

RESEARCH ARTICLE

A comparative analysis of amount of seafood waste disposal against the potential earnings from converting the waste into chitosan for TCSO Restaurant

Norwazli Abdul Wahab^{1*}, Liaw Wen Ping²

¹Faculty of Industrial Management, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebu Persiaran Tun Khalil Yaakob, 26300 Kuantan, Pahang, Malaysia

²Faculty of Chemical and Process Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebu Persiaran Tun Khalil Yaakob, 26300 Kuantan, Pahang, Malaysia

ABSTRACT - Seafood waste is a significant issue in Malaysia particularly when it comes to maintain environmental sustainability. There are several types of seafood waste such as shellfish waste, crab waste and shrimps' waste. In this research paper, we are focusing on shrimp's waste which can produce chitosan, a beneficial raw material in several industrial such as food, agriculture and medical. The weight of shrimps' waste disposal is taken count to know how much potential earnings based on the market price of chitosan. There is a research gap as the net price of chitosan produced remain unknown due to this research paper only focusing on a specific restaurant. There is requirement of further research about the actual profit that can earn when chitosan is produced from the shrimps' waste. However, we focus on 1 specific product of chitosan which its brand is RunJle. This chitosan provides high purity with specific mesh and DAC. This price of product can indirectly to calculate the revenue of selling chitosan based on its market price. This research paper shows the potential of utilise the seafood waste into beneficial raw material rather than treated as disposal waste. In addition, this paper shows that seafood waste can be minimised by making them as useful product and cut the cost of disposal.

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1. INTRODUCTION

Governance, integrity, and ethical considerations play a pivotal role in ensuring that seafood waste management aligns with sustainable development objectives. Effective corporate governance structures are essential to enforce compliance with environmental policies, promote transparency in resource utilization, and uphold ethical accountability in operations. For TCSO Restaurant, integrating ethical governance in the management of seafood waste ensures that waste-to-value initiatives, such as the conversion of waste into chitosan, are conducted responsibly and transparently. This approach not only mitigates environmental risks but also reinforces organizational integrity through adherence to sustainability reporting and regulatory standards. By embedding ethics and governance within the waste valorisation process, the restaurant demonstrates a commitment to both economic value creation and the broader ethical imperative of environmental stewardship. Malaysia is surrounding by South China Sea to the west. In simple word, it is surrounded by sea. From here, the seafood waste cannot be avoided. A strategic well management is crucial to minimize this matter. The most observable seafood waste in Malaysia is the exoskeletons of shrimp and crabs which also represents a significant byproduct of the seafood industry. Shrimp and crab shells are rich in chitin, making them valuable sources for chitosan production. These exoskeletons, which are primarily composed of chitin, a naturally occurring polymer, can be processed into chitosan.

Chitosan is a biopolymer derived from chitin through a deacetylation process, where acetyl groups are removed from the chitin molecule. It is one type of solid waste. The conversion of seafood waste into chitosan has several environmental and economic benefits. It not only helps reduce the environmental impact of seafood processing by utilizing what would otherwise be discarded, but chitosan itself has a wide range of applications. For example, chitosan is used in medical and food industries. In medical industry, it is used as wound healing. It quickens the healing and prevent infection. In food industry, it extends the shelf life of the product from growth of bacteria, fungi and mould. (Aranaz et al., 2021; Negi et al., 2021; Reshad et al., 2021) The conversion of seafood waste into chitosan helps minimize the environmental burden of shellfish disposal, offering an eco-friendly alternative to synthetic materials.

The natural source of chitosan such as the skeleton of crimps, shells and lobster is the waste that always produced from the seafood restaurant. There are not being classified in 5R. Even in recycling, there are not specified name list for it. This had made the seafood restaurant take easy on them and directly treat them as solid waste.

- i. The current practices result in the chitosan being treated as waste rather than being utilized as valuable raw material, heightening the need for effective transformation strategies.

- ii. The environmental impact of chitosan waste remains significant, necessitating strategies to minimize its adverse effects.
- iii. Chitosan’s potential is underutilized in many industries and expanding its use could offer sustainable solutions in fields.

In this research, we are going to discuss the amount of the seafood waste that can be produced by a restaurant namely TCSO. This restaurant is a seafood restaurant who order huge amount of seafood daily to ensure the seafood is fresh. The amount and prices of restock the seafood are collected as well as the amount of seafood disposal. Due to the limitation on focusing 1 company, the net price of the chitosan produced cannot be collected but the price of selling of chitosan is obtained through the market. The second data is collected based on the market price of chitosan and the journal about the yield of chitosan can be obtained from the seafood waste. Lastly, the analysis between the costs between the amount of disposal and potential earning if selling the raw materials after converting the waste.

There are 3 objectives had been determined in this topic which are shown as below

- i. Identify the amount of disposal of seafood waste
- ii. Determine the selling price of chitosan and its yield of chitosan from seafood waste through the market and journal research
- iii. Analyze and compare the costs of disposing amount of seafood waste with the potential earnings from converting the waste into chitosan

2. LITERATURE REVIEW

Chitosan is a type of solid waste. It can be produced through chemical and biological methods. It has been applied in a few industries fields such as agriculture and food technology. (Kou et al., n.d.; Reshad et al., 2021) It had the ability to be a cationic emulsifier as it had the amine and amino group. This shows that it can be applied for the petroleum industry. (Mallawarachchi et al., 2016). However, the source of the chitosan is treated as waste to be disposal. Thus, instead of spending the money on treating it as rubbish, we should spend it on treating it as useful raw material. The main source of the chitosan is from crustacean followed by fungal. Other than that, chitosan can be obtained through insects and some microalgae species. Figure 1 shows some sources of chitosan. (Iber et al., 2022).

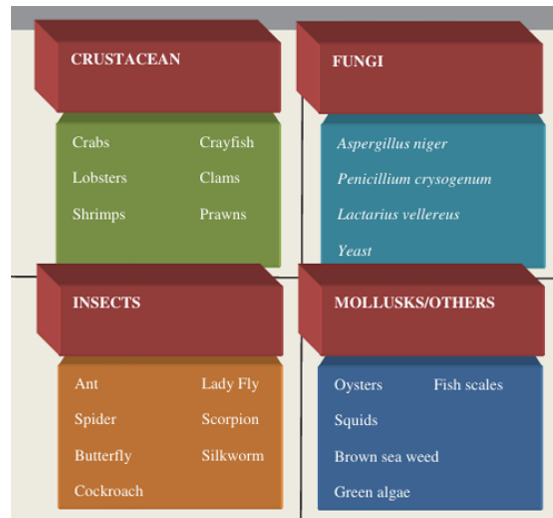


Figure 1. Source of chitosan (Iber et al., 2022)

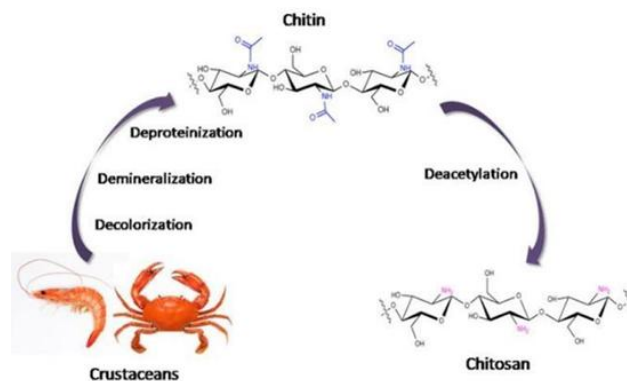


Figure 1. Process (Iber et al., 2022)

Due to the chitosan's versatility as a bio-product, chitosan is useful to apply across various sectors of the petroleum industry, including oil, exploration, transportation, and refining. Additionally, it is utilised in petroleum products and plays a role in treating oil sludge and refinery wastewater. Figure 2 below shows the simple explanation of the process from crustaceans to chitosan (Negi et al., 2021). Chitosan is considered as one of the biopolymers which is non-toxic and biodegradable. Before this, it has been widely uses in the food, medicine, agriculture, and chemical industries. It is because it has the potential as anti-inflammatory, antimicrobial, antifungal, antioxidant activities. (Alemu et al., 2023; Aranaz et al., 2021; Negi et al., 2021; Pellis et al., 2022; Reshad et al., 2021) The further study shows that it had the potential as an emulsifier in coating where it had the amino group that can react with acid and form cationic emulsifier. (Mallawarachchi et al., 2016). This supported by the shelf life of post-harvested longan (*Dimocarpus longan*) is increased when coating with the chitosan based edible coating. It is found that it is more beneficial compared to carrageenan-based edible coating due to its antifungal and antibacterial properties. (Lin et al., 2018) The amino group inside the chitosan make the chitosan shows the cationic behaviour when dissolve in acidic medium. (Alemu et al., 2023) It is supported by (Sharkawy et al., 2020) where the chitosan has cationic properties at low pH and produces a high transmittance and transparent solution. The value of hydrophilic-lipophilic balance (HLB) is at the range of 34-36.7 which suggests the chitosan has emulsifying potential. This property is due to the structural heterogeneity of chitosan.

3. METHODOLOGY

The data of prices and amount of disposal seafood waste are collected as well as achieve the first objective of this research. The restaurant (TCSO) had kindly given the data for my research. Due to ensure the freshness of the seafood and to satisfy the satisfaction of the customers, the restaurant had restocked the seafood daily. Moreover, the restaurant did not only take from one supplier but also multiple suppliers. This is to ensure they did not meet out of stock of the certain seafood which will affect the satisfaction of customers to come back to eat. In this case, we are focusing on the shrimps' waste as the brand of chitosan that being specified is RunJie which the chitosan is produced from shrimp's waste.

Due to the research requirement, the data of selling price of chitosan in market and yield of produce from seafood waste cannot be taken from this restaurant as this restaurant only focuses on selling seafood. Thus, the second data had been collected through research on market and journal research. Second data is focusing on the price of chitosan and yield of the chitosan that can be produced from the shrimp's waste. Through research, the chitosan can be produced through many methods which make the product of chitosan different based on the market demand. In this research, I had focused on RunJie brand of chitosan (80 mesh, DAC 90 % white powder, 1kg /pack, industrial grade). The 80 mesh of refers to 80 % of particle of chitosan pass through an 80-mesh sieve. The DAC 90% indicates that the purity level of Decalcified Animal Chitosan whereas 90 % of the product is chitosan while remaining 10 % is other substance.

Lastly, the analyze and comparison is made on the disposing amount of seafood wastes and the potential earnings from converting the seafood waste into chitosan. The revenue had been calculated based on the yield of chitosan that can be produced from the shrimps' waste and the market price of chitosan (Brand: RunJie). Refer to Figure 3.



Figure 3. Research process

4. RESULTS AND DISCUSSION

The amount of seafood is different everyday due to the demand. From the data provided in Table 1, the maximum amount of seafood restock is 60 kg in weekday while the maximum amount of seafood restock can reach 100 kg in weekend. The seafood restock of weekend is higher as there are more customers that come to eat in this restaurant. The amount of seafood throwing is collected and being sent to disposal.

Table 1. Amount of seafood restock

Days	1	2	3	4	5	6	7
Amount of seafood restock (kg)	60	55	53	56	55	100	80
Payment of the restock seafood (RM)	3000	2750	2650	2800	2750	5000	4000
Weight of shrimps throwing (kg)	23	17	13	19	15	37	31

Based on the research, Table 2 shows the yield of the chitosan can be produced is very dependent on the type of seafood and source of the seafood waste. However, RunJie brand of chitosan is from shrimps and crab. For RunJie brand of chitosan (80 mesh, DAC 90 % white powder, 1kg /pack, industrial grade) is based on the shrimps. The yield of the chitosan that can be produced from shrimps is in the range of 10.8 % - 46 %. (Iñiguez-Moreno et al., 2024; Mohammadi et al., 2023; Periyannan et al., 2023; Rebello & S, 2014) . The yield of chitosan can be produced is dependent on the method that use extract. The price of RunJie brand of chitosan is RM 100 per kg.

Table 2. Yield of chitosan

Days	1	2	3	4	5	6	7
Weight of shrimp throwing (kg)	23.00	17.00	13.00	19.00	15.00	37.00	31.00
Lowest yield (kg)	2.48	1.84	1.40	2.05	1.62	4.00	3.35
Highest yield (kg)	10.58	7.82	5.98	8.74	6.90	17.02	14.26

Calculation

Yield of chitosan from shrimps: 10.8 % - 46 %

Lowest yield: 10.8 %

Chitosan yield = $23 \times 0.108 = 2.48 \text{ kg}$

Highest yield: 46.0 %

Chitosan yield = $23 \times 0.46 = 10.58 \text{ kg}$

The data is calculated based on the lowest and highest range of yield produced from the chitosan. The weight of the shrimps throwing is small as the meat of shrimps is the major part which consists of 48 % of the total shrimps. The head consists of approximately 39 % while the shell approximately only 11 %. (Wan Norhana et al., 2010). Thus, it is possible that the weight of the shrimps obtained is lowest compared to other seafood waste such as crab, fish and prawns.

Table 3. Revenue from selling chitosan based on RM 100 per kg

Days	1	2	3	4	5	6	7
Revenue based on highest yield	248	184	140	205	162	400	335
Revenue based on lowest yield	1058	782	598	874	690	1702	1426

Calculation

Selling of chitosan is RM 100 per kg

Lowest yield (2.48 kg)

Revenue in a day = $2.48 \times 100 = \text{RM } 248$

Highest yield (10.58 kg)

Revenue in a day = $10.58 \times 100 = \text{RM } 1058$

From the analysis, chitosan remains highly profitable, even before accounting for manufacturing costs. As the collection of shrimps waste basically more than 1 kg in a day. Moreover, the chitosan is not only can be produced from the shrimps. It can also be produced form other seafood waste such as crab and shellfish. In this research, it only focusses on shrimps due to the brand of chitosan. In term of disposal this waste, it is better to generate profit as well as reducing the environmental impacts. From the calculation, it had been shown that there is a huge potential for converting this waste into chitosan without considering other seafood wastes.

5. CONCLUSIONS

In conclusion, the amount of shrimp waste is high from the data obtained which is mentioned in Table 1. This suggests that there is a huge potential to convert the shrimps waste into chitosan rather than just disposal it. From Table 2, it shows

that the amount of lowest yield of chitosan that is produced from the shrimps' waste is more than 1 kg. This means that the minimum yield has shown that there is still potential to earn profit. The yield of chitosan can be increased by using other efficient extraction methods which require more research and specific to the seafood waste that locally have in the area. This is the research gap for this paper which needs to specify the biggest seafood waste in Kuantan area and the most efficient extraction method that suitable for the collection of the seafood. The data on shrimp disposal indicates that seafood waste continues to have a significant environmental impact. This assessment is based solely on shrimp waste and does not account for other types of seafood waste. From Table 3, it shows the revenue of selling based on the lowest and highest yield of chitosan in term of RM 100 per kg. This price of chitosan refers to the RenJie brand. There is a recommendation that given to the restaurant. The restaurant manager can co-operate with the industries or government to minimise the seafood waste by transforming the seafood wastes into beneficial raw materials rather than treat as the waste. To make this chitosan be more beneficial, the use of it should not only focus on medical, food and agriculture. There should be more research to be made to maximise the use of chitosan so there is more investment can be attracted to further study about chitosan. This helps to minimise the seafood waste in Kuantan and cut disposal cost of seafood waste.

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AUTHORS CONTRIBUTION

Liaw Wen Ping (Conceptualization; Methodology; Project Writing – original draft; Investigation)

Norwazli Abdul Wahab (Supervision; Formal analysis; Validation; Writing – review & editing; Methodology)

AVAILABILITY OF DATA AND MATERIALS

The data supporting this study's findings are available on request from the corresponding author.

ETHICAL STATEMENT

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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