Freshness evaluation of Sharptooth catfish (*Clarias gariepinus* burchell 1842) stored in Ice Fish Box™ using quality index method


**Highlights**

- Quality Index Method (QIM) was used to evaluate freshness of Sharptooth catfish (*Clarias gariepinus*) with nine parameters and a total of 20 demerit points.
- Maximum recommended storage time for fish in Ice Fish Box™ was forty-eight (48) hours due to differences in biochemical and microbial profiles in fish.
- Regression equation was used to predict shelf life of fish quality.
Freshness evaluation of Sharptooth catfish (Clarias gariepinus burchell 1842) stored in ice fish box™ using quality index method


Nigerian Stored Products Research Institute Km 3 Asa Dam Road PMB 1439 Ilorin Kwara State Nigeria

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Abstract: Fish tend to spoil quickly after harvesting during handling, transportation and storage, thus needs intervention. Nigerian Stored Products Research Institute developed an insulated box for handling, transportation and storage of fresh fish. However, evaluation of fish quality including freshness is mostly done with the analysis of chemical and microbial parameters that are time consuming and costly. In Nigeria, no specific method exists for evaluating the freshness of fish when landed and its shelf life on ice. Sharptooth catfish (Clarias gariepinus) stored in two models of Ice Fish Box™ were assessed for freshness during storage using Quality Index Method (QIM) based on a structured scale for quality measurements to provide accurate and precise information in terms of freshness and to predict remaining shelf-life of catfish. The Quality Index scores had a correlation of 0.9839 and 0.9301 with new and old ice boxes, respectively and there was linearity between period of storage and quantity of ice with total scores of attributes such as colour, skin, gill, firmness and odour decreasing with storage time. Catfish had a shelf life of 48 hours in Ice Fish Box without further addition of ice. Based on this outcome, QIM can be used as an on-the-spot evaluation tool to evaluate freshness of fish and a useful guide for fishermen and setting standards for other stakeholders in the value chain which may enhance better post-harvest management of fish.

Keywords: quality; freshness; sensory; Quality Index Management; storage; sharptooth catfish

INTRODUCTION

Fish is rich in proteins, vitamins, minerals and unsaturated fatty acids (Rodrigues et al., 2017). Due to its physiological nature, fish is highly perishable, thus without proper handling, storage and transportation they deteriorate quickly resulting in loss of quality as a result of autolysis (Bernado et al., 2020). Global fish loss and waste is estimated between 30-35% despite advances in technologies and innovations (FAO, 2020). Fish consumption in Africa is the lowest in the world at 9.2 kg per capita despite fish contributing 18% of the total animal-source protein (Beveridge et al., 2013). Least developed countries are the worst affected due to quality of catch, lack of infrastructure and inadequate expertise leading to waste, spoilage, loss of nutrition and income. (FAO, 2020).

Quality issues such as appearance, taste, texture and odor need to be addressed in order to safeguard the health of consumers and reduce losses in the value chain which in turn influences consumer preference (Rasmussen et al., 2013). Sensory evaluation is one of the most important aspects of quality and freshness of fish and other aquatic related inspection (Bernardi, et al., 2013). Proper use of sensory evaluation gives reliable and distinct information about fish and other products (Hyldig et al., 2007). It was on this premise that Fonner and Sylvia (2014) found that consumers would characteristically show no bias in deciding the quality based on appearance, smell, origin, and vendor recommendations. Overall, consumers buy fish by assessing the quality using physical attributes. Therefore, it is necessary to maintain quality of fish to safeguard consumers’ health and retain consumers’ confidence. Thus, the need for quick and reliable techniques to measure the quality of fresh fish is imperative for increasing the market value and determines the shelf life of the fish. The quality assessment of fish (most importantly freshness assessment) protocols based on sensory features have been developed over the years. They include the European Union Scheme, the Torry Scheme and the Quality Index Method (QIM) (Rodrigues et al., 2017).

The Quality Index Management was developed by Tasmanian Food Research Unit (TFRU) Australia and improved by European Fisheries Research Institutions (Hyldig and Green-Petersen, 2004) as a tool to determine the freshness and quality of seafood. It is based on physical attributes such as colour, odour, appearance, and texture. It is a descriptive, simple, rapid and objective method of assessing sensory attributes in each specie that changes significantly during storage degradation (Ndraha, 2017). QIM uses a practical rating system in which the fish is inspected and demerit points are recorded (Sen, 2005).

This approach was derived from the understanding that during the storage of fish, the changes occur can be readily detectable and often measurable. This validates the fact that vast majority of chemical, biochemical, and microbiological tests on fish products start from either zero, or a low value and increase with both temperature and period of storage (Hyldig, 2010). The use of a scaling method establishes robust data, reflecting the different quality levels of the fish in a simple and well-documented way. The QIM is based on significant sensory quality parameters using the well-defined characteristics changes of outer appearance attributes for raw fish and a score system from 0 to 3

*Corresponding Author’s Email: the19icon@gmail.com

https://orcid.org/0000-0001-5509-6410

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demerit points (Martinsdóttir, 2002; Hyldig and Green-Petersen, 2004). The QIM scheme is advantageous among other schemes (European Union (EU) and Torry) because it addresses drawbacks in the EU grading scheme like no account on the difference between the species (Hyldig et al., 2010). It is also important in evaluating the degree or rate change of samples (Green, 2011). QIM gives scores ranges from 0 to 3 demerit index points. The summation of each parameter gives a total sensory score known as Quality Index (QI). The QI of zero represents high quality of freshness of fish and QI increases as deterioration sets in. Nigerian Stored Products Research Institute (NSPRI) developed an insulation technology for storage of fresh fish called Ice Fish Box™ in 2014. The structure consists of a small box fitted into another box with insulation between them. The insulated box uses ice as a cooling medium and with the insulator; it provides a conducive environment for effective cooling which maintains quality of fresh fish for 48 hours. The objective of this research was to assess sensory changes that occurred in catfish stored in two models of Ice Fish Box™ using Quality Index Method (QIM).

MATERIALS AND METHODS

Sample collection

Clarias gariepinus (sharptoothed catfish) of an average weight 950 g were obtained from a fish farm at Eyenkorin Ilorin, Kwara State Nigeria. The fish was transported using aerated boxes to the processing centre for set up. The insulated boxes were in two models referred to as “New Fish Box” which has a capacity of 35 kg and “Old Fish Box” with a capacity of 20 kg. The “New Fish Box” was made in 2020 as an improvement over “Old Fish Box” with distinguishing features such as better insulating material and better drain point. 17 kg of fish and 17 kg of ice were introduced into the New box while 9 kg of fish and 9 kg of ice were introduced into the Old box. Fish and ice were stacked alternately at a ratio of 1:1 (ice to fish). Ambient temperature and relative humidity and temperature in the boxes were determined using a data logger that was previously calibrated. Five fish from each box was analyzed on 12 hours basis till deterioration sets in.

Freshness Evaluation

Freshness evaluation was carried out using Quality Index Management (Hyldig et al., 2011) Seven fish were used to train five sensory panel members on the basics of QIM. The various attributes were explained in detail with an observation by the panel members. The fish were placed on a clean chopping board 20 minutes before evaluation and a specific code was given to each fish. The evaluation was carried out under strict hygienic condition in the sensory evaluation laboratory of NSPRI Processing Centre Ilorin Kwara State Nigeria under good illumination with no discussion among the panel members.

RESULTS AND DISCUSSION

The average temperature and relative humidity during the period of storage was 29.1°C and 85% respectively, while for the two boxes, the average temperature and relative humidity was 13.4°C, 79% (Old Box); 12.9°C, 75% (New Box) respectively. Quality Index scores of fish stored in the old and new boxes were presented in Tables 1 and 2 respectively, while sum of individual attributes were presented in Figures 1-6. The total demerit points in the old box were 15 points after 48 hours; 9 points were skin and appearance, 3 related to the eyes, 3 related to the gills, while the total demerit points in the new box were 10 after 48 hours; 7 points were on the skin and appearance, 1 related to the eyes, 2 related to the gills. Initially, the demerit points related to skin was zero within the 24 hours in both boxes. This could be due to the natural stiffening of the muscle, which increased with the storage period. This might be because of proteolysis, leading to softening of the muscle (Lanzarin et al., 2016; Ritter et al., 2016). The overall appearance and the quality changes could primarily be observed on the skin in the old box while it was less pronounced in the new box. The evaluation of firmness of fish flesh was performed by finger pressure on the muscle, which returns to its original form as soon as pressure was released.

The points accrued to belly in the old box had the highest points of all the attributes which was an indication of loss of stiffness attributable to microbial proliferation and biochemical changes (Castillo-Yanez et al., 2014; Pessu et al., 2016). Attributes such as eye shape, clarity, blood on gill cover, smell and general appearance remain fairly stable in both boxes during the initial storage period before they started increasing. Generally, all quality attributes presented a similar trend during the storage period showing a steady progression. Odour and colour are considered attributes that change most with the maximum demerit point during the storage period, however odour and colour were observed to be fairly low in the two boxes. Off-odour generally is the primary cause of the decrease in acceptability of fish (dos Santos et al., 2014). The significant change in odour during storage may be due to the large amounts of non-protein nitrogen, high content of fat and autolytic enzymes in fish tissues (Ndhra, 2017). It was observed that the mean scores of most attributes have increased with the storage period in ice. The scores for appearance of skin, belly, stiffness and smell showed sharp increased during the storage period in both boxes. This could be attributed to the rate of melting of ice and the ambient temperature at the time of the experiment. However, the observed attributes (Figures 1-6) were not near to the maximum values of QIM at the end of the storage period in both boxes. It was also observed that the longer the period of storage of Clarias gariepinus, it lowers the fish quality because the higher value of QIM is an indication of poorer quality which is consistent with the design of QIM.

Quality Index (QI) of Clarias gariepinus in New and Old boxes formed a linear relationship with the period of storage in ice (Figures 7 and 8). The linear relationship between QI and period in ice in the new box was: \( y = 0.1208x - 0.12 \) (R² = 0.9839), while in the old box, it was \( y = 0.0717x - 0.08 \) (R² = 0.9301), where x is the time in ice and y is QI. A linear regression between product QI and storage time has been reported previously (Okeyo,
Table 1: Quality Index scheme developed for sensory evaluation of *Clarias gariepinus* stored in ice for old box.

<table>
<thead>
<tr>
<th>Quality parameters</th>
<th>Storage time (hr)</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
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<tr>
<td>Skin</td>
<td></td>
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<tr>
<td>Blood spot on gill</td>
<td>0</td>
</tr>
<tr>
<td>Cover</td>
<td>0</td>
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<td>Stiffness</td>
<td>0</td>
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<tr>
<td>Belly</td>
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<td>Smell</td>
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<tr>
<td>Eyes</td>
<td></td>
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<tr>
<td>Clarity</td>
<td>0</td>
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<tr>
<td>Shape</td>
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<td>Gills</td>
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<td>Colour</td>
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<td>Smell</td>
<td>0</td>
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<tr>
<td>Sum of scores</td>
<td>0</td>
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(0 min, 20 max)

Table 2: Quality Index scheme developed for sensory evaluation of *Clarias gariepinus* stored in ice in new box based on storage time in hours.

<table>
<thead>
<tr>
<th>Quality Parameters</th>
<th>Storage time (hr)</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
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<td>Smell</td>
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<td>Sum of scores</td>
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</tbody>
</table>

(0 min, 20 max)

Figure 1: Mean quality index scores for skin of *Clarias gariepinus* against period in ice stored in new and old boxes.

Figure 2: Mean quality index scores for spot on gill cover of *Clarias gariepinus* against storage period in ice in new and old boxes.
2009; Hyldig, et al., 2011; Bernardi et al., 2013), which may be understood as the sum of the scores given to each of its sensory characteristics on each day in storage. The correlation of product QI and storage time showed that the attributes gradually deteriorated over time as it is assumed in the QI Method where the scores of all quality parameters were increased with the storage time (Martinsdottir et al., 2003; Borges, et al., 2013). According to Figure 2, all the attributes were not close to their maximum values given in the QIM scheme by the end of the period of storage in ice. The total QI score of thawed Greenland halibut sample reached 22.29 points after 14 days under refrigeration, during which time the fish had already deteriorated (López-Garcia et al., 2014). Evaluation on pacu (Piaractus mesopotamicus) acquired the maximum QI score of 28.4 points after 17 days (Borges et al., 2013), tambacu (Colossoma macropomum x Piaractus mesopotamicus) with 22.4 points after 16 days (Borges, A. et al., 2014), gutted Amazonian Pintado (Pseudoplatystoma fasciatum x Leiarius marmoratus) received 15.25 point after 30 days (Lanzarin et al., 2016), tambatinga (Colossoma macropomum x Piaractus brachypomum) with 15.41 points after 30 days (Ritter et al., 2016), gutted red tilapia acquired 21 points after 17 days and un-gutted red tilapia reached 29 points after 16 days (Gutiérrez et al., 2015). These variations are possibly due to the species of fish and storage conditions used. QIM gives scores of zero for fresh fish while deterioration occur as scoring increases; higher value of QI indicates deterioration which can be hastened by combination of microbial and chemical parameters.

Figure 3: Mean quality index scores for stiffness of *Clarias gariepinus* against storage period in ice in new and old boxes.

Figure 4: Mean quality index scores for belly of *Clarias gariepinus* against storage period in ice in new and old boxes.

Figure 5: Mean quality index scores for smell of *Clarias gariepinus* against storage period in ice in new and old boxes.

Figure 6: Mean quality index scores for eye clarity of *Clarias gariepinus* against storage period in ice in new and old boxes.
CONCLUSION

The regression equation could be used for prediction of shelf life of fish in insulated box. QIM scores can be used to sort fish into different categories of quality and market based on specific sensory attributes. It is therefore recommended that QIM can be used as an objective assessment tool in determining freshness of fish. Training and enlightenment should be given to stakeholders in the fish value chain for improving post-harvest management of fish. It was established that forty-eight (48) hours is the maximum storage time of fish in Ice Fish Box™.

ACKNOWLEDGEMENT

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DECLARATION OF CONFLICT OF INTEREST

The authors hereby declare there is no conflict of interest in this research work.

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Food and Agriculture Organization of the United Nations: Rome (2020). Sustainability in Action World Fisheries and Aquaculture. ISSN 1020-5489. DOI: https://doi.org/10.4060/ca9229en


