As. J. Food Ag-Ind. **2013**, 6(04), 180-192

OPEN ACCESS

Asian Journal of Food and Agro-Industry

ISSN 1906-3040

Available online at www.ajofai.info

Research Article

Development of quality index method (QIM) scheme for Arctic charr fillets and application in shelf life study simulating sea and air transport

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Abstract

The overall aim of this research was to develop a method to evaluate the freshness of Arctic charr fillets and to learn about the procedures required for the development of the quality index method (QIM). Furthermore, the aim was to study the effect of simulated air and ship freight temperatures on the shelf life of Arctic charr fillets. A QIM scheme for Arctic charr fillets was developed and used in a shelf life study of Arctic charr fillets stored at temperature simulating air (group AIR) and sea (group SHIP) freight export up to 15 days. The freshness and deterioration process of the fillets was evaluated with sensory evaluation (QIM and quantitative descriptive analysis) and microbial analysis (Total viable counts (TVC) and H_2S-producing bacteria). A QIM scheme for Arctic charr fillets to evaluate freshness was proposed. The Quality Index (QI) increased linearly with storage time for both AIR and SHIP (r = 0.8781 and 0.8846 respectively). The shelf life of Arctic charr fillets was more than 15 days based on QDA and H_2S-producing bacteria counts. However, the results indicated that the fillets were close to end of shelf life, especially AIR samples which had higher bacterial counts (both TVC and H_2S-producing bacteria counts) and hints of spoilage odours and flavours. A longer shelf life may therefore be reached by storage at steady low (-1°C) temperature which is a realistic option during sea freight, as compared to storage at fluctuating temperatures which is often the case during air freight. Therefore the results show that sea freight could be a feasible option, due to shelf life extension and cheaper way of export. Further research is proposed, including longer storage time, more sampling days and retesting of a revised QIM scheme for Arctic charr fillets.

Keywords: *Salvelinus alpinus*, QIM, post-harvest handling, seafood, Vietnam, Iceland.

Introduction

The principal method to evaluate the freshness of seafood raw materials and final products in Vietnam is sensory, chemical and microbiological analysis. The methods based on EU scheme, structured scaling, grading schemes are often used in sensory evaluation of fish but do not always provide adequate information about the fish freshness. Therefore it is important to establish a new methodology to effectively assess the quality of the products. The method should provide the necessary information,

be routinely applicable and simple in use, Quality Index Method (QIM) is still not familiar in practice in the seafood plants. QIM in Europe has widely been used in research and proven to be valuable tool in evaluating fish freshness and Europe is one of the main seafood export market of Vietnam's fisheries.
QIM is based on well-defined sensory characteristics and different scores are given for each attribute according to their importance. The scheme has descriptions of each sensory attribute, which is evaluated separately and given a score from 0 to 3. The scores are added to give a quality index. The schemes are developed in such a way that a linear relationship is between QIM-index points and storage time of fish in ice and therefore shelf-life can be predicted in an easy way [1].

The overall aim of this study was to develop a method to evaluate the freshness of Arctic charr fillets and learning about the procedure of the development of the quality index method. Furthermore, the aim was to study the effect of simulated air and ship freight temperature on the shelf life of Arctic charr fillets.

The objectives of the project will be realized by: (1) analysing and defining the parameters to be used for the development of a Quality Index Method (QIM) scheme for Arctic charr (*Salvenilus alpinus*) fillets, (2) training of panellists for the sensory evaluation of raw and cooked Arctic charr fillets, (3) studying the shelf life of Artic charr fillets stored at temperature simulating sea and air freight export, (4) comparing the results from sensory analysis (such as QIM, QDA) with microbiological test results (such as Total Viable Counts (TVC) and H_2S-producing bacteria).

The methodology to develop a QIM scheme for Arctic charr fillets will be adapted to a new species in Vietnam. This study will benefit the Vietnam fisheries sector by improving means of evaluating freshness of fish. By introducing these methods to students at Nhatrang University who will later work in the industry. The methods will be put in practice.

Materials and Methods

Experimental design

This study was carried out in two phases at MATIS, Reykjavik-Iceland between December 2010 and January 2011. Phase 1 was development of QIM scheme and QDA scale for Artic charr fillets. Phase 2 was shelf life study simulating sea and air transport.

Phase 1: Development of QIM scheme

The methodology used to develop and evaluate the QIM scheme was based on the method earlier described by Martinsdóttir, Sveinsdottir, Hyldig and Green-Petersen [2, 3, 4, 5].

For the development of a QIM scheme for Arctic charr fillets, including a preliminary observation (pre-observation) and training of the sensory panel, Arctic charr fillets were ordered from local fishmongers. The fillets were packed in 5 kg EPS (expanded polystyrene) and stored at -1 ^{0}C at Matis facilities.

Four Arctic charr fillets were observed by four panellists, including three experts in sensory evaluation using QIM scheme under development on the day 2, 6, 9 and 13 after slaughtering in two sessions. The observations of Arctic charr fillets were always carried out in the same room with as little disruption as possible, at room temperature, under fluorescent light.

Six to eight panellists participated in two training sessions. Four Arctic charr fillets from different storage days were evaluated. The storage day was given with a coded number note next to each fillet. At the end of the session, the panel was informed about the storage time.

In the first training session, the panel used the scheme developed during the pre-observation of Arctic charr fillets. The panel leader explained how to use the scheme and how to evaluate each quality parameter. Then, the panel evaluated Arctic charr fillets by themselves. The panellists had an opportunity to ask questions regarding the evaluation at any time during the session. After each session,

the panel leader and the panellists discussed the scheme and the panel leader made changes to the scheme according to their suggestions. The panellists were notified about these changes at the next session. Before the last training session, the QIM scheme for Arctic charr fillets was completed.

Phase 2: Shelf life study simulating sea and air transport

Total of 84 fillets slaughtered and processed on the 6th of January 2011 were used in the shelf life study simulating sea and air transport temperature. Arctic charr of harvest size, was purged in brackish water for a minimum of seven days prior to harvest. The fish were then transported alive to the processing plant on the southwest coast of Iceland (Samherji, Íslandsbleikja Grindavík), using a specially equipped tank car. During transport, the oxygen level of the water was controlled and closely monitored. Upon arrival the fish was pumped into a tub within the production plant where it remains alive until slaughtering.

The fish was transported to a tub containing ice water prior to bleeding. The gill arches were cut on one side and the fish bled for 15-30 minutes in cold water. The fish was then cooled properly prior to gutting and filleting. After gutting and filleting, the fillets were packed in 5 kg EPS boxes with 250 g ice packs on the top of the boxes and transported to the Matis Laboratories in Reykjavík (around 11:30 am on the same day).

Temperature loggers were used to monitor temperature outside the boxes (located on the top of the boxes) and within the boxes (located on the top of the products, in the corner of the boxes). On arrival at the laboratory on the day of packing, Arctic charr fillets were randomly divided into two groups for different treatments. The first group was stored at fluctuating temperature simulating sea freight export (SHIP) as shown in Table 1A. The second group was stored at fluctuating temperature simulating air freight export (AIR) as shown in Table 1B. During each sampling day, 10 fillets were evaluated in the laboratory using sensory evaluation (QIM and QDA) and two fillets were used for microbiological techniques. The sampling occurred 0, 8, 12 and 15 days from processing.

Table 1: Arctic charr fillets stored at fluctuating temperature simulating sea freight (A) and air freight (B) export in EPS boxes.

Step	Ambient storage temperature (°C)	Time (h)	A) Simulation of sea freight
1	2	4	Storage in the plant's chilled storage room
2	-18	16 h 30 min	Storage in the plant's frozen storage room
3	-1	4 days (96h)	Sea transportation from Iceland to Europe
4	2	Time left	Retail storage
Step	**Ambient storage temperature (°C)**	**Time (h)**	**B) Simulation of air freight**
1	2	4	Storage in the plant's chilled storage room
2	-18	16h30 min	Storage in the plant's frozen storage room
3	18	12	Air transportation from KEF airport to Europe, unchilled storage
4	2	Time left	Retail storage

Sensory evaluation of raw Arctic charr fillets

The QIM scheme was used to evaluate raw fillets of Arctic charr with skin-on in four sessions. Total 28 fillets were analysed with QIM during the shelf life study simulating sea and air transport; four fillets per group per storage day 0, 8, 12 and 15 coded with three-digit numbers without information about the storage time.

The QIM scheme developed for raw Arctic charr fillets during the training sessions was applied for the sensory analysis of raw Arctic charr. The panellists evaluated 4 fillets of each group each sampling day individually and registered their evaluation for each quality parameter in the scheme. All evaluation of the

fillets were carried out under standardised conditions at room temperature using electric light and with as little distraction as possible. The panellists had no information of the storage time of Arctic charr fillets. Each session took 20 – 30 minutes. The evaluation was carried out in 4 sessions on day 0, 8, 12 and 15 post slaughter and processing.

Sensory evaluation of cooked Arctic charr fillets

Samples for QDA of the Artic charr fillets weighing 40-50 g were taken from the fillets without skin. Three samples were collected from each Arctic charr fillet and total 36-40 samples were prepared for each session of QDA. The samples were placed in the aluminium boxes. Each sample was coded with three random digit numbers. Samples were cooked in a preheated electric oven Convostar (Convotherm GmbH, Eglfing, German) at 95-100°C for 6 minutes with air and steam circulation. After that the boxes were closed with plastic covers and then served to the panel. Each sample was evaluated in duplicate.

Microbial evaluation

For microbial evaluation, the Arctic charr fillets were taken out the skin. The flesh uesd for this experiment. Minced flesh (20 g) were mixed with 180 g of cooled Maximum Recovery Diluent (MRD, Oxoid, UK) in a stomacher for 1 minute. Successive 10-fold dilutions were done with cooled MRD as required. Total viable psychrotrophic counts (TVC) and counts of H_2S-producing bacteria were evaluated on iron agar (IA) as described by Gram and others (1987) with the exception that 1% NaCl was used instead of 0.5% with no overlay. Plates were spread-plated and incubated at 17 °C for 4-5 days. Counts were reported as logarithmic average values (log10 colony-forming units cfu/g).

Data analysis

The mean values, variance, standars deviations (SD) of QI, QDA, TVC and selective counts of H_2S-producing bacteria were plotted separately against the storage time (using Microsoft Excel 2010). Analysis of variance (ANOVA) was carried out in the statistical program NCSS 2000 (NCSS, Kaysville, UT). Duncan's multiple-comparison test was used for stepwise comparison.

Results and Discussion

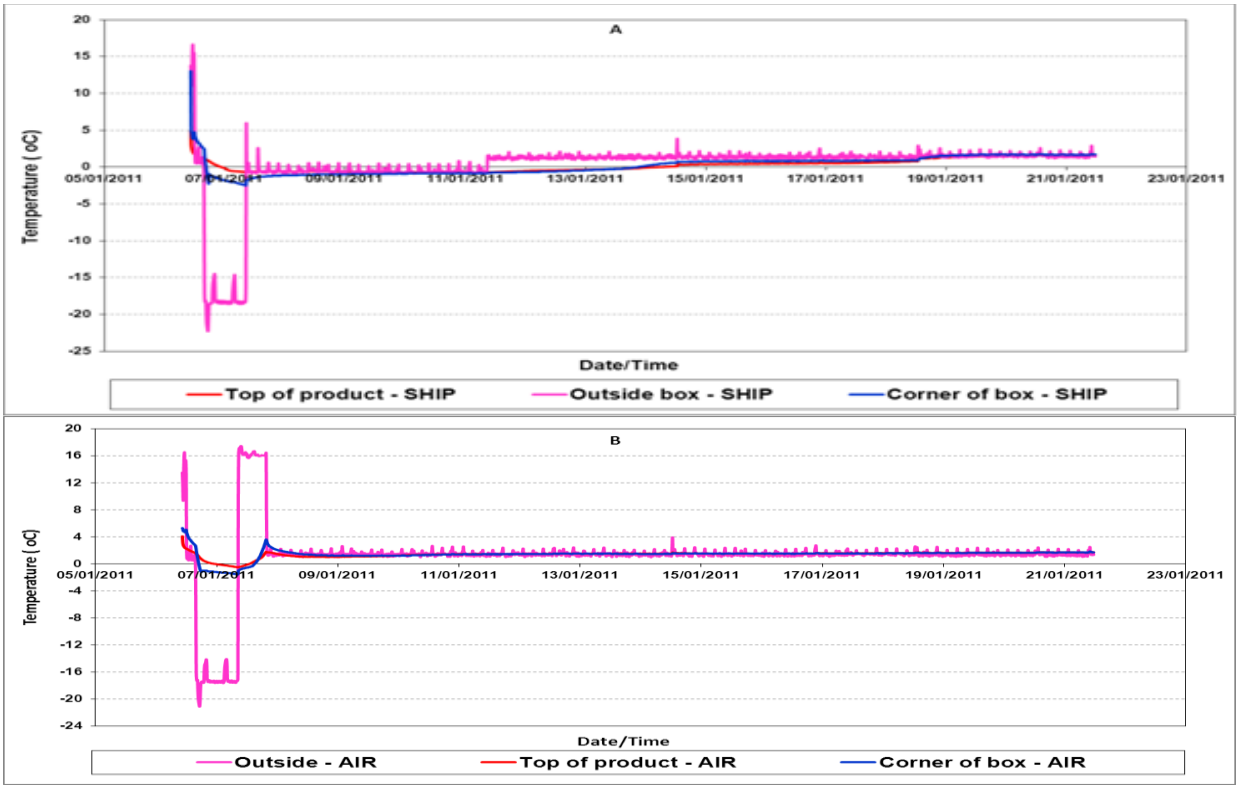


Figure 1. Temperature profile (average temperature of loggers (n = 2) per measurement location) outside box, top of product, corner box of SHIP (A) and AIR (B).

Temperature changes and the effect on the fillets during the simulation air and ship transport

At the beginning of the temperature simulation of air or sea transport, both groups were stored at -18°C for 17 hours, resulting in lowering of the product temperature from above 0 °C (1.4-3.5°C) to temperatures slightly below 0°C. In the simulation of sea transport, the ambient temperature was kept at -0.5°C for 4 days and then at 1.4°C for the remaining storage time (retail), resulting in an average product temperature of 0.5 to 0.7°C. And the simulation of air transport, the temperature was kept at 17°C for 11 hours and then at 1.4°C for the remaining storage time (retail), resulting in an average product temperature around 1.5 °C. As can be seen, the average product temperature of SHIP group were kept lower than AIR group. It is the same trends with earlier studies. The narrow increase in temperature negatively affected the shelf life of the abused lot compared to the iced fish [6, 7]. Compared to air freight transportation, temperature during sea transportation in refrigerated containers is well controlled, keeping a very stable temperature during the whole transportation process [8].

Sensory evaluation of raw Arctic charr fillets

- ***Development of QIM scheme***

Parameters that describe changes in skin and flesh were listed in a preliminary scheme during the pre-observation of raw Arctic charr fillets. The maximum sum of points was 19.

Table 2: Quality Index Method scheme developed for Arctic charr fillets (*Salvelinus alpinus)*

Quality parameter		Description	Score
Skin	Brightness	Iridescent pigmentation	0
		Rather dull	1
		Dull	2
	Colour on belly flap	Pearly white, light pink	0
		Slightly yellowish	1
		Yellowish	2
	Odour	Neutral, grassy, cucumber	0
		Melon	1
		Sour milk, spoiled melon	2
		Rotten, sulphur	3
Flesh	Texture	Firm	0
		Rather soft	1
		Very soft	2
	Odour	Neutral, fresh grass, cucumber	0
		Fresh melon, grass	1
		Sour milk, table cloth, spoiled melon, spoiled fruit	2
		Rotten, sulphur	3
	Colour	Dark red orange	0
		Orange	1
		Pale orange, yellowish	2
	Brightness	Shiny	0
		Less shiny, rather dull	1
		Dull, matt	2
Quality index (0-16)			

During the training sessions, the descriptions of skin odour, flesh odour were modified to get the best words that defined them. The gaping attribute was removed because it was not significant with simulation storage time. After the last training session, the scheme was completed. The total sum of points was 16 (Table 2). The scheme described three parameters for skin and five for flesh.

- ***Evaluation of the QIM scheme in a shelf life study of Artic charr fillets stored temperatures simulating sea and air freight export***

Individual attributes/descriptors

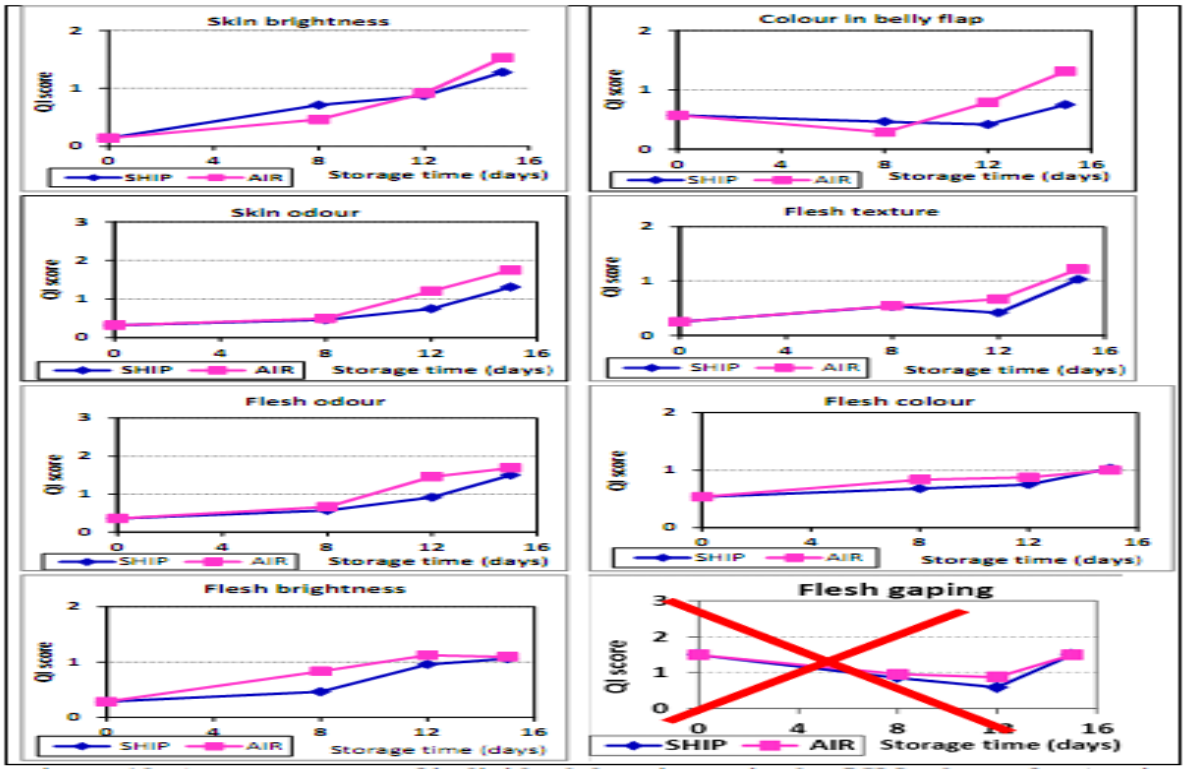


Figure 2. Average scores of individual descriptors in the QIM scheme for Arctic charr fillets stored at fluctuating temperature simulating sea (SHIP) and air freight (AIR) export.

Quality Index

The sum of the scores evaluated according to the QI scheme was presented as the Quality Index (QI). The QI was calculated for four different storage days (0, 8, 12 and 15) and increased with the storage time as shown in Figure 2 and Appendix 6.

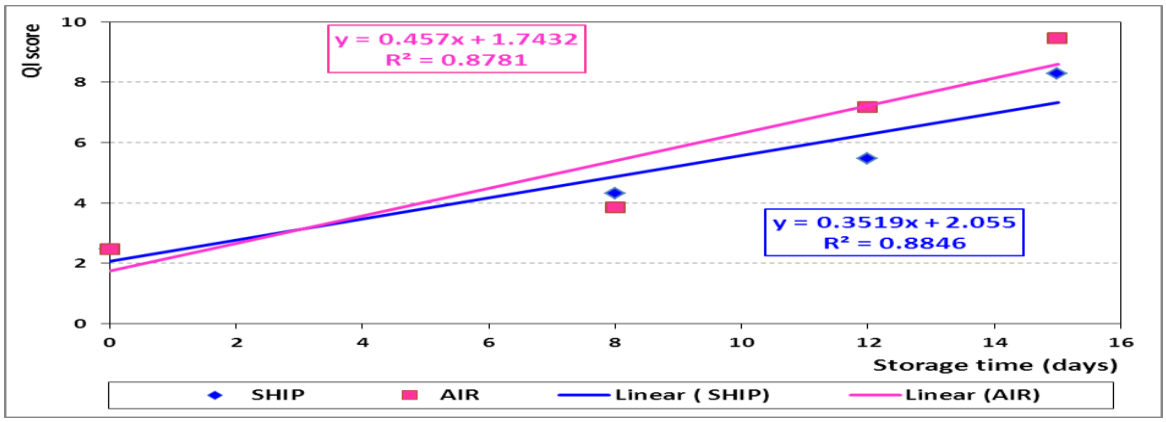


Figure 3. The linear relationship of average QI score of each storage analysed and storage time of Arctic charr fillets stored at fluctuating temperature simulating sea (SHIP) and air freight (AIR) export.

During the pre-observation, changes occurring in Arctic charr fillets were observed. In the development of the scheme, the parameters; Scores were omitted or added and some changes in the selection of words were made to describe the changes more precisely skin odour, flesh odour for getting the best words that defined them. After the development of the scheme, the total sum of the points was 16, describing 7 sensory attributes for brightness, colour on belly flap, odour of skin and texture, odour, colour, and brightness of flesh Arctic charr fillet.

The gaping parameter did not changed the same trend with the storage time such as it was high in day 0 and decreased in day 8, day 12 after that it increased in day 15 so that the linear relationship with correlation R^2 = 0.7971 for AIR and R^2 = 0.7528 for SHIP between QI score for each storage day and storage time was very low. After the remove of gaping attribute in this study, there was linear relationship with correlation R^2 = 0.8781 for AIR and R^2 = 0.8846 for SHIP between QI score for each storage day and storage time.

Quality Index showed a high correlation of R^2 =0.9727 with storage time for the well-handled (iced) whole Arctic charr in research by Cyprian [6], compared to R^2 =0.9517 reported earlier by Milanes [9]. A high correlation also shown by Bonilla [10] with R^2 = 0.9897 for cod fillets in ice. According Cyprian [7], there were the high correlation of R^2 = 0.943 for tilapia fillets chilled at 1^0C and R^2 = 0.913 for tilapia fillets superchilled at 1^0C. Bonilla and Cyprian used gaping attribute for their researches. In this study, the gaping parameter was removed because it was not correlation with storage time of Arctic charr fillets.

The Quality Index of AIR group was shown higher than SHIP group. It may be the effect of simulation temperature of two group and the sensory attributes changed different from both groups as all results in this study.

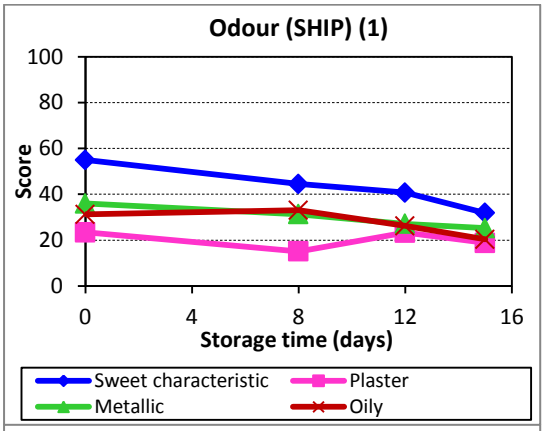
Sensory evaluation of cooked Arctic charr fillets

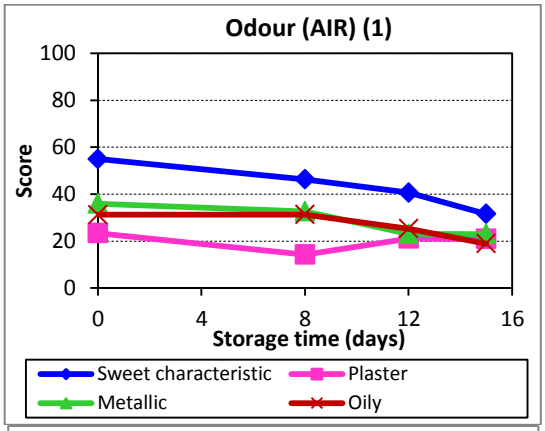
Ten panellists of the Matis laboratories sensory panel familiar with the QDA method and experienced in sensory evaluation of Arctic charr were trained to evaluate cooked Arctic charr fillets with the QDA method in one session. The panel used a list of words that described the quality parameters of odour, flavour and texture of cooked artic charr from the QDA developed by Ginés [11]. After that they observed differences in odour, appearance, flavour, texture of samples cooked fillets and developded some sensory attributes for sensory evaluation of cooked Arctic charr fillets by QDA. All sensory attributes was shown in Table 3.

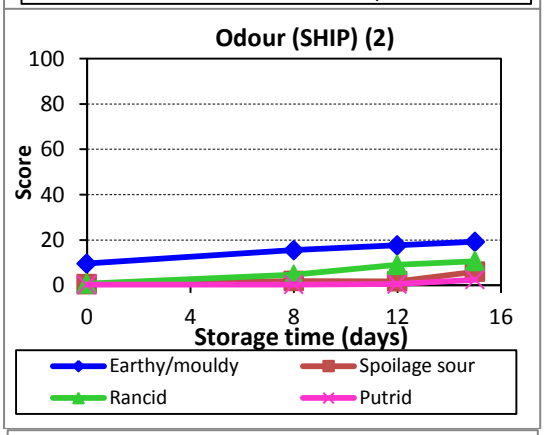
Table 3. Sensory attributes (n=25) evaluated in cooked Arctic charr fillets adopted and modified from Ginés *et al.*, 2004.

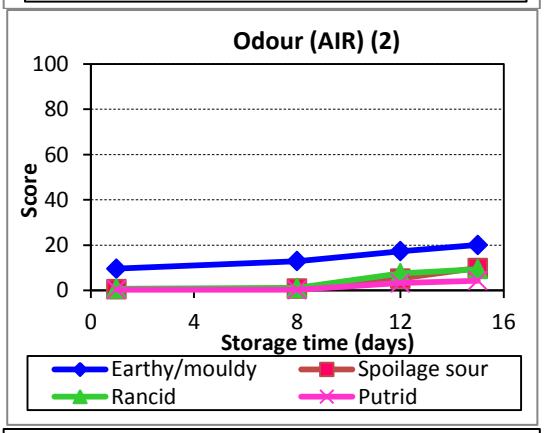
Sensory attribute	Scale		Attribute description
ODOUR			
Sweet characteristic	none	much	Characteristic sweet odour of boiled charr
Plaster	none	much	Reminds of plaster or disinfectant
Metallic	none	much	Metallic odour
Oily	none	much	Odour of fresh unspoiled oil
Earthy/mouldy	none	much	Earthy, mouldy odour
Spoilage sour	none	much	Spoilage sour odour
Rancid	none	much	Skin side, rancid odour
Putrid	none	much	Putrid odour
APPEARANCE			
Heterogeneous	homogenous	heterogeneous	How heterogeneous is the sample surface
Yellow liquid	colourless	yellow	How yellow is the liquid in the box
Fat in liquid	none	much	Quantity of fat in the liquid
White precipitation	none	much	White precipitation on the sample surface
Yellow tinge	none	much	Yellow or orange tinge or scale on sample surface
Colour	white	orange	Inside sample. How white / orange is the fish
FLAVOUR			
Sweet characteristic	none	much	Characteristic sweet flavour of boiled charr
Metallic	none	much	Metallic flavour
Oily	none	much	Flavour of fresh unspoiled oil
Earthy/mouldy	none	much	Earthy, mouldy flavour
Spoilage sour	none	much	Spoilage sour flavour
Rancid	none	much	Rancid flavour
Pungent	none	much	Pungent flavour
TEXTURE			
Soft	firm	soft	Softness in first bite
Juicy	dry	juicy	Dry: draws liquid from mouth. Juicy: releases liquid when chewed
Tender	tough	tender	Tenderness when chewed
Sticky	none	much	Glues together teeth when biting the fish.

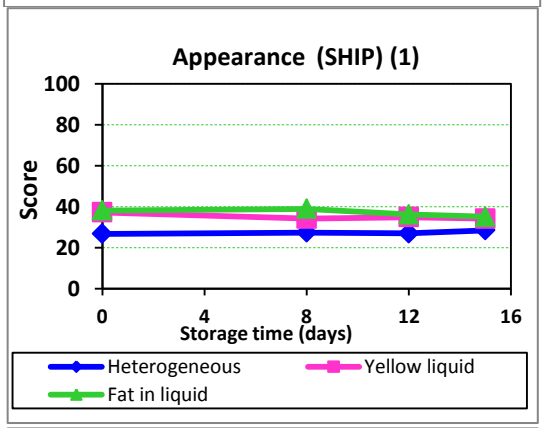
The panellists evaluated the attributes of odour, appearance, flavour, odour and texture of the samples using the list of attributes from the QDA training sessions. Mean sensory scores for the cooked Arctic charr fillets are shown in Figure 4.

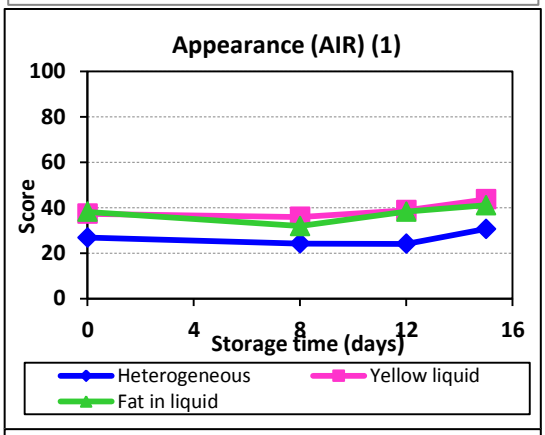

Odour (SHIP) (1)
Score
Storage time (days)
Sweet characteristic
Plaster
Metallic
Oily

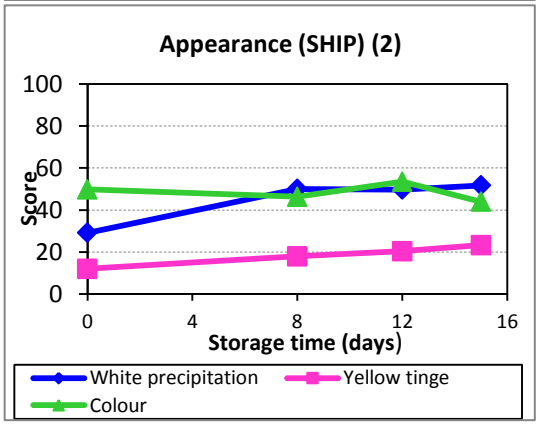

Odour (AIR) (1)
Score
Storage time (days)
Sweet characteristic
Plaster
Metallic
Oily

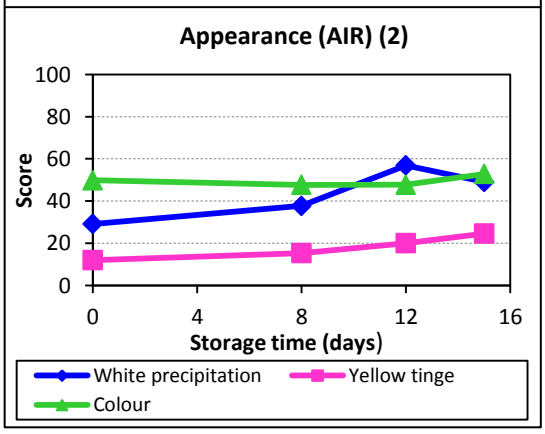

Odour (SHIP) (2)
Score
Storage time (days)
Earthy/mouldy
Spoilage sour
Rancid
Putrid


Odour (AIR) (2)
Score
Storage time (days)
Earthy/mouldy
Spoilage sour
Rancid
Putrid


Appearance (SHIP) (1)
Score
Storage time (days)
Heterogeneous
Yellow liquid
Fat in liquid


Appearance (AIR) (1)
Score
Storage time (days)
Heterogeneous
Yellow liquid
Fat in liquid


Appearance (SHIP) (2)
Score
Storage time (days)
White precipitation
Yellow tinge
Colour


Appearance (AIR) (2)
Score
Storage time (days)
White precipitation
Yellow tinge
Colour

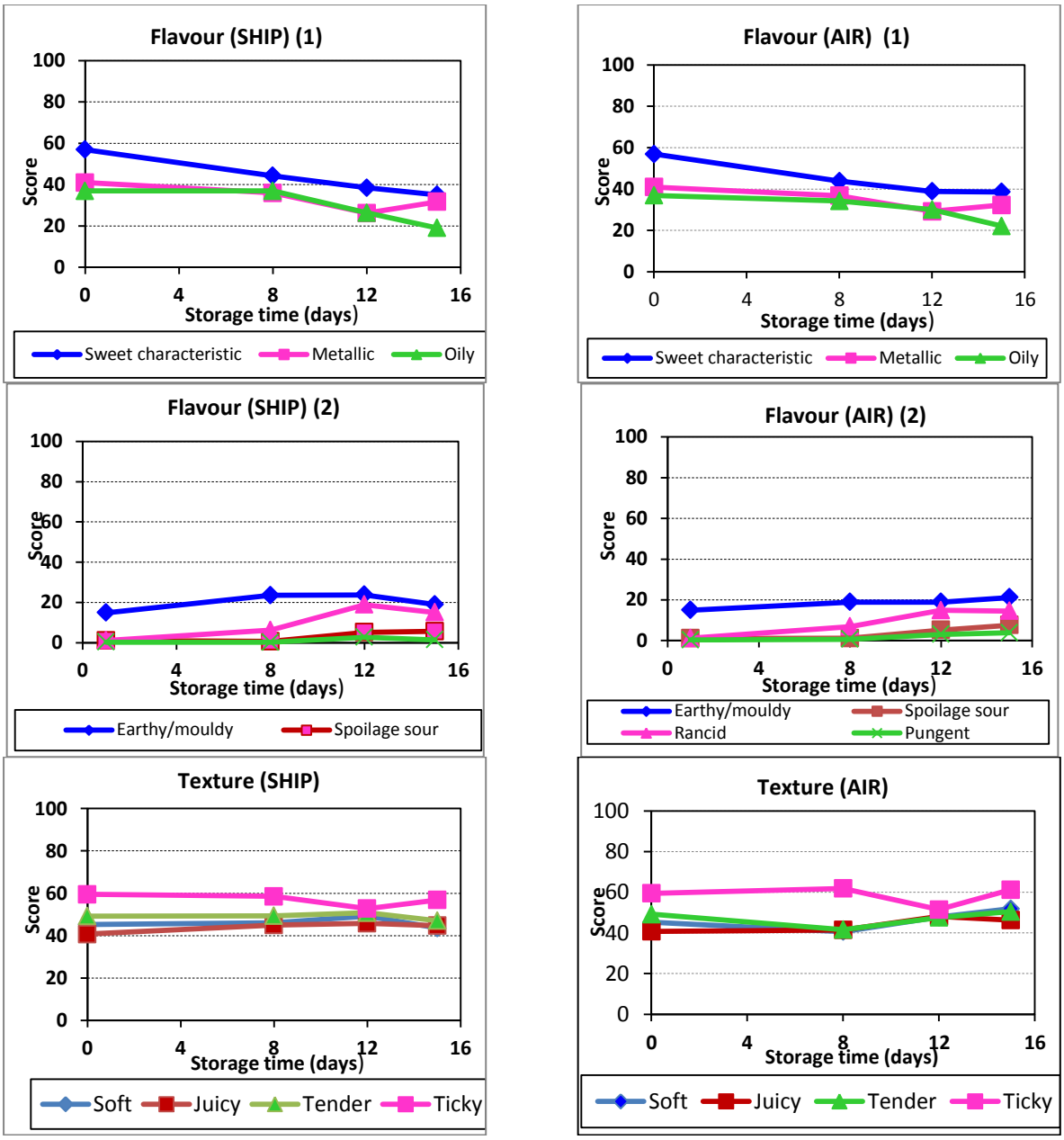


Figure 4. Changes in the mean odour, texture, appearance, flavour attributes score for Arctic charr fillets with storage time as simulation sea (SHIP) and air freight (AIR) export as observed by a trained QDA panel.

The panel used a list of words that described the quality parameters of odour, flavour and texture of cooked artic charr from the QDA developed by Ginés [11]. After that they observed differences in odour, appearance, flavour, texture of samples cooked fillets and developded some sensory attributes for sensory evaluation of cooked Arctic charr fillets by QDA. After the training sesion, the panel leader and all panellists developed the sensory attributes for cooked Artic charr fillets with 25 attributes included 8 in odour , 6 in appearance, 7 in flavour and 4 in texteur attribute as shown in Table 6. There was 16 sensory attributes for cooked Arctic charr from earlier research by Ginés [11.]

At the beginning of the storage time, Arctic charr fillet was characterised by the attributes e.g sweet characteristic, oily…and decreased during the storage time for two groups. After day 15 of storage, the rancid odour, rancid flavour increased above 10, but had no different from the other samples on day zero, 8, 12 and 15 (Table 4). The oily attribute of SHIP group were from 37 on day zero to 19 on day 15 while AIR group were from 37 to 22, the p-value was < 0.001. The spoilage sour odour attribute of AIR group on day 15 are different from the samples from SHIP group on day 15 and all samples of

day 0, 8, 12 of storage time of both group, but it was not high as around 10, the p-value was < 0.01 in this case.

According to previous studies [3, 10] end of shelf life has been determined when spoilage related attributes such as sour and rancid become evident (between 20 and 30). These limits were not reached in our shelf life study as odour and flavour related to spoilage, such as rancid, spoilage sour and putrid and pungent were all below the score 20 during the storage time. According Cyprian [7] the maximum shelf life of whole Arctic charr was 15 days for the temperature-abused fish and 17 days for fish in iced throughout the storage time.

Microbial evaluation

The microbial counts increased with storage time (Figure 4 A and B). The results show a low initial bacterial load on day zero of storage, and an increasing trend for the following days of storage in both lots.

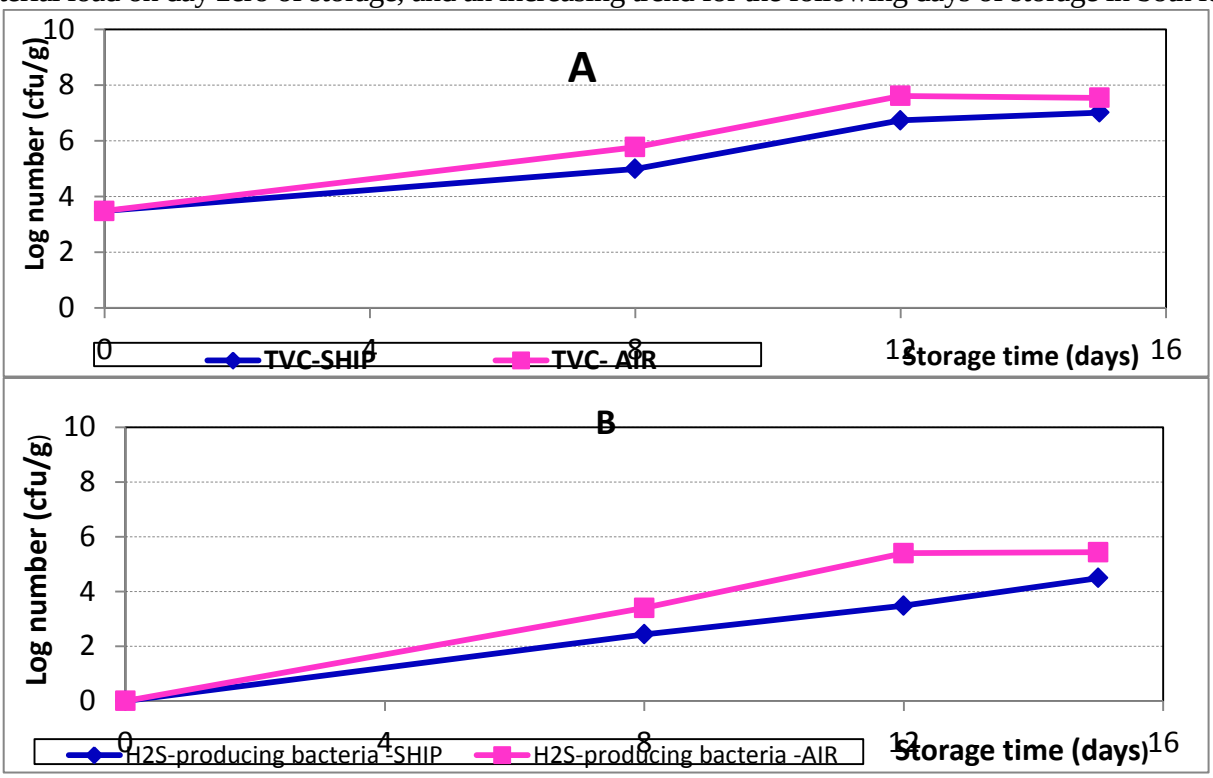


Figure 4. Total viable counts (TVC) (A) and selective counts of H2S-producing bacteria (B) in flesh of Arctic charr fillets stored as simulation ship and air freight export.

Growth curves for TVC and counts of H_2S-producing bacteria had very similar shape, though the proportion of H_2S-producing bacteria of the TVC increased with storage time. At the beginning of storage, the TVC were around 10^3 cfu/g and no H_2S-producing bacteria were detected. On day 15 of storage time, the TVC was approximately 10^7 cfu/g for SHIP but higher 10^7 cfu/g for the AIR samples. At the same time the H_2S-producing bacteria had reached around 10^4 cfu/g for SHIP and 10 5 cfu/g for AIR.

The TVC and H_2S-producing bacteria of Arctic charr flesh at the beginning of the storage time observed in this study was considerably similar to what was found earlier in studies after 15 – 16 days of storage from Huynh [12] on Arctic charr fillets storage and effect of dry ice and superchilling. The TVC and H_2S-producing bacteria of Arctic charr flesh at the end of the storage time observed in this study was similar with results from Cyprian [8] for whole Arctic charr storage at abused temperature but this result was higher than what was found earlier in studies from Milanes [9] on whole Arctic charr. All differences could be Arctic charr from different sources, different handling step, different storage temperature in shelf life.

When the number of microoganisms grows to higher than 10^7-10^8 cfu/g [13] and/or the number of H_2S-producing bacteria exceeds 10^6 cfu/g [14], significant amounts of volatile sulphur-containing compounds are produced and spoilage becomes sensorially evident. The microbial result in this study is show that the shelf life of Arctic charr fillets more than 15 days for AIR and SHIP group.

Comparison of evaluation methods

Comparing QIM and QDA results, QIM increased linear with storage time. AIR had sooner higher QDA scores for spoilage, (spoiled faster) also QIM scores higher. The microbial results shows the same trend with sensory evaluation and lower than this limit (10^6 cfu/g) suggested by Gram and Huss, 1996. Thus SHIP and AIR did not reach end of shelf life after 15 days. It is longer. It is necessary to evaluate more sessions and more storage days of the Arctic charr fillets to find big differences between sampling days and between two lots as AIR and SHIP group and also to determine the end of shelf life.

Conclusions

The simulation of ambient temperature during air and sea freight showed that the steady and low ambient temperature during sea freight resulted in lower product temperature as compared to the higher and more fluctuating ambient temperature simulating air freight. The difference in product temperature affected the quality of the groups as estimated by sensory evaluation and microbial analysis.

A QIM scheme was developed for Artic charr fillets and used in a shelf life study. A difference was found between the two groups (AIR and SHIP) used in the shelf life experiment. The linear relationship between QI (y) and storage time (x) was found by the formula: $y = 0.3519x + 2.055$ with correlation ($R^2 = 0.8846$) for SHIP (the group stored at temperature simulating ship freight) and $y = 0.457x + 1.7432$ with correlation ($R^2 = 0.8781$) for AIR (the group stored at temperature simulating air freight). The correlation between the Quality Index (QI) and storage time was rather low. The results from the shelf life study showed that the scheme need to be futher adjusted to the quality changes of Arctic charr fillets during storage time to be able to obtain a significant linear relationship between QI and storage time.

The sensory attributes of cooked Arctic charr fillets did not change much during storage time. However, attributes that were prominent during the first days of storage, such as sweet and oily odour and flavour decreased with storage and hints of spoilage attributes such as rancid odour and flavour were appearing at the end of the experiment. The samples were not rejected based on these results, as the scores did not reach levels of rejection.

The TVC and H_2S-producing bacteria counts were higher in the AIR group compared to the SHIP group. During ship transport the temperature can be kept constant and low but the time of transport longer. The results indicate that the resulting product temperature affects the shelf life. The results also indicated that the fillets were close to end of shelf life, especially AIR samples which had higher bacterial counts (both TVC and H_2S-producing bacteria counts) and hints of spoilage odours and flavours. By how much must be confirmed in a shelf life study where the fillets are kept longer than 15 days.

To develop these methods for Vietnamese species of raw fish fillets, it would be necessary to keep in mind the recommendations such as:

- The study using the QIM scheme, QDA and microbiological methods (total viable counts and H_2S-producing bacteria) from day zero (when the fish are slaughtered).
- To analyze more storage days (e.g. 0, 3, 5, 7, 9, 11, 13, 15, 17, 19…).
- To use 10 to 12 panellists in each sensory analysis session for the raw fish fillets and cooked filleted fish.
- To use three samples instead of two in the case of microbiological analysis.

Acknowledgements

The authors would like to acknowledge the financial support from United Nations University-Fisheries Training Programme (UNU-FTP).

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