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EFFECTS OF CRUSHED AND CUBED ICE STORAGE TOWARDS FAT, ASH AND MOISTURE CONTENT IN RED SNAPPER AND INDIAN MACKEREL

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Abstract:

This study evaluates the effect of crushed and cubed ice on the preservation of fat, ash, and moisture content of the Red Snapper and Indian Mackerel stored for seven days. The determination of fat, moisture, and ice storage content was determined at three days (0,4,7) throughout the storage period. Statistical

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analyses were carried out to indicate the significant difference in the effects of treatment days and physical characteristics of ice on the crude fat, ash, and moisture content. The fat and ash percentage decrease while the moisture content in both ice storage increases throughout the storage period. Red Snapper comprises 1.32% fat, 78.00% moisture, and 1.03% ash content, while Indian Mackerel is composed of 1.30% of fat, 72.50% moisture, and 1.06% ash content during the initial storage period. The fat content in both species starts to decrease during day four in both storages, where the highest deterioration of fat (42-43%) was found for both species kept in cubed ice. The moisture content results show an increase in the moisture content for both species, where the highest percentage (7-8%) was found in both species kept in cubed ice. The ash content decreased in both species kept in cubed ice (22.00 - 42.00%) throughout the storage period. The study suggested that crushed ice is one of the fish preservation options for preserving fish quality.

Keywords:

Ash, Crush Ice, Cube Ice, Fat, Fish Quality, Moisture

Introduction

Fish consists of elements such as water, protein, and fat. Water is the main component in fish flesh, accounting for 75-80% of fish weight, while the amount of protein in fish muscle is about 20% depending on the species. The fat content in fish flesh varies from one species to another and usually ranges from 5-15% of total fish weight (Petricorena, 2015). The unique characteristic of fish tissue is the presence of long-chain polyunsaturated fatty acids (PUFA), especially omega-3 and omega-6 (Muhamad & Mohamad, 2012). These two types of fatty acids promote an essential benefit to humans, such as reducing the appearance of cardiovascular diseases and improving learning ability (Pal et al., 2018).

The quality of fish depends on the nature of fish species, handling and storage conditions, and changes after catching due to chemical reactions and microbiological spoilage (Sampels, 2015). Maintaining the quality of fish started when fish were harvested and transported from the harvesting site to end customers. Usually, fish have been exposed to high ambient temperatures at the landing site, which reduces the quality of the fish. Marketing of fish as practised in Malaysia's wet market is usually done at ambient temperature, which enhances the spoilage and reduces the quality of the fish (Ayodeji Ahmed, 2020).

The quality and shelf life of the fish can be maintained and extended by using several types of preservation techniques. Methods such as chilling and freezing are reported to maintain the quality of and extend the shelf-life of the fish (Lu et al., 2015). Chilling fish and fishery products can be done using different methods such as ice, the Chilled Fresh Water (CFW) system, Refrigerated Sea Water (RSW) system, and cold air storage.

However, most methods used to chill the fish are ice because ice has a high latent heat of fusion, which can remove a large amount of heat and melt without changing the temperature (Kumano et al., 2016). Distinct types of ice will affect the fish's quality (Kamaruddin et al., 2020). Therefore, this study investigated the effect of crushed and cubed ice on the preservation of fat, ash, and moisture content of the Red Snapper and Indian Mackerel.

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Literature Review

Seafood especially, fish is made up of substances including water, protein, and fat. Water elements make up most of the fish's weight; depending on the species, the quantity of protein in fish muscle is just around 20%. The decrease in moisture content is beneficial since it lowered the fish's susceptibility to microbiological spoilage and oxidative polyunsaturated fatty acid breakdown, which improved the quality and preservation of the fish (Abdel-Naeem et al., 2021). Long-chain polyunsaturated fatty acids (PUFA), particularly omega-3 and omega-6, are present in fish tissue, which makes them exceptional (Muhamad & Mohamad, 2012). These two varieties of fatty acids support a critical advantage for people, such as lowering the occurrence of cardiovascular diseases and enhancing cognitive function (Pal et al., 2018). The creation of some physiologically active compounds, tissues, cells, and organs depends on fatty acids as fundamental building blocks. Long-chain fatty acids called omega-3 polyunsaturated fatty acids are crucial for many biological processes, such as reducing oxidative stress and maintaining cardiovascular health. The benefits of an omega-3 fatty acid-rich diet on one's health and well-being are widely recognised (Muhammad Alinafiah et al., 2022).

Enzymatic autolysis, oxidation, and microbial growth are three basic mechanisms resulting in fish spoilage activity (Ghaly, 2010). Ghaly (2010) also mentioned that low-temperature storage and chemical techniques for controlling water activity, enzymatic, oxidative, and microbial spoilage commonly happened in the industry today. The quality of fish is affected by the species, how it is handled and stored, and changes that occur after it is caught because of chemical reactions and microbiological spoilage (Sampels, 2015). When fish were collected and moved from the harvesting site to final consumers, the process of maintaining fish quality began. At the landing location, fish are frequently subjected to high ambient temperatures, which lowers the quality of the catch. The wet market in Malaysia typically sells fish at ambient temperature, which increases spoilage and lowers the quality of the catch (Ayodeji Ahmed, 2020).

Methodology

Sample Preparation

The sample of fresh Red Snapper and Indian Mackerel were purchased at Lembaga Kemajuan Ikan Malaysia (LKIM) Kuala Perlis, Perlis, Malaysia. All the samples were divided into two batches: cubed ice and crushed ice. The sample was stored for seven days, and the ice was replaced every three days throughout the storage. The flesh of both species was taken at an interval of (0,4,7) days to analyse the proximate contents.

Proximate Content

Fat Content

The Soxhlet extraction method determined the sample's crude fat (Thiex, 2009). 1 g of moisture-free sample was kept inside the Whatman thimble. The thimble was plugged with cotton loosely and placed in a Soxhlet extraction unit. Petroleum ether AR grade (40-60^{o}C) was used as a solvent.

Heating was achieved by a thermostatically controlled mantle. The temperature was set to 500 - 600^{o}C, and extraction was continued for 16 h. After the extraction, the pre-weighed receiver

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flask containing the extracted fat was dried in a water bath at 98-100oC and then in an oven at 60 ± 5°C. The flask was cooled in desiccators and repeated until a constant weight was obtained. The fat content of samples was calculated by using the following formula in Equation 1:

$$\textbf{\textit{Fat Content}} = \frac{W_2 - W_1}{S} \times 100 \quad (1)$$

Where,
W_1 = Weight of crucible with sample
W_2 = Weight of crucible with ash
S = Weight of crucible

Then, 5 g of the sample was weighed into the thimble. The thimble was then placed in the Soxhlet extractor. Afterwards, a 150-round bottom flask was filled with 90 ml cyclohexane. The whole setting was placed on a heating mantle, allowing cyclohexane to boil. The extraction process proceeded for almost 6 hours. The condensing unit was removed from the extraction unit and let the sample cool down. All the lipid was removed. After that, almost all the solvent was collected after distillation. The sample was placed in the oven, and after removing it, it was placed in the desiccator. Then, the weights of the samples were taken.

Ash Content

The ash content of the samples was determined by the method described in (Thiex, 2009). 1 g of moisture-free sample was taken in a pre-weighed silica crucible. The crucibles were removed and cooled in a desiccator and weighed. Ash content was calculated from the weight difference of the crucible and expressed as the ash content in percentage on a dry weight basis using Equation 2.

$$\textbf{\textit{Ash Content}} = \frac{W_2 - W}{W_1 - W} \times 100 \quad (2)$$

Where,
W_1 = Weight of crucible with sample
W_2 = Weight of crucible with ash
W = Weight of crucible

Moisture Content

The moisture content was determined following the method (Thiex, 2009). 5 g of fish meat of each species was taken and dried in a hot air oven by keeping it open without a lid. The oven temperature was maintained at 100 ± 5°C, and the samples were observed for 3 - 6 hours. The samples were cooled to room temperature in a desiccator containing silica gel. Drying and cooling were done repeatedly till constant weight was obtained.

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Total moisture content was calculated by using the formula in Equation (3)

$$\textit{Moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \quad (3)$$

Where,
W_1 = Empty weight
W_2 = Sample weight before drying
W_3 = Sample a weight after drying

Data Analysis

All the experiment was done in triplicate. The data obtained from moisture content, crude fat, and ash content analysis were further analysed using Statistical Package for Social Science (SPSS, version 25.00). An independent sample t-test was performed to compare the changes in proximate composition between the cubed and crushed ice and between the species. The significance of the difference was defined at $p<0.05$.

Results and Discussion

The Crude Fat Contents

The initial crude fat content of Red Snapper stored in cubed and crushed ice is 1.39% and 1.37%, respectively. The percentage of fat content decreased to 1.27% and 1.29%, respectively, during 4 – days in storage. A reading of 0.97 % and 1.20% of crude fat content was recorded during 7- days in the storage when Red Snapper was treated with cubed and crushed ice.

For the Indian Mackerel, the initial crude fat content is 1.32% and 1.28% during the 0 – day of storage. The fat content of Indian Mackerel shows a decrease in the percentage with a reading of 1.17% during 4 – days in storage and 0.89% during 7- days in storage when the samples were kept in cubed ice storage. A decreasing pattern was also observed for the sample held in crushed ice. The crude fat content was recorded at 1.21% and 1.06% during day 4- days in the storage and 7 days in the storage, respectively. It was found that there was no significant effect ($p<0.05$) of different ice on the crude fat content of the fish. **Figure 1** shows the crude fat content of Red Snapper and Indian Mackerel in cubed and crushed ice storage for seven days.

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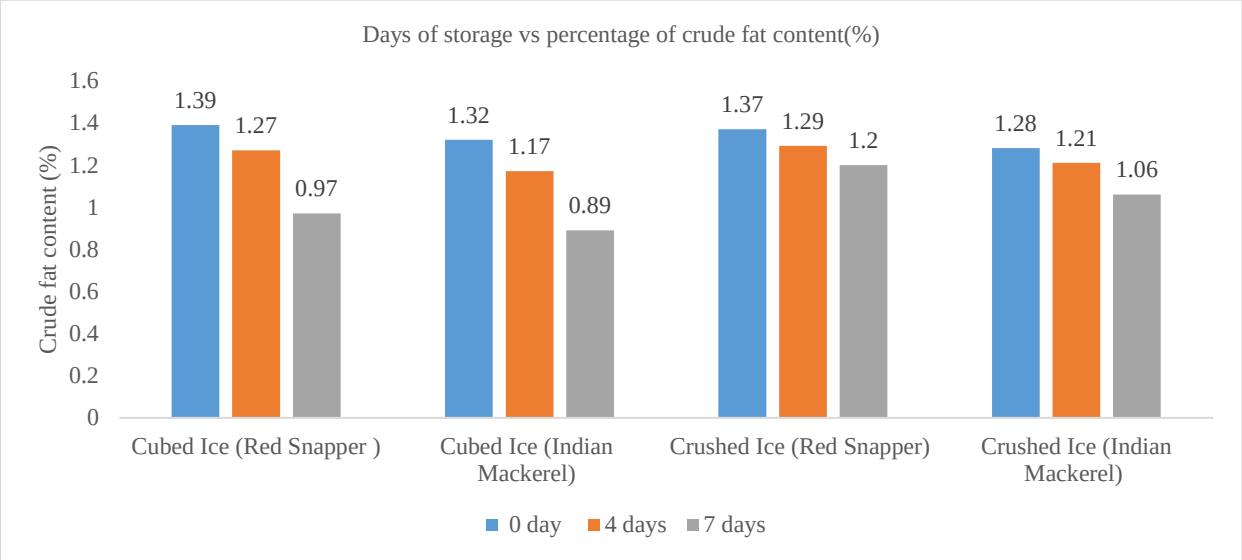

Figure 1: Crude Fat Content of Both Species Kept in Cubed and Crushed Ice Storage for Seven Days ($p<0.05$)

Overall, it was found that crushed ice is superior to cubed ice in preserving the crude fat content for both species. The result also found that the fat content decreases as the storage time increases. The finding is in line with the previous study reported by Kamaruddin et al. (2020). The reduction in fat content as the time of storage increase is due to the decrease of fat in fish flesh (Daramola et al., 2007). The lipid oxidation of food, especially of PUFA contained in fish, is instead linked to the formation of off-flavour components, less quality during different storage conditions, loss of nutritional value, and even formation of anti-nutritional molecules (Ali et al., 2022).

The Ash Contents

The study found that the initial ash content in Red Snapper is 1.02% and 1.05% when kept in the crushed and cubed ice storage. A reading of 0.89% and 0.80% were recorded during the 4 - days and 7 - days when this species was kept in the crushed ice. While a reading of 0.87% and 0.84% were recorded during the 4 – days and 7 – days when this species was kept in the cubed ice storage.

On the other hand, the study found that the initial ash content in Indian Mackerel is 1.09 % and 1.03%. The ash content shows a slight decrease in the percentage as the time in the storage increases. The reading of the ash content of Indian Mackerel kept in the crushed ice is 0.74% during 4 - days in storage and 0.67% during 7 - days in storage. The same trend was also observed when this species was kept in cubed ice storage. The percentage of ash is 0.83% during 4 – days in cubed ice and 0.71% during 7 – days in the cubed ice.

There was no significant effect ($p<0.05$) of different ice on the ash content of the fish. **Figure 2** shows the ash content of Red Snapper and Indian Mackerel kept in crushed and cube iced throughout seven days of storage.

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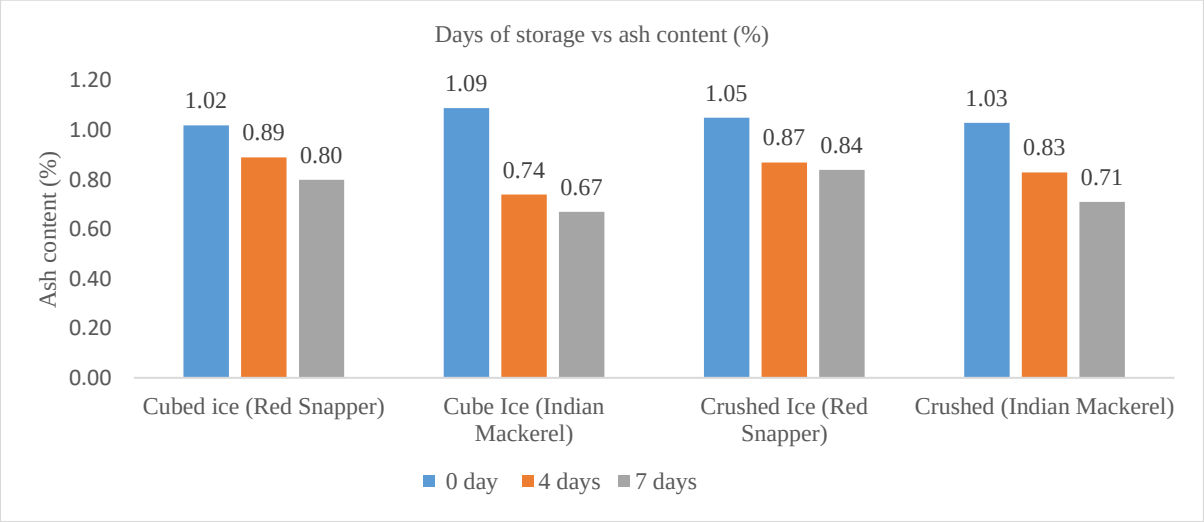

Figure 2: Ash Content of Both Species Kept in Cubed and Crushed Ice Storage for Seven Days ($p<0.05$)

The overall experiment indicates that crushed ice is superior to cubed ice preserving the ash content for both species—the ash content decreases as the storage time increases. The decrease in the ash content was also found in the previous study reported by Kamaruddin et al. (2020). According to Al-Ghanim (2016), the reduction in ash content was attributed to drip loss during the iced storage period.

The Moisture Contents

The study found that throughout the seven days in the storage, moisture content shows a percentage increase. The percentage of the moisture content increase as the time of the storage increase. It was found that the initial percentage of moisture content in the Red Snapper is 78.00% for both crushed ice and cubed ice storage. There is a slight increase in the moisture content of the Red Snapper throughout the storage. The moisture content reading is 79.20% during 4 - days in the storage and 80.20% during 7- days in the storage when kept in the crushed ice. The same trend of increase in the moisture content was also found when this species was kept in cubed ice. The moisture reading is 80.00% during 4- days in the storage and 84.00% during 7- days in the storage.

The initial percentage of Indian Mackerel is 72.80% and 72.20%. The moisture content of Indian Mackerel increased with a reading of 74.00% during 4 – days in storage and 78.00% during 7 – days in storage. The increasing pattern was also found in Indian Mackerel that was kept in cubed ice, where the moisture content was recorded at 76.00% during 4 - days in storage and 79.20% during 7- days in storage. The study also found a significant difference ($p<0.05$) in the moisture content among the two species. **Figure 3** shows the percentage of the moisture content of Red Snapper and Indian Mackerel kept in crushed and cubed ice storage.

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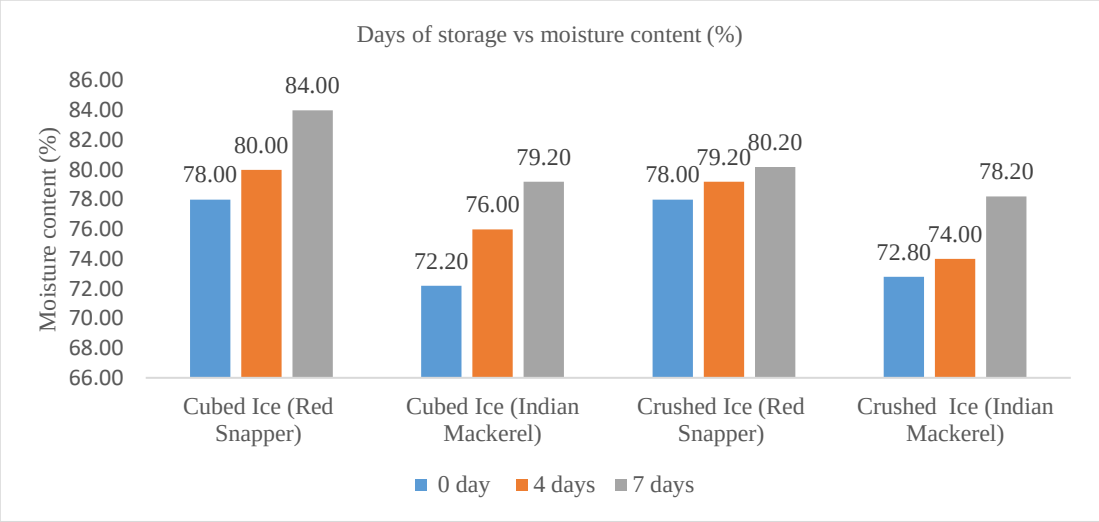

Figure 3: Moisture Content of Both Species Kept in Cubed and Crushed Ice Storage for Seven Days (P<0.05)

The initial increase in moisture content of the fish with the increase in ice storage time could be because the fish absorbed moisture during the first days of storage (Al-Ghanim, 2016; Daramola et al., 2007). As reported by Daramola et al. (2007), the decrease in moisture observed after day six could be attributed to the difference in the moisture of the fish relative to its surrounding. Dehydration of the fish is an essential physical reaction caused by the evaporation of ice due to differences in vapour pressure over the product surface and the air of the storeroom. Loss of moisture by evaporation of ice causes the fish surface to dry, resulting in a dull appearance and even discolouration, as observed by Singh et al. (2021).

Preservation Using Ice

Preservation techniques are an essential factor in determining the end quality of fish. It is well known that chilling by using ice is an efficient method that has been used to reduce the effect of post-mortem changes and extend the shelf life of the fish. However, the chilling rate depends on the size and ice particles (Shawyer & Pizzali, 2003).

Cube ice is more significant in size than crushed ice, giving advantages for a more extended period of preservation. However, as reported by Baheramsyah et al. (2017), the use of cube ice in preserving the fish can cause damage to fish skin due to this type of ice having hard and rough surfaces. As for crushed ice, the small shapes and sizes give advantages that can increase the cooling rate as it has a large surface area compared to cubed ice. Shawyer and Pizzali (2003) reported that crushed ice has advantages over refrigerated seawater and ice slurry during chilling. The same finding was also reported by (Kamaruddin et al., 2020), who found that crushed ice gives advantages over cubed ice in maintaining the quality of the fish preserved.

Conclusions

The crude fat and ash percentage decreased as the ice storage time increased. While the moisture content increased significantly as the time in the storage increased. It was found that crushed ice is a good choice in maintaining the quality of fish as compared to cubed ice. Further analysis should be done on the study of fatty acids, protein, carbohydrates, microbial analysis, etc., and the storage period is extended for a month to investigate the pattern and effects of

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cubed ice on the crude fat, ash, and moisture content composition of Red Snapper and Indian Mackerel.

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