RESEARCH ARTICLE

Assessment of Processing Methods for Sandfish (*Holothuria scabra*) in Pangasinan, Palawan, and Davao, Philippines

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ABSTRACT

The Philippine beche-de-mer is reported to get the lowest prices compared to Indo-Pacific Islands competitors, mainly due to small sizes, inferior end-product quality, and use of low-value species. With this, the traditional methods of processing sandfish (*Holothuria scabra*), a high-value sea cucumber species, were assessed through survey questionnaires (n > 30) and documentation. The identified study sites were coastal areas where sandfish production and processing are abundant, namely: Anda and Bolinao, Pangasinan; Palawan; and Davao and Compostela Valley. Processing sea cucumbers into beche-de-mer involves the primary steps of cleaning, boiling, and smoke or sun-drying. Variations were observed in the order and number of doing each primary step, as well as in the specific manner of cleaning (slitting, gutting, brushing), boiling, and smoke or sun-drying. Quality evaluation of the products from these different processing methods is recommended to theorize how to improve the overall status of Philippine beche-de-mer, as well as the updating of these findings.

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1. INTRODUCTION

Sea cucumbers are traded worldwide in fresh, frozen, or dried forms, with dried products accounting for more than 98% of the 1995-2001 export trade figures published by the FAO (Ferdouse 2004). Dried sea cucumber, widely known as beche-de-mer (French) or trepang (Indonesian), is called *balatan/balat/ba-at/bat* in the Philippines (Trinidad-Roa 1987; Espejo-Hermes 1998; Akamine 2001). Although highly produced in the country, domestic consumption of beche-de-mer as a delicacy is not customary (Paler-Calmorin 2006). Instead, it has been an important export commodity to Asian countries, especially China, Hong Kong, Taiwan, and Singapore (Conand 2004; Ferdouse 2004; CITES 2006), associated with Chinese cuisines for around five centuries (Akamine 2001; Labe et al. 2007). Akamine (2002) noted that the most popular species consumed in Hong Kong are *Holothuria scabra* and *H. fuscogilva*, and in China is *Actinopyga echinites*.

The Philippine coastal waters are home to about 200 sea cucumber species, of which around 40 species are highly valued (Juinio-Meñez and Samonte 2016). Thirty-five (35) of these commercially important species are listed in the Philippine National Standard (PNS) for Sea Cucumber (BAFPS 2013), of which the majority belongs to the genus *Holothuria*. The species of *Holothuria* spp. are commonly found in La Union and Zambales (northern Philippines), Panay Island and Eastern Samar (central Philippines), and Zamboanga-Sibugay and Compostela Valley (southern Philippines) (Labe et al. 2007). Sandfish (*H. scabra*) has a thick body wall, which primarily makes it more valued (Espejo-Hermes 1998; Akamine 2002). Its body walls are composed of bio-medically important compounds such as peptide, collagen, gelatin, polysaccharide, and saponin (Oh et al. 2017).

Sea cucumber fishery is a multi-million US dollar industry that offers livelihood to more than 60 coastal communities of the Philippine archipelago (Labe et al. 2007). According to Trinidad-Roa

(1987), harvesting sea cucumbers for drying was first recorded in the country in 1911. In the 1980s, the Philippines ranked 2nd to Indonesia in the world exports of various sea cucumber products and reached its peak export production of 3,499 tons worth USD 3 million in 1985 (Conand and Byrne 1993; Akamine 2002; Ferdouse 2004; Gamboa et al. 2004). To et al. (2018) reported the Philippines as top 5 in Hong Kong imports, comprising 6% of the total contribution of dried beche-de-mer in 2012-2016. In 2015, the Philippine Statistics Authority (2016) recorded dried sea cucumber export of 164 MT valued at PHP 179 million.

From an interview excerpt of Hatchery International, sandfish hatcheries in the Philippines to date are only research-based, used for experiments, and pilot-scale culture production (Gonzalez 2017). Consequently, overexploitation of high-value sea cucumber resources resulted in the fishermen resorting to processing low-value species to compensate for the growing demand (Gamboa et al. 2004; Juinio-Meñez and Samonte 2016). This gave rise to Hong Kong's massive import of Philippine beche-de-mer, purchased at lower prices that are meant for re-processing and re-exporting to other countries, most especially to mainland China (Conand and Byrne 1993; Tiensongrusmee and Pontjoprawiro 1998; Ferdouse 2004; Choo 2008).

This has also initiated trade problems resulting in low-priced products from poorly processed, undersized, and selling under-valued species (Labe et al. 2007; Ragaza 2007; Choo 2008; Juinio-Meñez and Samonte 2016). The selling power of beche-de-mer depends on size, color, texture, dryness, shape, and cleanliness (Lo 2004; Purcell 2014a). *H. scabra*, in particular, is regarded as a high-value species made more expensive by large samples, as Purcell et al. (2018) found out an exponential increase in price with product length. In Hong Kong alone, dried *H. scabra* had an average price of USD 369 per kilogram (max USD 1,898/kg for extra-large premium quality) in 2016; about 2.4-7.5 fold higher compared to stores in Guangzhou (Purcell 2014a; Purcell et al. 2018). As for the other considerations, Lo (2004) presented data on valuation criteria from wholesalers and retailers from Singapore.

Purcell (2014b) mentioned that the product should have a cut in the proper place, sand removed, undamaged and unbroken, cleaned of external salt residue, straight not bent, fully dried, and good color. With the aforementioned concerns, the efficacy of processing methods is of utmost importance.

Therefore, this study aimed to assess the different traditional methods of processing sea cucumbers, specifically sandfish (*Holothuria scabra*), one of the highest commercial value (Schoppe 2000; Akamine 2002) and is successfully cultured. It aims to assess the practices and procedures employed by local processors in the provinces of Pangasinan, Palawan, and Davao, Philippines, with the hope of improving the traditional processing methods for the products to boost their selling power and competitiveness in the world market.

2. MATERIALS AND METHODS

2.1 Study sites

Assessment of existing processing practices and methods for producing dried sandfish (*H. scabra*) was conducted in coastal communities where they are reportedly abundant. Identification of study sites was conducted in coordination with the Bureau of Fisheries and Aquatic Resources – Regional Fisheries Offices (BFAR-RFOs) and was narrowed down to the following: Anda and Bolinao, Pangasinan; Palawan; and Davao and Compostela Valley (Figure 1).

2.2 Collection of data

Meetings with stakeholders, Local Government Units (LGUs), and the respective BFAR-RFOs of the abovementioned sites were held to identify key informants involved in sea cucumber processing–fishers, processors, and traders. Data were obtained through interviews using the semi-structured questionnaire in Annex A, targeting a study population of $n > 30$. Description of the step-by-step processes in drying sandfish was surveyed, along with other production information such as prices, size grading, and others. Some processors also performed an actual demonstration of their methods. The majority of interviewees lived in coastal areas; thus, only small-scale processors were surveyed. This paper presents the data gathered from May 2008 to March 2009.

2.3 Quality evaluation of samples

Sensory Evaluation. Seven panelists were asked to evaluate selected Pangasinan products' sensory attributes such as size (length and weight), appearance, odor, color, texture, etc. using a Descriptive Sensory Evaluation Form adapted from

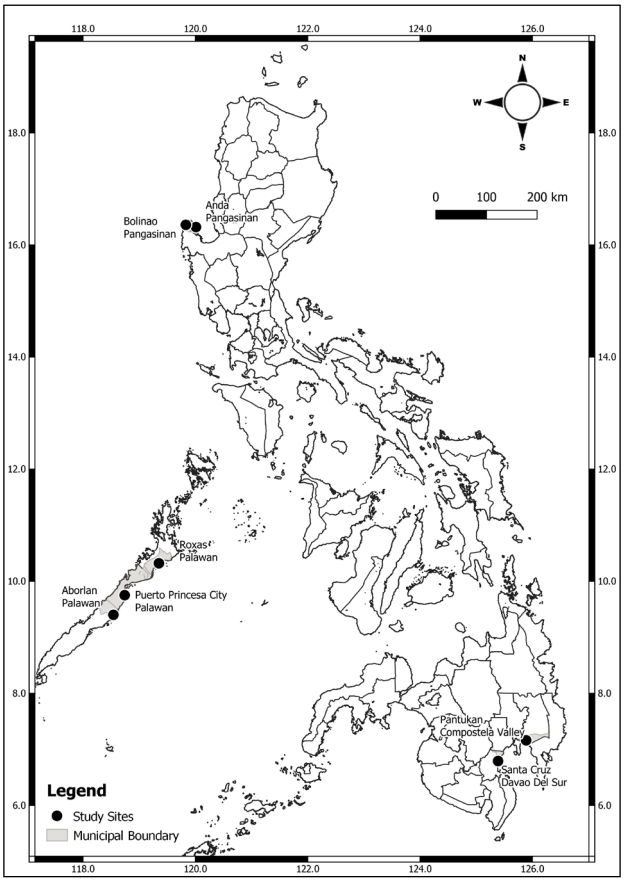

Figure 1. Study sites

"Beche-de-mer grading features as used in Hongkong" (See Annex B). The samples' length was taken using a ruler and the weight using the OHAUS top loading balance.

3. RESULTS AND DISCUSSION

Processing sea cucumbers into beche-de-mer primarily involves cleaning (slitting, gutting, brushing), boiling, and smoke or sun-drying. These processes have been adequately described by Trinidad-Roa (1987), Espejo-Hermes (1998), Subasinghe (1992), SPC (1994), Tiensongrusmee et al. (1998), and Purcell (2014b). Ragaza (2007) noted that practices in the Philippines remained unchanged; however, variations among processors were observed in each locality in the study duration.

Other than the primary steps mentioned above, descumming is an added step necessary for sandfish, where the most notable differences were observed during the assessment. This step aims to remove the chalk-like deposits in the outer skin when dried (Espejo-Hermes 1998). The outer skin's presence in end products indicates poor processing, and their removal is hard to attain with traditional methods (Peranginangin et al. 1994).

Nonetheless, SPC (1994) mentioned the grading characteristics of dried sandfish: straight or slightly bent shape; large number of grooves around the body; no smoky smell; small slit only on the posterior end through the anus; brown-black to black upper side and greyish brown underside color; and large sizes of 8-12 pcs/kg that are 10-15 cm in length.

3.1 Sea cucumber processing in Anda and Bolinao, Pangasinan

The existing sea cucumber fishery in Pangasinan is mainly on the northern side of Lingayen Gulf and in areas where seagrass beds and fine sand can be found. The local processors focus on processing high-value species such as sandfish, black teatfish, and *Stichopus* spp. (Figure 2). Sandfish are noted to have been harvested in bulk and are in the highest frequency in Anda and Bolinao. Conversely, Gamboa (2004) mentioned that Bolinao is almost mono-specific for

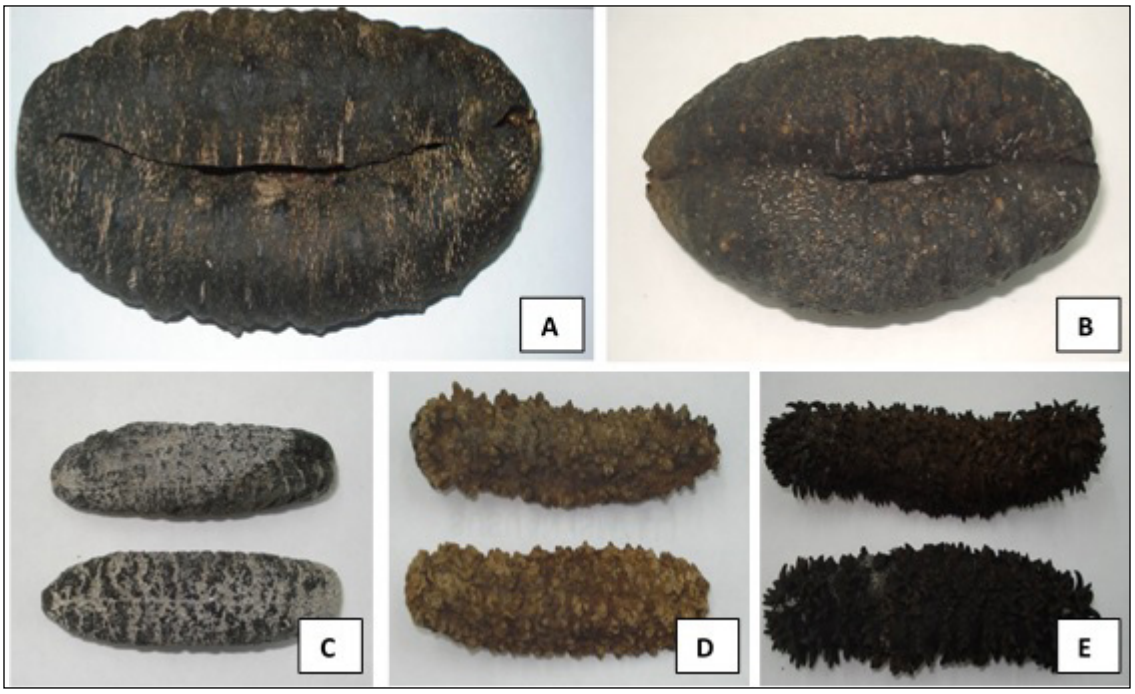

Figure 2. Processed high-value species of sea cucumbers from Pangasinan (a) black teatfish (susuan), (b) boli-boli, (c) sandfish (putian), (d) Stichopus spp. (hanginan), and (e) pinya (Photos by Rosa A. Bassig)

H. scabra. Five processor-traders were interviewed in Bolinao; while, three processors and one trader were interviewed in Anda.

The frequency of production noted in Anda is daily to monthly to every two months, with a production of one bag per month to two to three sacks every two months. Processing starts whenever raw materials placed inside pails with seawater are delivered to the processors' houses. One processor in Anda specializes in sandfish processing, in both chilled and dried forms.

The methods employed by the local processors interviewed follow the primary processing steps. The method for sandfish *H. scabra* is different from the methods used for *H. fuscolgilva* and *H. nobilis*. Four existing processing methods were identified in Pangasinan (Figure 3) for sandfish alone.

Brushing was noted to have used steel or plastic brush or any hard material (broken coral, hollow block). Traditionally, the use of coconut husks was recorded, but any suitable material can be used (Espejo-Hermes 1998). Two processors were observed to brush the animals twice (once after each cooking) while the other two processors brush the animals once only as seen in Figure 3 as the brushing step was inefficient in removing the sandfish's hard spiculy layer. The traditional method of descumming (SPC 1994) by burying the sandfish in sandpits was not observed in any interviewed processors.

One processor was also observed to cut the sandfish from end-to-end and dries them with splints between the slits, similar in teatfish processing (Subasinghe 1992), to hasten the drying process. This practice has not been observed in published works of literature as long slits in the back are done only in sea cucumbers other than sandfish. Suggested gutting procedures for different sea cucumber species were laid down by Purcell (2014b).

Two processors were also observed to perform third boiling (with and without salt). According to them, this practice increases the weight of the products. Conversely, no published literature reports the practice of boiling thrice, as Purcell (2014b) states that third boiling is done only when the body walls are still bent or if salt residues are evident.

The results of sensory evaluation of samples from Bolinao, Pangasinan is presented in Table 1. About 51 pieces of extra small, dried *H. scabra* were evaluated. As reflected in the samples' cleanliness, the processing technology employed during the assessment may lack good manufacturing practices; furthermore, inconsistency in product quality may imply the need to improve traditional methods. The sensory evaluation results agree with the interview

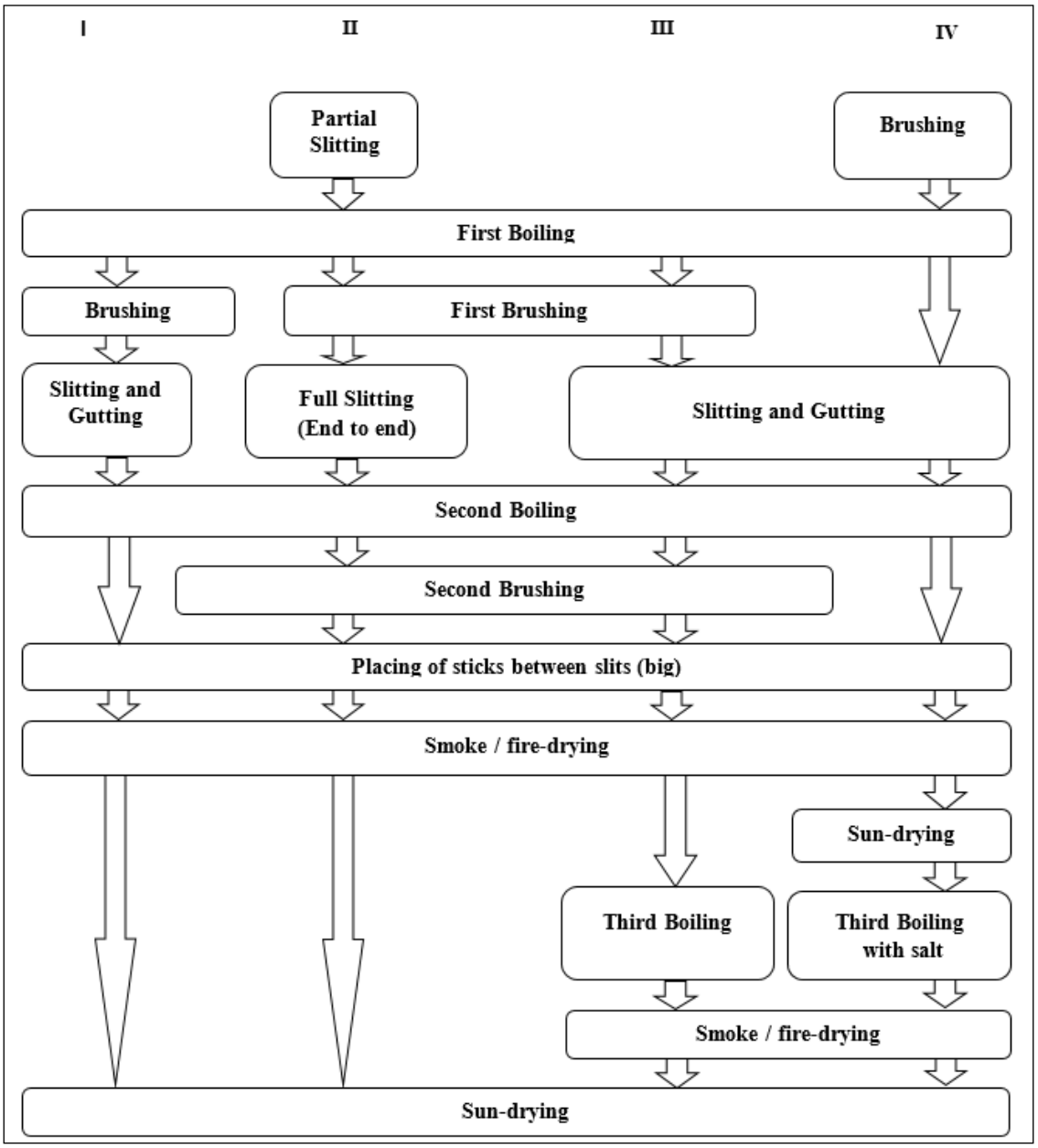

Figure 3. Different sandfish processing methods in Pangasinan.

with processors, stating the following reasons for product rejection: dirt (especially sand), damaged (burst body wall upon cooking), too wrinkly, churned or burnt, wet or insufficient drying, half-cooked, and ill-shaped.

The size and weight classification of dried *H. scabra* in Anda is presented in Table 2, while price changes in trade are shown in Table 3. During the interviews, the traders finance the processors, a reason for which the traders buy the processed products at a lower price. Rejected products are either purchased around 20-25% of the selling price or returned to the processors-traders.

3.2 Sea cucumber processing in Palawan

Akamine (2002) stated that Palawan is one of the most active places in the Philippine beche-de-mer or trepang trade. Preliminary studies on the sea cucumber industry in Palawan conducted by Schoppe (2000) from October 1999 to March 2000 revealed that 25 species were regularly collected and processed into beche-de-mer.

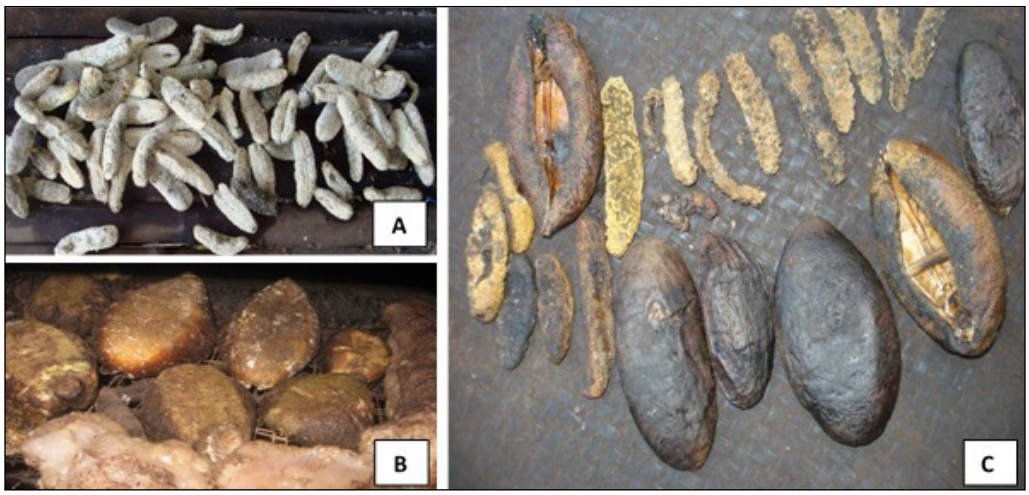

Figure 4. Samples of processed sea cucumbers from Pangasinan (a) hard outer layer (chalky spicules) not removed in sandfish, (b) wet or insufficiently dried and damaged body wall, and (c) burnt and unevenly shaped

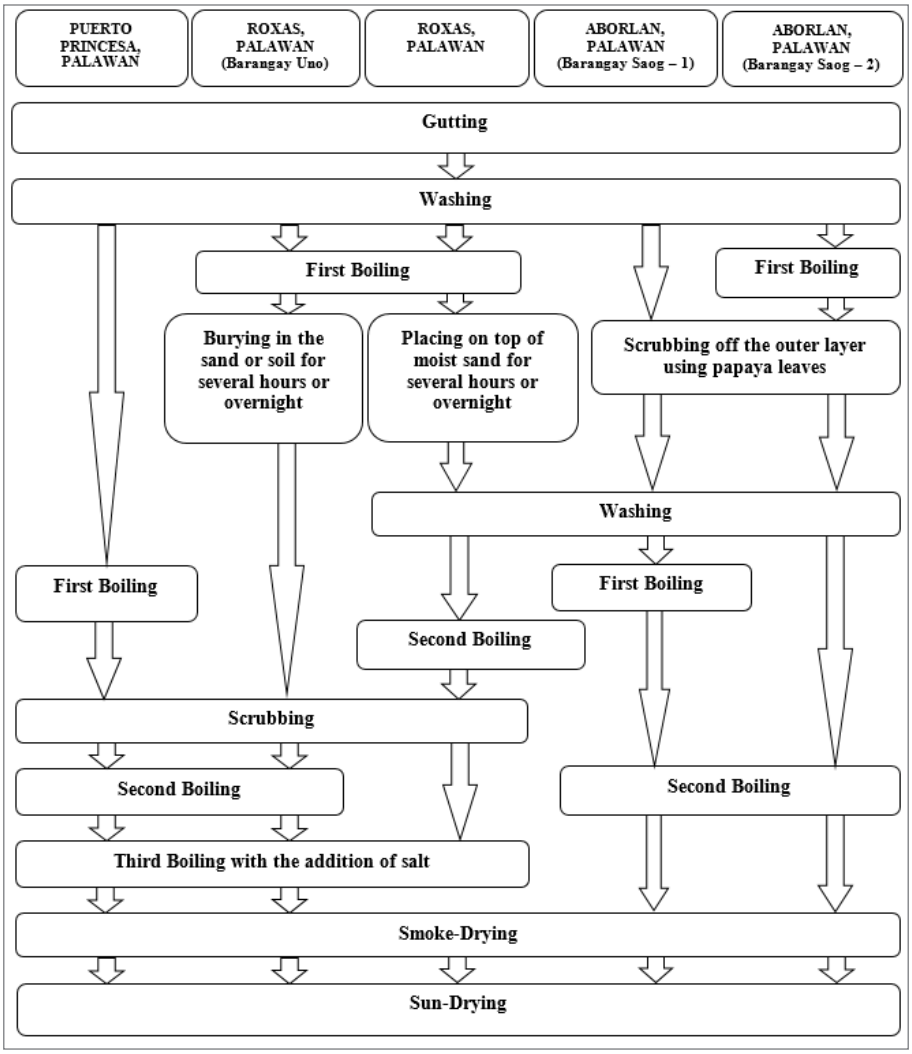

Figure 5. Different sandfish processing methods in Palawan.

Table 1. Descriptive evaluation of dried *H. scabra* from processors in Bolinao, Pangasinan.

Attribute	Processor		
	A	B	C
Shape	Wrinkled / distorted	Wrinkled / distorted	Wrinkled / distorted
Appearance	Uniformly shaped: damaged	Damaged; burned	Uniformly shaped
Odor	Smoked odor	Slight off odor	Slight off odor; smoked odor
Color	Black; brownish	Black; with whitish calcified substance	Black; gray
Texture	Hard and dry	Hard and dry	Insufficiently dried; not so hard
Cleanliness	Presence of dirt especially sand	Presence of dirt especially sand	Presence of dirt especially sand

Table 2. Size and weight classification of dried *H. scabra* in Anda, Pangasinan.

Classification	Size (in)	Weight (g)
Extra Large	>5	>150
Large	3 - 5	100 - 149
Medium	2 - 3	70 - 99
Small	<2	<70
Extra Small	-	-

Table 3. Price changes (in Php) of *H. scabra* during trade in products from Anda, Pangasinan (May to October 2008).

Size	Price per stage of trade (Php/kg)		
	Gatherers – Processors*	Processors – Traders**	Traders – Manila Exporters**
Extra Large	120 - 150	2700 – 3000	4500 – 4700
Large	70	2400	4300
Medium	-	1400	3800
Small	50	800	2600 – 2800
Extra Small	-	-	1000

*live *H. scabra*
**dried *H. scabra*

Five processors were interviewed in the Municipality of Roxas, while two processors were interviewed in both Puerto Princesa and Aborlan, Palawan. During the assessment study, there are many species of sea cucumbers found in Palawan. These include *H. scabra*, *H. nobilis*, *Stichopus* spp, *Actinopyga lecanora*, *H. fuscogilva*, *Bohadschia marmorata*, *Thelenota anax*, and *Actinopyga echinites*. The animals are placed inside pails and basins with seawater before they are brought to processors.

H. scabra has peak harvests from November to March. The duration of the whole processing depends on the species, weight, and size of the animals being processed. The current production frequency is from daily to monthly to every two months, and a production of one bag per month to two to three sacks every two months. *Balat* or *balatan* are brought to five major buyers or exporting companies; thus, marketing is not much of a problem to local processors.

Local processors also employ primary methods of beche-de-mer processing in Palawan. There were predominantly five processing methods identified in different areas, which are summarized in Figure 5.

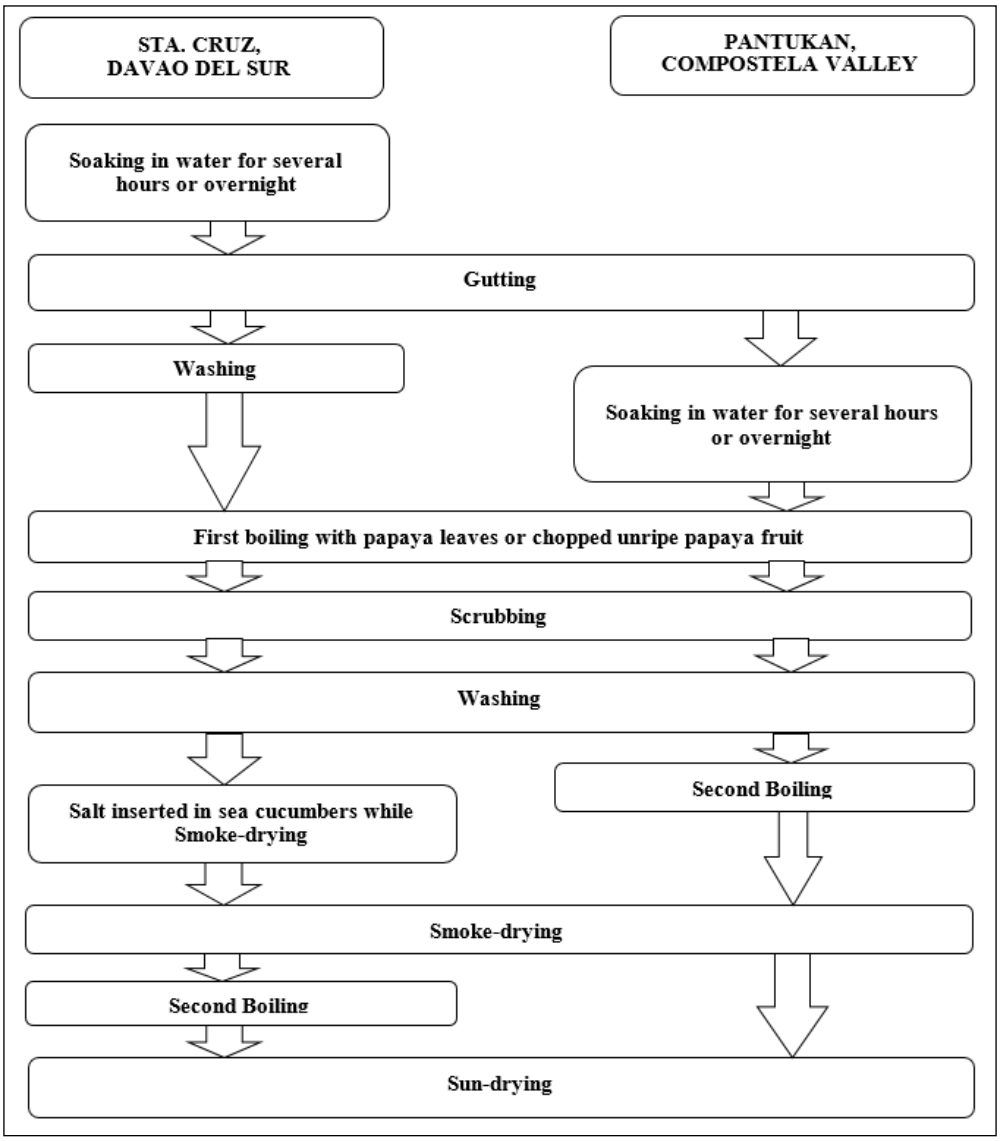

Figure 6. Different sandfish processing methods in Davao.

There were variations in the incision or slit location and in the type of material used in gutting. Some processors allow the animals to self-eviscerate by making a 3-5 cm slit in the mouth or anus area. Other processors make a longitudinal cut from the anus to the mouth, passing through the stomach. Instead of a long slit, a small slit on the posterior end is enough to aid in the gutting process of sandfish (SPC 1994). However, extensive slitting makes the product prone to the unwanted opening of body walls (Espejo-Hermes 1998). Espejo-Hermes (1998) stated the need to gut sandfish before cooking, while other species do not, to remove unwanted mud and sand from the animal's body.

The traditional descumming of burying under the sand was observed only in Palawan. According to Tiensongrusmee et al. (1998), bacteria in this set-up aids in decomposing the calcareous materials in the skin; however, it leaves a pasty material further removed by brushing. Another method noted was the scrubbing with papaya leaves, which was also observed by Brown et al. (2010) in Palawan. Several studies on the effectiveness of papaya in the removal of the spiculy layer were already published. One example was observed by Lavitra et al. (2008) as in Toliara, Madagascar. In Indonesia, Peranginangin et al. (1994) found that papaya leaf extracts in dipping solutions (after first cooking) were more effective than papaya fruit and tuber root extracts.

Third boiling with salt was also observed in 3 out of 5 processors interviewed. The processors claimed that this practice increases the weight of the products, commanding higher prices. Purcell (2014b) agreed that salting makes the product heavier and increases the drying rate; however, the addition of salt is suggested after cleaning or first boiling, not on the succeeding cooking process. Tiensongrusmee et al. (1998) observed the addition of salt after the first boiling in China. Nonetheless, these products must abide by the standard for the salt content of dried sea cucumber in the Philippines at 2.5% maximum (BAFPS 2013).

3.3 Sea cucumber processing in Davao and Compostela Valley

Five and two local processors were interviewed in the coastal areas of Sta. Cruz, Davao del Sur and Pantukan, Compostela Valley, respectively. Most species processed in the Davao area were *Holothuria* spp. like *H. scabra* and *H. fuscogilva*, and *Stichopus* spp. *Holothuria* species are termed "hard" species primarily because of the animals' hard outer covering layer, while the rest are termed "soft" species.

The sea cucumber processing methods in the Davao region include the primary processing steps. During the assessment, the soaking of "hard species" in water was observed in some areas. The same practice was also noted by Choo (2004) in Malaysia; however, with the use of brine. Though some self-embowel during soaking in seawater, manual gutting is still advised to ensure efficient removal of this physical debris (Tiensongrusmee 1998).

Local processors were noted to cook "soft" species together with alum and salt. In contrast, "hard" species are soaked in water overnight before boiling in water with papaya leaves or chopped unripe papaya fruit (Figure 6) to remove the outer covering or the skin. Trinidad-Roa (1987) mentioned that slow cooking with alum prolongs storage by controlling yeast and mold growth and hastens the boiling time leading to minimal shrinkage.

On the other hand, cooking with papaya leaves for descumming is also suggested by Purcell (2014b). The same practice was also noted by Choo (2004) in Malaysia, with boiling using papaya leaves. According to local processors, the use of papaya leaves renders the animals soft, making brushing easier. Green papaya fruit and papaya leaves contain papain, a proteolytic enzyme widely used as a meat tenderizer (Moy 2003; Quaglia and Gennaro 2003).

Pangan et al. (2017) and Pardua et al. (2018) presented recent handling and processing practices for sandfish in the Philippines, including some quality parameters determined. The government is also initiating recent developments in sea cucumber processing in the Philippines. Anonas (2009) mentioned that the Philippine Council for Aquatic and Marine Research and Development (PCAMRD), and Philippine Council for Industry and Energy Research and Development (PCIERD), both agencies under the Department of Science and Technology (DOST), promoted sea cucumber-based products and value-added products in 2008. These agencies also helped make new technologies in improving the qualities of dried sea cucumber (PhilStar 2005).

Moreover, through the initiatives of the Philippine Council for Agriculture and Aquatic and Natural Resources Research and Development (PCAARRD), a prototype mechanized sea cucumber processing line was developed and tested in coastal communities. This resulted in products that could meet the Philippine National Standard (PNS) for dried sea cucumber, to which the drying process alone was reported to give an approximate 70% increase in profits (Juinio-Meñez and Samonte 2016; Samonte 2018). Training programs were also led by the same agency on improved traditional drying practices, catering to several State Universities and Colleges (SUCs), government agencies, and Local Government Units (LGUs) (Samonte 2016).

Other than drying, several product developments on sea cucumbers were also studied by local researchers. Paler-Calmorin (2006) mentions a study on trepang "sitsaron" with "very much acceptable" qualities, while Reyes et al. (1991) cited that other than "sitsaron," sea cucumbers are also processed into jellies and their internal organs into a fermented sauce. Egloso and Delantar (2018) also developed sea cucumber food chips that is said to be a promising income generator for the locals. These inventions may further increase sea cucumber's marketability, as Lo (2004) mentions that the industry may lose market popularity in the absence of innovations. On the contrary, the wild stock and production management through aquaculture must be prioritized first for a more sustainable sea cucumber fishery.

4. CONCLUSION

Generally, the processing of sea cucumber in the provinces assessed depended on the traditional and manual labor, including the primary processing

steps such as cleaning (slitting, gutting, brushing), boiling, and smoke sun-drying. Notable variations in the primary practices include:

- Order and number of doing each primary step;
- Cleaning (slitting, gutting, brushing, and descumming);
- Extent of slitting (in sandfish);
- Use of papaya leaves or fruit or salt in boiling; and
- Use of salt while drying

Results from this study may not hold true to the current sea cucumber processing technologies employed by local processors; therefore, updating of these information and research on the modern-day technologies can be conducted for trend monitoring of adapting new technologies. Quality evaluation of the products from these different processing methods is recommended as a basis to theorize how to improve the overall status of Philippine beche-de-mer. In addition, the versatility of processing sea cucumbers, through value-adding, can be explored to provide various products other than beche-de-mer once the sea cucumber stock production has been improved.

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AUTHOR CONTRIBUTIONS

Bassig RA: Project Leader, Conceptualization, Product processing, Data gathering, Writing-original draft preparation, Writing-review and editing. **Obinque AV**: Assistant project leader, Data gathering. **Nebres VT**: Product processing, Data gathering. **Delos Santos VH**: Product processing, Data gathering. **Ragaza RJ**: Supervision. **Ramos CAM**: Writing-review and editing. **Madrid AJJ**: Writing-reviewing and editing. **Montojo UM**: Visualization, Supervision.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

No animal or human studies were carried out by the authors.

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ANNEX A

SAMPLE QUESTIONNAIRE

Name of processor: _____ Date of interview: _____

Address: _____ Barangay: _____

Source / Harvest site: _____

Number of years as processor: _____

Type of enterprise (backyard, cottage, micro, small, medium): _____

Volume of production: _____

Cost of production: _____

Frequency of production: _____

Species used: _____

Final product form: _____

Packaging: _____

Destination: _____
_____
_____

Name and address of exporters: _____
_____
_____

Classification: _____

Grading system used: _____

Sizing: _____

Color preference: _____

Selling price: _____

Problems encountered: _____
_____

Reasons for product rejections: _____
_____

Processing practices / methods: include cost of raw material and ingredients and equipment/utensils used:

_____
_____
_____
_____
_____
_____
_____
_____
_____

Yield: _____

Price per serving or per kilo _____

Packaging: _____

Shelf-life: _____

ANNEX B

DESCRIPTIVE SENSORY EVALUATION FORM FOR DRIED *H. Scabra or* sandfish (PUTIAN)

Name: _____ Date: _____

Instruction: Please check the appropriate description for each sample

Attribute	Sample A	Sample B	Sample C	Sample D
Size (length and weight): the larger the better L = 8-12 pcs/kg = 10-15 cm M = S = XS =				
Appearance:				
Straight or slightly bent				
Large numbers of grooves around the body				
Distorted,twisted, shrunken, unevenly shaped				
Outer spiculy layer not removed				
Odor:				
No smoke odor				
With smoke odor				
Off-odor				
Color:				
Upperside – brown-black to black				
Underside – grayish brown				
Others – please specify				
Texture:				
Hard and completely dry				
Soft and wet				
Cut:				
Small slit only in the posterior end through anus				
Others – please specify				