THE EFFECTS OF CHILLING AND FREEZING TO THE CRUDE FAT, ASH AND MOISTURE CONTENT OF *Channa striata* AND *Clarias batrachus*

Sharir Aizat Kamaruddin*, Muhammad Huzaifah Jaafar, Muhammad Ariff Zakariya, Muhammad Fayyadh Fadzilan, Aliff Iqbal Ahmad Nadzri, Khairul Naim Abd.Aziz, Muhammad Akmal Roslani and Zamzila Erdawati Zainol

Faculty of Applied Sciences, Universiti Teknologi MARA, Perlis Branch, Arau Campus, 02600, Arau, Perlis, Malaysia

**Corresponding author: shariraizat@uitm.edu.my*

Abstract

This research is conducted to investigate the effects of cubed and crushed ice on the crude fat, ash, and moisture content of *Channa striata* and *Clarias batrachus.* The samples were chilled to four and seven days in the Polyvinyl chloride plastic (PVC) boxes filled with cubed ice and crushed ice. Before the determination of crude, ash, and moisture content, the samples were frozen for 1 week. Statistical analyses were carried out to indicate the significant difference in the effects of treatment days and physical characteristics of ice towards the crude fat, ash, and moisture content. The result concludes that crushed ice is more superior to cubed ice for all experiments. The outcomes of this research benefit many parties specially to cubed ice suppliers to support aquaculture industries and the socio-economic sectors in Malaysia.

Keywords: cubed ice, crushed ice, *Channa striata, Clarias batrachus*

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Introduction

Commonly known as stripped snakehead, *Channa striata* (*C. striata*) is a popular freshwater fish among Malaysians. *C. striata* is native to Malaysia and can be found in many Southeast Asia countries (Lee & Ng, 1994). The species is characterized by having an elongated body with the broad and flattened head part. The species can be discovered in freshwater plain and during the dry season, it would burrow under the bottom mud of lakes and canal to remain moist (Tan et al., 2012). Even though *C. striata* is common in Cambodia, the fish is well distributed from Sri Lanka to Indonesia, the Philippines and China (Basri et al., 2015).

On the other hand, *Clarias batrachus* (*C. batrachus*) or commonly known as the walking catfish is also native to this country and other Southeast Asia countries such as Singapore, Indonesia, Laos and Thailand (Christianu et al., 2013). *C. batrachus* has an elongated body with irregular bumps on its spines (Sahoo et al., 2010). The species can be found in the temperate, tropical and freshwater ecosystems (Singh et al., 2009). Compared to *C. striata, C. batrachus* are globally distributed due to introductions in many regions including in North America such as New York, New Jersey, etc. (Schofield & Loftus, 2014).

In terms of economical values, the global capture production for *C. striata* is recorded at 70802 tons while the global aquaculture production is recorded at 21721 tons in 2016 (FAO, 2016). Nevertheless, there is less information regarding the global capture and aquaculture production of *C. batrachus.* However, *C. batrachus* is popular in commercial fisheries, aquaculture, and aquarium (Fauji et al., 2018).

Due to their high geographical distribution and economic values, both species are found to be an important consumption for Malaysians. Both species can be cooked, fried, steamed or stir-fried to make varieties of dishes (Ahmad, 2016). Moreover, consumers can purchase them easily in the morning or night markets throughout Peninsular Malaysia, Sabah and Sarawak. Furthermore, sustainable aquaculture activities of these species are important to ensure both ecosystem and industry provide a long term economic and social benefits (Kamaruddin et al., 2018; Kamaruddin et al., 2019, Kamaruddin et al., 2020). Consequently, monitoring the effects of the preservation process of *Channa striata* and *C. batrachus* is significant to maintain the fish freshness and quality before they reached the end consumers (Horner, 1997).

Chilling is the most commonly method used to preserve the fish (Roşca et al., 2017). Preservation and storage using ice promotes moist condition and it is suitable during the process of transferring the fish from one destination to another (Li et al., 2018). Ice would reduce the temperature of the storage and the rate of enzymatic reactions thus, extending the rigor mortis period (Álvarez et al., 2019). Today, there is a variation of physical characteristics of ice that can be used for fish preservation and storage (Medina et al., 2009).

The quality and freshness of fish depend on the way they are chilled or frozen. Ice is an economical and convenient way to retain fish freshness (Bernardi et al., 2013). Chilling with ice is useful especially when freezing technology is unavailable (Keys et al., 2017). Generally, crushed ice is used to preserve the fish whether during fishing activity, business activity or even preservation by the consumers at home (Kauffeld et al., 2010).

To date, there has been less information regarding the effects of the cubed and crushed ice to *C. striata* and *C. batrachus*. Thus, this research is conducted to determine the effects of different characteristics of ice and storage period towards the composition of ash, moisture content and crude fat content of *C. striata* and *C. batrachus*. The outcome of this research would benefit many sectors especially in aquaculture production and socioeconomic involving *C. striata* and *C. batrachus* species. The research is also found to be significant in aquaculture industries since the lack of attention on the preservation of fish with ice would lead to contamination of microorganisms and reduce its freshness.

Methods

Research design

A sample of *C. striata* and *C. batrachus* was selected randomly. The sample was grouped in three blocks. Each sample has five fish for each block. The fish were collected on November 4th, 2019. The methodology used in this research followed Yang et al., (2013).

Sample collection and types of equipment

The samples of *C. striata* and *C. batrachus* were obtained from the night market of Pasar Malam Arau, located in the region of Arau, Perlis. 20 samples of *C. striata* and *C. batrachus* were immediately transferred to the laboratory for the experiments. 15 samples of *C. striata* and *C. batrachus* were used for Block I, Block II and Block III while 5 samples were used for the control group.

The cubed ice and crushed ice were obtained from the local edible ice supplier. The ice samples were ensured to be clean, clear, and safely used for preservation and consumption. To ensure the quality, the ice was purchased from Atlas Edible Ice [Kangar] Sdn Bhd. The company has been recognized by few certificates such as ISO22000;2015 Certification, Mesti Certification and Halal Certification (Atlas Edible Ice, 2019). The ice has immediately been transferred to the laboratory on the same day when the *C. striata* and *C. batrachus* were purchased.

The insulated storages of Polyvinyl chloride plastic (PVC) boxes with the size of 200L were used for the chilled storage stage. The PVC boxes were rinsed thoroughly with distilled water and less concentrated alcohol was smeared to the wall of PVC boxes to reduce the contamination of any microorganisms. Freezers located at the marine laboratory of the Universiti Teknologi MARA Perlis Branch, Arau campus were used for freezing processes.

All the experiments and determination of the crude fat, ash, and moisture content were carried out at the biology laboratory and marine technology laboratory located at the Universiti Teknologi MARA Perlis Branch, Arau campus.

Treatments

The samples of *C. striata* and *C. batrachus* were layered (3 layers) with cubed ice and crushed ice. Davey (2012) stated that the ice to the fish ratio in tropics is 1 kg ice to 1 kg fish, and ice to the fish ratio in the temperate climate and the insulated van are 1 kg ice to 2 kg fish. In this experiment, the ratio of ice to the samples is 1 kg of ice to 1 kg of fish. The samples were left in PVC storage to four and seven days in freezing condition. Water from melted ice was drained using a tap located at the bottom of insulated storage. The ice was added into the PVC storage by layering on the top of samples for each block, once per day. After the period of chilling, the samples were undergoing the freezing storage for a week at -18^0C. The samples were carefully wrapped with aluminum foil and arrange in the freezer using the tin container. After the freezing stage, the samples were thawed overnight at 4^0C for analyses. The samples were kept in clean container. To check whether the samples were in good quality, observation and monitoring of the flesh and odor were made. The analyses were performed immediately in triplicates for composite samples.

Before the analyses, the skins, scales, bones of *C. striata* and *C. batrachus* were removed. Only the white muscle in fish was used for the analyses. Due to limited time and sources, only three tests were conducted that include crude fat, moisture content and ash content.

Analyses

The methods presented here followed the standard method of Cunniff (1997). Determination of crude fat content was carried out using the Soxhlet extraction method 920.39. Determination of ash and moisture content was carried out using method 935.42 (Dry Ashing) and 930.15, respectively.

Statistical analysis

All statistical tests were 2-tailed and the alpha, α was set before to 0.05 using the Statistical Package for the Social Sciences, SPSS software (version 14.0; SPSS Inc, Chicago, IL). P value of <0.05 was considered as significant and p values<0.001 were considered as highly significant.

Result and Discussion

The crude fat contents

In the analysis of crude fat content of *C striata*, 1.76% and 1.82% of crude fat content were recorded on 0-day treatment. A reading of 1.68% and 1.51% was noticed for 0-4 days treatment and 0-7 days treatment when the samples were chilled using cubed ice. The decreasing pattern of crude fat content was also observed in the experiment by using the crushed ice treatment. The crude fat content was recorded at 1.75% and 1.54% during the 0-4 days treatment and 0-7 days treatment, respectively.

For *C. batrachus,* the initial crude fat content was recorded at 1.63% and 1.56% for treatment using cubed and crushed ice, respectively. During the period of 0-4 days, the crude fat content was recorded at 1.53% and 1.42% for both experiments. 1.28% and 1.31% of crude fat content was recorded during the 0-7 days of treatment when *C. batrachus* was treated with crushed ice.

Overall, crushed ice is more superior to cubed ice in preserving the crude fat content in both species. The research also has observed that the crude fat content decreased with increasing period of chilled storage. The findings were correlated with Gopakumar & Nair (1972). The decreased content of crude fat in both species could be as the result of leaching out of the ice of few lipids' constituents (Mahboob et al., 2019). Daramola et al., (2007) also found that the crude fat content decreases with the increasing storage time as the result of fat reduction in flesh. Oxidation of polyunsaturated fatty acids in flesh can also become another factor contributing to the decreasing content of crude fat during storage (Kaya et al., 2008). Fat is important in fish for long term energy requirements during periods of extensive movement. Fat is also important during periods of inadequate food. Freshwater fish contains high fatty acids composition compared to saltwater fish. *C striata* have been known to contain fatty acids and

protein (Januar et al., 2015; Zakaria et al., 2007). Figure 1 shows the crude fat content during the 0-day, four-days and seven-days treatment for both species.

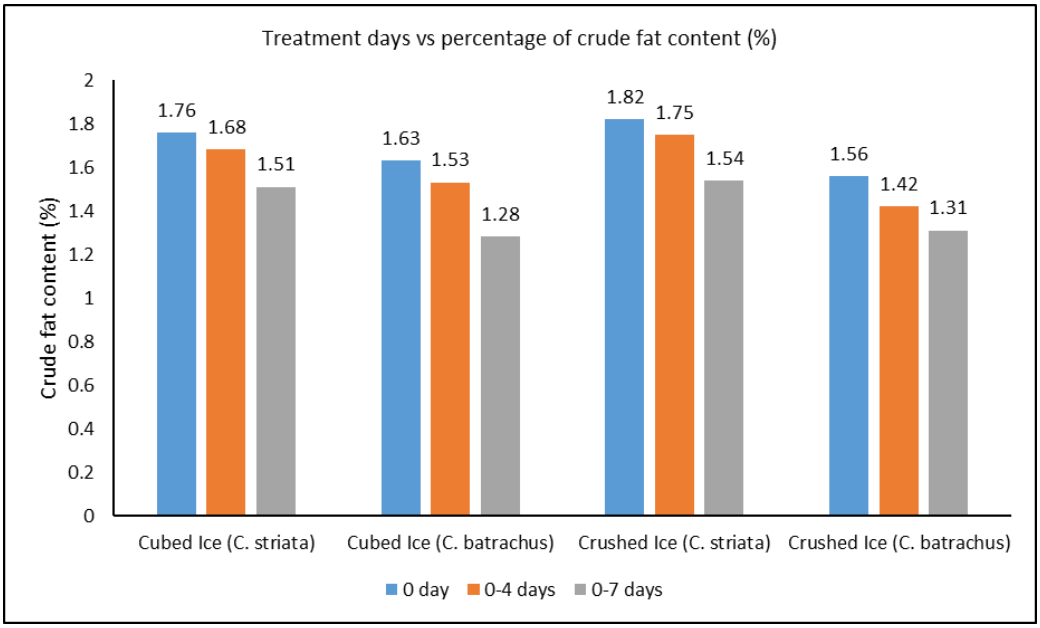

Figure 1 Crude fat content for 0-day, four-days treatment and seven-days treatment for both species treated with cubed ice and crushed ice ($p<0.05$).

The moisture contents

In the analysis of moisture content, a decrease of 80.62% and 84.34% was recorded when *C striata* were treated with cubed ice during the period of 0-4 day and 0-7 day, respectively. A decline moisture content of 83% and 85.53% was also reported when *C striata* were treated with crushed ice during the period of 0-4 days and 0-7 days, accordingly.

For *C. batrachus*, a loss of 62% and 79.74% was recorded when the samples were treated with cubed ice during the period of 0-4 days and 0-7 days consecutively. Besides, a depletion of moisture content was noticed at 85.7% and 77.3% when *C. batrachus* were treated with crushed ice during the period of 0-4 days and 0-7 days, respectively.

Overall, the analysis implies that cubed ice is superior that crushed ice in maintaining the moisture content for *C striata*. On the other hand, crushed ice and cubed ice are recommended for short-term and long-term chilled preservation of *C. batrachus*. The reducing moisture content could be the result of the loss of water holding capacity by protein in flesh. The result correlates with Dawson et al., (2018). In contrast, the increasing in moisture composition could be the result of the lost water capacity in tissue (El-Lahamy et al., 2019). Figure 2 shows the crude fat content during the 0-day, four-days and seven-days treatments for both species.

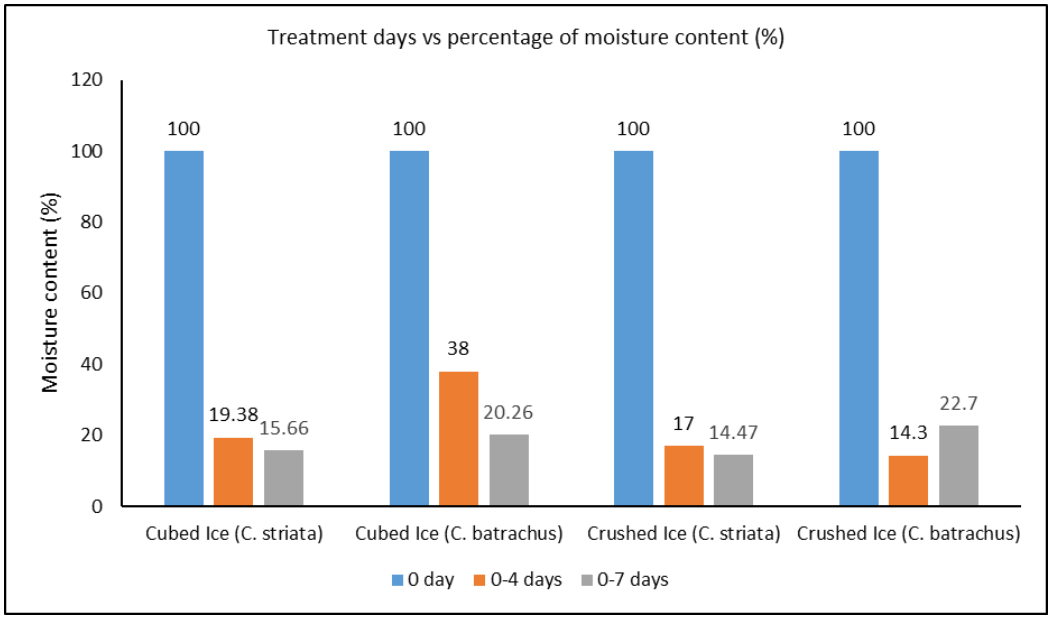

Figure 2 Moisture content for 0-day, four-days treatment and seven-days treatment for both species treated with cubed ice and crushed ice ($p<0.05$).

The ash contents

The initial weight of *C striata* were 10.89 g and 11.61g before treated with cubed and crushed ice, respectively. During the period of 0 – 4 days of treatment, the ash content of the samples was recorded at 0.85% while during the 0-7 days of treatment, 0.77% of ash content calculated when the samples were chilled with cubed ice. On the other hand, for the experiment using the crushed ice, 0.94% of ash content was recorded during the 0-4 days of treatment while 0.89% recorded during the 0-7 days of treatment.

For *C. batrachus*, the initial weight was recorded at 9.5g and 9.90g before treated with cubed and crushed ice respectively. During the period of 0 – 4 days and 0-7 days of treatment, the ash content of the samples was recorded at 0.86% when the samples were chilled with cubed ice. In contrast, for the test using the crushed ice, 0.9% of ash content was recorded during the 0-4 days of treatment while 0.88% was recorded during the 0-7 days of treatment.

The overall experiment indicates that crushed ice is more superior to cubed ice preserving the ice content. The research also found that, the ash content in all samples decreased for all treatments. The decreasing ash content by storage period has also been observed by Gandotra (2012). Emire & Gebremariam (2009) stated that decreasing ash could be contributed by drip loss during the thawing process. The fluctuation of cold storage can also contribute to the dehydration of fish samples (Dawson et al., 2018). Figure 3 shows the ash content for 0-day, four-days treatment and seven-days treatment for both species treated with cubed ice and crushed ice.

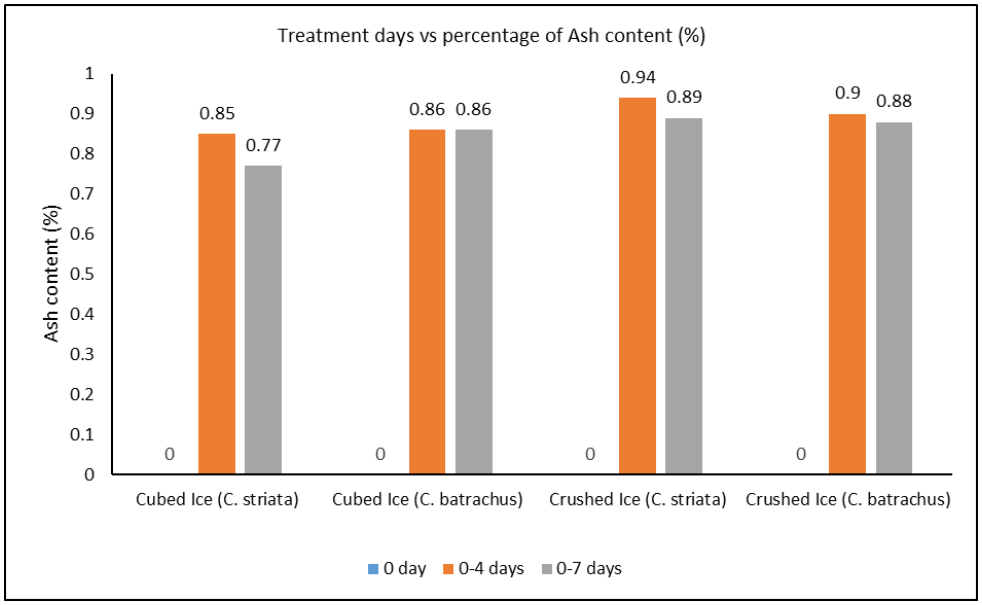

Figure 3 Ash content for 0-day, four-days treatment and seven-days treatment for both species treated with cubed ice and crushed ice ($p<0.05$).

The characteristics of ice

Physical characteristics of ice play an important role during the preservation process of fish. The rate of chilling depends on the size and ice particles (Shawyer & Pizzali, 2003). Physically, the size of cubed ice is larger than the crushed ice and this gives the advantage for the preservation of fish to last longer. Furthermore, cubed ice can compensate for thermal loss during the preservation stage. However, due to small in shapes and sizes compared to cubed ice, crushed ice can shield and wrap the fish effectively. Huss (1995) stated that the crushed ice also tends to damage the skin and flesh of fish. Crushed ice increases the rate of cooling as it has a large surface area compared to cubed ice. Shawyer & Pizzali (2003) stated that crush ice has advantages over refrigerated seawater and ice slurry during the chilling process.

Conclusion

In summary, the percentage of crude fat, ash, and moisture content decreased with increasing storage period. Crushed ice is found to be superior to cubed ice in maintaining the percentage of crude fat, ash, and moisture content for both species. The research recommends that the analysis of protein, carbohydrate, microbial analysis, etc. have been tested and the storage period is extended for a month to investigate the pattern and effects of cubed ice to the crude fat, ash, and moisture content composition of *C. striata* and *C. batrachus.*

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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