascimento *et al.* 2003). Contaminants inherent in the leaves may build up during washing; thus, frequent water change is necessary. Potable water should be used at all times. The use of sanitizing agents could also be considered during the washing of BL (Nascimento *et al.* 2003). Simons (2001) also noted that washing should be implemented at < 5 °C to prevent internalization of microbial pathogens and control enzymatic activities that otherwise may lead to physiological disorders. Cooling systems and ice addition could help maintain the low temperature and regulate further deterioration and spoilage (Simons 2001). Thus, the use of chilled water for washing BL should be explored and evaluated.

Subsequently, washed BL should be immediately dried to avoid further microbial growth and deterioration (Simons 2001). Conservation of water and prevention of cross-contamination should be taken into consideration in the BL washing step. As a whole, the washing step is a cumbersome process. Alternatively, dirty and contaminated leaves should be rejected rather than washing them.

Singeing and oven-heating are also implemented by some foodservice establishments. Similarly, heating is also employed for BL used in cooked foods in Colombia (INIBAP 2001), *tamales* in Mexico (Angeles *et al.* 2013), and *suman sa lihiya* in the Philippines (Luna 2018).

Essentially, heating is done to soften BL, making it more pliant to facilitate handling when used as an FCM. Luna (2018) also reported the same reason for heating leaves. Respondents also claimed that heating is done to kill pathogens that may potentially harm consumers. However, there is no empirical evidence that heating ensures the safety of leaves. A disadvantage in heating as a preparation method is overheating of BL.

Foodservice respondents relayed that in singeing, BL is passed over the flame for  $\leq 20$  s allowing it to change color from light to dark green without burning. On the other hand, in oven-heating, pre-cut leaves are exposed to hot air for 20–30 s. Singeing can potentially generate soot that may contaminate food. Moreover, uneven BL heating may occur due to the manual singeing process. Although these are not observed in oven-heating, the oven size is a limitation because it dictates the BL length to be accommodated. Both heating methods are tedious; thus, designing new mechanical heating equipment suitable for BL could be explored. A thermally controlled metal plate device where the leaf could be pressed between may be considered in the prototype design.

After documenting the BL preparation methods employed by the foodservice, their efficacy in BL quality and safety should be further evaluated. Sanitary practices should also be employed from BL receipt until its usage as an FCM.

### Association between Methods of BL Preparation and Type of Food Products

Results of the chi-squared test of independence showed a significant ( $p$ -value = 0.0030) association between methods of BL preparation and type of food products at a 5% level of significance. Furthermore, as shown in Figure 2, three

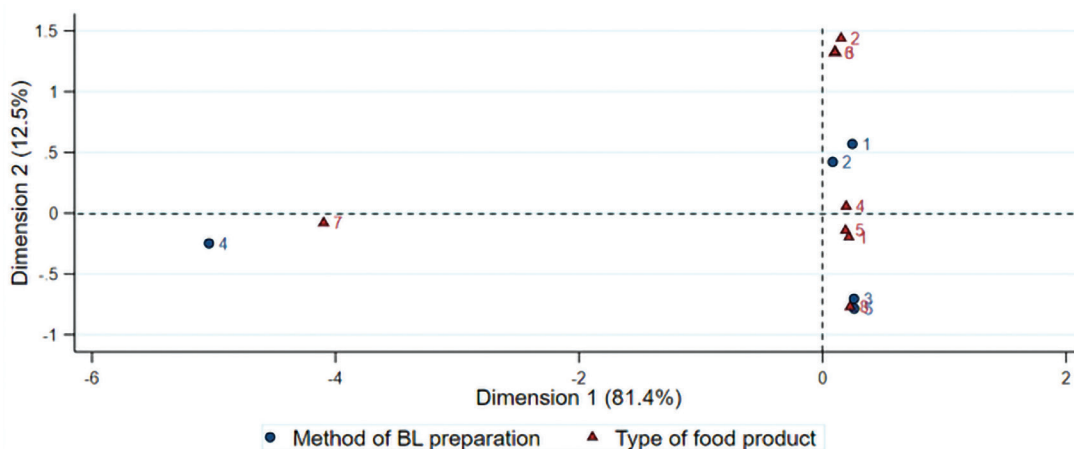
patterns of specific associations were observed based on the correspondence analysis. Oven heating is the method of BL preparation generally used with *kakanin* (*bibingka* or *suman*); wet and dry wiping for *pancit*, *kakanin* served on BL, fruit-based products, and fruit-based halo-halo products; finally washing and singeing for viand and grilled products (served on BL and cooked with BL).

For heated-BL used as FCM, breaches in food safety and quality are less likely to occur. Heating during cooking may potentially kill spoilage and pathogenic microorganisms. It is also crucial that foods cooked in BL should be served immediately after proper cooling to reduce microbial recontamination. On the other hand, for washed, wet, and dry wiped BL used as FCM, the quality and safety of food products may be compromised since recontamination of food after assembly or cooking may occur.

Foodborne outbreak incidence due to post-process contamination is remarkably higher in foodservice and catering foods, mainly in developing countries (Azanza *et al.* 2019). Post-process contamination is likely to occur due to unsanitary practices of the food handler. Thus, the sanitation standard operating procedures for foodservice establishments should be in place. Furthermore, regular training for food handlers is recommended to ensure the implementation of proper food handling practices (Rustia *et al.* 2017).

### Challenges Encountered by Foodservice Establishments in BL Utilization as FCM

Contributory factors to challenges or issues faced by foodservice establishments on BL as an FCM are shown in Figure 3. Foodservice establishments encounter issues on BL supply, price, and quality. Insufficient BL supply is due to the seasonal growth of the leaves and adverse



**Figure 2.** Correspondence analysis biplot of methods of BL preparation (1 – wet wiping, 2 – dry wiping, 3 – washing, 4 – oven-heating, 5 – singeing) and types of food products [1 – viand and grilled products (served on BL and cooked with BL), 2 – *pancit*, 3 – fried fruit-based products, 4 – *kakanin* served on BL, 5 – grilled products, 6 – fruit-based *halo-halo* products, 7 – *kakanin* (*bibingka* or *suman*), 8 – viand].

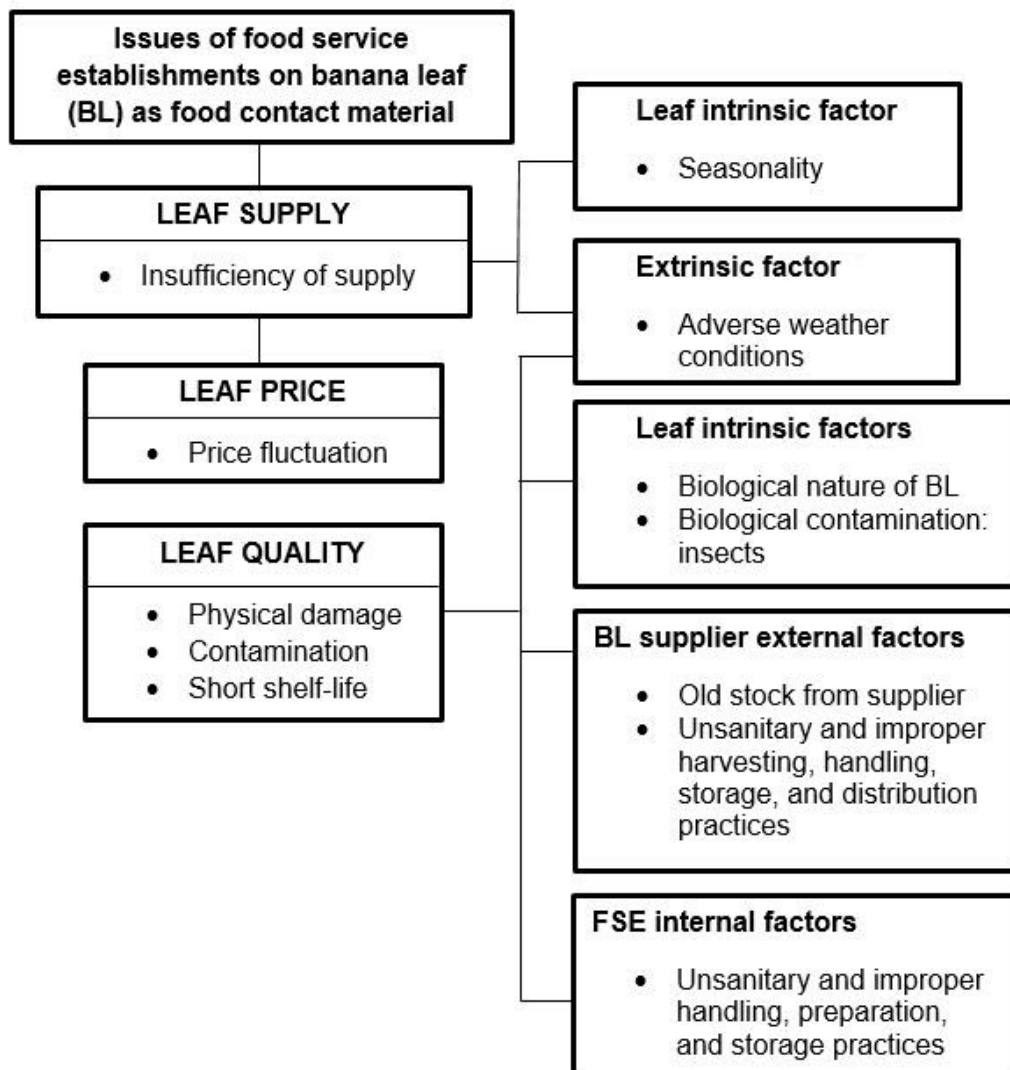


Figure 3. Contributory factors to issues of participating foodservice establishments on BL as FCM.

weather conditions. Monsoon rains and typhoons uproot banana plants and damage BL. Banana plants also wither during the dry season. As a result of low supply and high consumer demand, the selling price of BL increases. To compensate for the limited BL supply, foodservice establishments produce fewer products utilizing BL. Some use porcelain or paper plates, wax paper, and others as an alternative to BL. When there is no BL available, the products that require BL in cooking are not offered. These include boodle fight services and cooked products like grilled fish, *suman*, and other *kakanin*.

Foodservice establishments also encounter BL quality problems due to its perishability and susceptibility to contamination, adverse weather conditions, and BL handling and storage practices. As observed, some foodservice establishments store prepared leaves unpackaged, which makes them susceptible to contamination. Moreover,

foodservice establishments either store BL at low or ambient temperature conditions. In the case of *suman sa lihiya* processors, BL is only stored at the ambient temperature due to a lack of cold storage facility (Luna 2018). At low temperature ( $\leq 4\text{ }^{\circ}\text{C}$ ) conditions, microbial growth, enzymatic browning reactions, and leaf senescence are delayed. However, if storage is prolonged, BL may become dehydrated (Esguerra and Bautista 2007). On the other hand, at ambient temperature storage in closed shelves, the heat of respiration may build up in leaf bundles, accelerating deterioration (Esguerra and Bautista 2007). Thus, leaves should be appropriately stored in a well-ventilated and temperature-controlled area. Timely leaf acquisition should also be practiced for its optimum utilization as an FCM. At times, foodservice receives severely contaminated and defective leaves, which are considered critical defects that render the leaves non-

functional.

Issues regarding leaf quality may be properly addressed by understanding the various processes involved, from cultivation to utilization by stakeholders within the BL supply chain. Thus, knowledge and practices of BL suppliers and other actors should be first documented before proper preventive and control measures may be appropriately developed to improve leaf quality and safety.

#### **Aspirations of Foodservice Establishments in BL Utilization as FCM**

Primarily, foodservice aspires for the growth of the BL industry. Specifically, they envision expanded BL utilization due to its positive impact on the food product, environment, culture, and customer safety. Some respondents claimed that BL is usually not given much importance as a resource since it is considered a waste material. If its usage as an FCM is promoted in foodservice, it may result in BL waste reduction, making it a value-added resource. This could provide additional income to farmers and all actors involved in the BL supply chain.

To promote the utilization of BL as an FCM in foodservice, a more holistic approach should be made involving the academe, government, and all stakeholders within the BL supply chain. A full understanding of the functionality of BL should be realized through research programs focusing on the identification of different BL varietal sources and their characterization as FCM; evaluation of current practices from harvesting, distribution, preparation, and utilization; improvement of the quality and safety of BL; establishment of standards for BL as an FCM; and development of innovative FCM using BL as a raw material. On the other hand, the government should establish stringent policies to encourage the use of BL and other leaf packaging materials. More importantly, knowledge generated by the academe and policies established by the government should be properly disseminated to all the actors within the BL supply chain to ensure BL safety and quality.

In India, the leaf packaging industry is reported to flourish locally and globally (Kora 2019). Specifically, the banana germplasm was evaluated for its suitability in the leaf industry (Uma *et al.* 2003). More recently, innovative leaf plates and other packaging formats have been developed, and government policies on leaf utilization have been instituted (Kora 2019). With the initiatives implemented in India, the future of BL and other biodegradable materials as FCM shows vast potential.

#### **CONCLUSION**

In the foodservice industry, BL is commonly used in

various raw and cooked foods as liner, wrapper, or garnish. Aside from the conventional functions attributed to food packaging materials, the functionality of BL as an FCM is attributed to Filipino ethnicity, enhanced sensory properties of the product, and its environment-friendly nature. These BL functional properties are more recent concepts relevant to promoting sustainable development goals and are worthy of further research. For the first time, BL specifications as an FCM for foods served in the Metropolitan Manila foodservice industry are documented. Particularly, young to mature, long, wide, whole, and clean BL are specified. Also, it is perceived that *saba* and *latundan* are the leaf varietal sources used. Wiping, washing, and heating are the most common BL preparation methods employed prior to its usage. A significant association was established between these preparation methods and food product types. The efficacy of these methods should be evaluated to ensure the quality and safety of food products utilizing BL. To achieve a more holistic perspective of BL utilization, the entire foodservice supply chain from cultivation to usage should be further studied. This will serve as baseline information for the establishment of Philippine standards for BL as an FCM.

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