Economically important sea cucumber processing techniques in South Sulawesi, Indonesia

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Abstract. Sea cucumbers are fisheries commodities that have important economic value. Indonesia is the largest producer of sea cucumbers in the world, and South Sulawesi Province is the largest producer of sea cucumbers in Indonesia. Although the export volume of Indonesian dried sea cucumbers or trepang is large, the export value is not high due to the low quality of trepang. This study aims to examine the techniques or method of sea cucumber processing in two locations in South Sulawesi where sea cucumbers are processed to produce trepang. The study was conducted by observing the processing stages used in the Sembilan Islands Sub-District, Sinjai Regency and Labbakkang Sub-District, Pangkep Regency. The study found that, in general, the basic stages in trepang processing were removal of the viscera, salting, boiling and drying. The most prominent difference in the processing of trepang in the two research areas was the lack of a fumigation process. In other countries where the quality of trepang is better; the process of fumigation is an important stage to increase the durability and aroma of trepang.

1. Introduction
Sea cucumbers are a valuable fisheries commodity, and Indonesia is the largest producer of dried seaweed (trepang) in the world [1]. Within Indonesia, South Sulawesi Province is a major trepang producer [2]. One reason trepang has become such a high value commodity is the high nutritional value of this product. Trepang is a nutritious seafood with a high protein and low lipid content, and it is also rich in gluten, nitrogen, iodine, and other nutritional elements [3–5].

Sea cucumbers are a group of echinoderms whose flesh contain various useful compounds; they can be used as a source of protein as well as for medical uses, e.g. as wound medicine and anti-inflammatory agents [6]. These benefits make dried sea cucumbers a product of high economic value, exported worldwide from Indonesia [7].

Sea cucumbers are exported in the form of dried product or trepang [8–10]; therefore sea cucumber processing into trepang is an important process in maintaining nutritional value and quality.
Processing techniques or methods greatly affect the trepang quality. During the processing, there are several steps that are commonly carried out, in particular the removal of the viscera (evisceration), washing, scraping the outer skin, repeated boiling and drying [8,11,12]. During the drying process, Indonesian trepang are usually processed using traditional methods with several stages such as salting, repetitive boiling and sun drying for 2-3 days [13]. In trepang processing, different species of sea cucumbers require different processing steps [14], depending on the thickness and texture of the skin and body wall as well as the water retention rate after boiling.

One area in Indonesia known for its sea cucumber production is Sulawesi [15]; where South Sulawesi is the top trepang producing region [2]. Within South Sulawesi, two traditional trepang processing centres are Sembilan Islands Sub-District, Sinjai Regency and Labbakkang Sub-District, Pangkep Regency. In the Sembilan Islands, many species of sea cucumbers are processed, while at Labbakkang only one species of sea cucumber is processed, the sandfish *Holothuria scabra*.

Although the export volume of Indonesian trepang is large, the export value is often relatively low due to the quality of the trepang which is often classified as moderate to low [10] due to the limited knowledge of the processors and the technology used. This study aimed to examine the processing method of trepang in South Sulawesi, Indonesia. The processing methods used were analyzed and compared to the methods used by fishermen in other trepang producing countries, especially those that produce higher quality trepang than Indonesia.

2. Materials and Methods
This study was conducted from December 2018 to May 2019 at two sites in South Sulawesi, Indonesia: the Sembilan Islands Sub-District, Sinjai Regency and Labbakkang Sub-District, Pangkep Regency (Figure 1). Labbakkang is located on the mainland coast of Sulawesi Island, facing the Makassar Strait. The Makassar Strait is one of the main fishing grounds in South Sulawesi [16]. The Sembilan Islands are located in the Gulf of Bone which is also an important fishing ground in South Sulawesi [17].

![Figure 1. Map showing the two research sites in South Sulawesi, Indonesia](image)

The sea cucumber species which were the object of trepang processing were *Bohadshia vitiensis*, *B. similis*, *Holothuria edulis*, *Actinopyga miliaris*, *Thelenota ananas*, *Stichopus vastus*, and *H. scabra*. 
Observation and interview methods were used to obtain information by participating in the trepang processing in both study areas. The observations made were evaluated with reference to processing methods that are widely used in other trepang producing countries [8,11–18].

3. Results
In general, trepang processing at the study sites consisted of evisceration, salting, boiling and drying (Figure 2). In the Sembilan Islands three methods of trepang processing were found, while at Labbakkang only one method of trepang processing was found. The classification of the four methods used was based on the sea cucumber species to be processed. The flesh of each species of sea cucumber has a different character, and therefore requires a different treatment to produce good quality trepang.

3.1. First method
This first method or model was used for drying sea cucumber species with very soft skin and body walls such as Bohadshia vitiensis, B. similis, Holothuria edulis and Actinopga miliaris. The skin of these species can easily be damaged if they are boiled immediately, while fresh. Therefore, these sea cucumbers need to be salted before further processing. The processing of these species involves five stages: removal of the viscera (evisceration), wet salting, dry salting, boiling and sun drying (Figure 3).
3.2. Second method
This second method was used for drying *Thelenota ananas* and *Stichopus vastus*. These species have a thick hard skin which does not need to be salted before boiling. The hard skin of these species requires repeated boiling and drying. The processing involves eight stages: the removal of the viscera (evisceration), first boiling, cooling down, dry salting, second boiling, first sun drying, third boiling, and second sun drying (Figure 4).

3.3. Third method
This third method was used for the drying of the sandfish, *Holothuria scabra*. This species has a thick, tough and chalky outer skin layer which needs to be removed before drying. The processing involves six stages: first boiling, evisceration, scraping off the outer skin, dry salting, second boiling, and sun drying (Figure 5).
Figure 4. Second method or model, used in the Sembilan Islands Sub-District for processing *Thelenota ananas* (A, B) and *Stichopus vastus* (C)

Note: weeding = evisceration

Figure 5. Third method or model, used in the Sembilan Islands Sub-District for processing *Holothuria scabra* (A, B)

Note: weeding = evisceration
3.4. Fourth method
The only sea cucumber species processed in Labbakkang Sub-District was the sandfish, *H. scabra*. The processing scale was smaller because fewer sea cucumbers are caught in this area. The method used was more complex than that used for processing *H. scabra* in the Sembilan Islands Sub-District. The processing comprised eleven stages: evisceration, first boiling, storage in the refrigerator, second boiling, softening the outer skin with papaya, scraping the outer skin, second evisceration, third boiling, salting, fourth boiling, and sun drying (Figure 6 and 7).

![Diagram of the fourth method for processing *Holothuria scabra*](image)

**Figure 6.** Fourth method or model, used in Labbakkang Sub-District for processing *Holothuria scabra* (A)

Note: weeding = evisceration
Figure 7. Processing sandfish *Holothuria scabra* to produce trepang:  
1: viscerated sandfish  
2: Boiling  
3: Softening the outer skin with papaya leaf  
4: Scraping the outer skin  
5: Second evisceration  
6: Salting  
7-8: Sun drying

4. Discussion  
Based on observations in the two study areas, it appears that trepang processing is still carried out using traditional methods without meaningful modern technology input. From the two study areas, four processing methods were obtained, each with a different number of processing stages, ranging from five to eleven. However, there were only four main processes used: evisceration, salting, boiling and drying. The method to be used was based on the characteristics of the sea cucumber body wall, especially the thickness of the flesh, the presence or absence of a hard chalky outer skin layer, and the number of sea cucumbers available for processing. As reported from the Pacific Islands [14], these characteristics were used to determine the number of processing steps. In particular, sea cucumber species with soft and thin body walls generally require an additional processing step in the form of preliminary salting in order to protect the skin from being easily damaged when boiled [19,20].

The salting process used in the two study areas was similar to that used in other countries [11,19,20]. The only difference was in the amount of salt used. Based on observations made during the study, the amount of salt used depends on the characteristics of the sea cucumber being processed, in particular the body wall. Sea cucumbers with thinner and softer flesh require more salt.

The method used in the Sembilan Islands for scraping off the chalky outer skin of *H. scabra* is similar to that reported by Purcell [11], where shells were used to scrape off the chalky outer layer. In Labbakkang, the method used to scrape off the chalky outer skin was similar to the method used by
Herliany, Nofridiansyah and Sasongko [8], and consisted in rubbing the surface of the skin with finely chopped papaya leaves. The use of papaya leaves can facilitate the removal of the chalky outer skin layer [11,12] because the leaves contain the enzyme papain which can hydrolyse the protein collagen in sea cucumber skin [21]. However, papaya leaves must be used with care because if the dose of papain is excessive it can damage the skin of the sea cucumber [21].

The boiling stage in the processing of H. scabra at Labakkang was different from boiling methods applied in other countries. In Labakkang, the first boiling used high temperatures (95-100\degree C), while in Fiji lower temperatures (45-80\degree C) were used; however the boiling times were similar [8,11,20]. There was also a difference in the number of boiling stages, with three boiling stages reported for H. scabra, in Fiji, compared to just one boiling stage in the Sembilan Island Sub-District. In Fiji, the number of boiling stages will determine the quality of the trepang produced: Grade C trepang are only boiled once, Grade B trepang are boiled twice, and Grade A trepang are boiled three times [19]. This could explain the lower quality of trepang from Indonesia, in particular those produced in the Sembilan Islands, as with only one boiling, the trepang produced can only reach Grade C.

Differences were also found in the drying process, in particular in terms of drying time and technology. For example, in the Sembilan Islands B. vitiensis was dried for a maximum of four days, while in Fiji drying takes at least one week for Grade C, and can be longer for Grades A and B [19]. There were also differences in drying methods and equipment used. For example, [8] used an oven at 60\degree C for 14 hours to obtain a higher quality trepang product.

The most prominent difference between the trepang processing methods used in the two study areas and those common elsewhere is that there was no smoking stage. In countries where the quality of processed trepang products is generally higher, smoking is considered a mandatory processing stage [11,19,22]. In fact, there used to be a time when sea cucumber processing at the study sites and other areas in South Sulawesi included a smoking stage before drying [2,5,10]. The reason given for the discontinuation of the smoking process was that the volume of sea cucumbers to be processed has become lower and lower. Smoking tends to be carried out later by the collecting traders (middlemen) or exporters who reprocess the trepang before they are exported. Thus, the trepang produced in the two study areas seem to reach an intermediate processing stage rather than being a finished product.

5. Conclusion

This study found four processing methods, each with a different number of stages, ranging from five to eleven. However, in general there were just four main processes used to produce trepang at the two study sites: evisceration, salting, boiling and drying. The number of processing stages was increased or decreased depending on the characteristics of each sea cucumber species, especially the skin and body wall texture and thickness. Sea cucumbers with thinner and softer skin and flesh required an additional salting stage. The most prominent difference between the processing of sea cucumbers in both study areas compared to the methods used in other countries where the quality of trepang is higher was the absence of smoking. The smoking stage is widely considered as an important step to increase the durability and improve the aroma of the final processed trepang product.

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