The Evolution of Freshness Characteristics from Three Fish Species in the Refrigeration Period

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Abstract
The quality of fish meat is very different than animal meat. The physical, chemical and bacteriological characteristics of three different fish species (carp, pike, and catfish) were examined in this study. All of these characteristics were examined after sampling and then after 24, 48 and 72 hours of refrigeration between + 2 and + 4ºC. For all three types of fish meat the physical and chemical indicators (pH and total volatile bases nitrogen) had an ascendant evolution in this period. The values of these parameters had overrun the admitted limit after 72 refrigeration hours. The biggest values for the studied characteristics were recorded in the pike meat. The bacteriological indicators studied (mesophilic and psychrophilics bacteria) were in the limits of meat salubrity at the beginning of the refrigeration period and their values were kept at the same level for a period of 24 hours. After 48 hours of refrigeration. in the pike meat both indicators had bigger values than the meat of the others fish species. After three days of refrigeration the differences were more accentuated and this was more evident for the psychrophilic bacteria.

Key words: Fish, freshness indicators, salubrity

Introduction

In human alimentation fish represent an important proportion due to its meat quality. The fish meat has excellent sensitive qualities and a high nutritive value due to its big content in proteins and lipids with superior biological value and a high digestibility degree.

Because of the particularities of chemical composition and a special microbiologic state fish meat starts decomposing much easier than animals meat. [1,2]

The principal problem of fish meat selling consists in its quality maintenance taking in consideration its conservability. [3]

Fish meat has a high content of water, its muscle fiber is fine and with a low connective tissue. The glycogen reserve from fish muscles is low and fish meat pH is around 6.0. [3] From these properties results that fish meat is a very good media for bacteria development and for rapid alteration.

Taking in to consideration these aspects and the necessity to acquire more information in a field were there are few data, especially in the Romanian scientific literature, the study presented in this paper followed the evolution of the physical, chemical and bacteriological characteristics of three fish species in the refrigeration period.

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Materials and methods

The fishes used in this study were obtained by capture in the stream water from the South – West of Romania.
Different fish species were used in the study: Cyprinus carpio (carp), Esox lucius (pike) and Silurus glanis (catfish).
The fishes were transported to the laboratory after capture in maximum one hour, at the temperature of +10 ºC. In the experimental period the fishes were kept at the refrigeration temperature of between + 2 ºC and + 4 ºC.
The physical and chemical freshness indicators examined were: the pH and the total volatile basic nitrogen and the bacteriological ones were represented by the total mesophilic germs and total psychrophilic germs. These indicators were determinated at different time periods: after 30 minutes of evisceration, at 24 hours, at 48 hours and finely at 72 hours after that.
The sensorial characteristics were determinated in the refrigeration period after 24 hours, 48 hours and finely 72 hours.
For all of these indicators were used fillets samples from the muscle.
The methods used for physical and chemical indicators analyzing were those presented in the Romanian standard STAS 5386/ 86 and for the bacteriological ones the SR EN ISO 4833/2003. [4,5,6]
The sensorial characteristics were analyzed using methods presented in the Romanian standard and ISO methodology. [5,6,7,8,9]
The obtained results were statistically calculated and presented in tabular forms.

Results and discussions

The evolution of the physical and chemical freshness indicators obtained by analyzing the fishes from three different species is presented in table 1.

Table 1. The evolution of physical and chemical indicators of fish meat freshness from three different species

Species	Indicators	Time determination after :			
		30 min.	24 hours	48 hours	72 hours
Cyprinus carpio (carp) (n=20)	*pH*	6.00 ± 0.02	6.06 ± 0.01	6.13 ± 0.01	6.22 ± 0.02
	NH_3 mg %	8.20 ± 0.12	16.20 ± 0.18	27.02 ± 0.15	38.00 ± 0.11
Esox lucius (pike) (n=26)	*pH*	5.92 ± 0.02	6.30 ± 0.03	6.54 ± 0.02	6.76 ± 0.02
	NH_3 mg %	13.00 ± 0.08	21.56 ± 0.11	33.60 ± 0.09	43.50 ± 0.09
Silurus glanis (catfish) (n=24)	*pH*	6.08 ± 0.02	6.11 ± 0.03	6.18 ± 0.01	6.28 ± 0.02
	NH_3 mg %	8.80 ± 0.09	18.60 ± 0.11	28.15 ± 0.11	37.40 ± 0.12

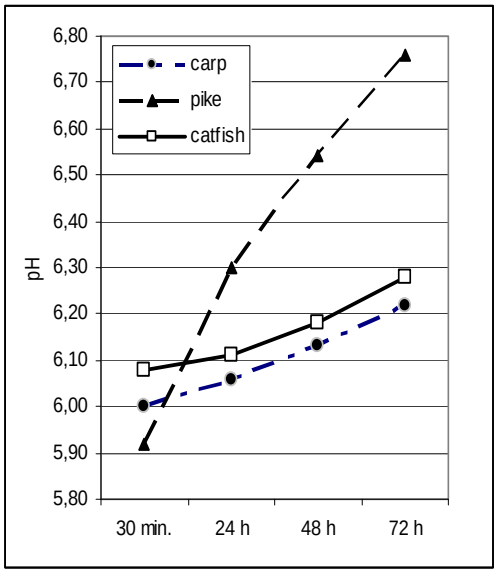

Figure 1 The evolution of pH indicator of fish meat freshness from three different species

From the obtained data was observed that the pH value after 30 minutes from evisceration of all three fish species was around 6.0, that means that these indicators are in the specific range that characterize a meat in the ante rigidity period. (table 1 and figure 1)
After 24 hours of refrigeration at temperature values of between +2 and +4 ºC the pH value in the meat of all three fish species was bigger comparatively with the anterior recorded value. Only in the meat from pike the pH value was above the admitted value presented in the norm STAS 5386/86, around 6.2. [6]
From the pH analysis was observed that the glycogen reserve from the muscle after the death of fish is a constant phenomena in all three species. This conclusion is supported the fact that in all studied species the pH value recorded a light rising after 24 hours of refrigeration. At the end

of the experiment the value of this indicator was bigger than the similar from animal meat.
The duration of fish meat ante rigidity and the muscle rigidity period were very short (under 24 hours). This aspect is very important in the fish technology because it influences the optimal period of fillets preparation.[10,11,12] The sampling of the fillets in the rigidity period is followed by breaks in the muscle and this has a negative influence on those qualities. If the fillets are obtained in the ante rigidity period they will be shortened because of muscle retraction. [13]
Because the pH values obtained in this experiment after 24 refrigeration hours was under the admitted limit (pH=6.2) or slightly above in case of the pike meat it could be considered that the standard limit imposed for this indicator (if the temperature is kept at the value imposed in the experiment) is severe and it is not in concordance with the sensorial aspects that characterize the putrefaction alteration state.
After 48 hours of refrigeration the value of the pH continued increasing but in both the carp and catfish meat did not exceed the standard admitted limit. In the pike meat the rise of this indicator was more evidenced, the pH was 6.54 ± 0.02, but the sensorial quality was not influenced.
In contradistinction to the pH value, the total volatile basic nitrogen expressed as mg NH_3 % seems to be a more truthful indicator for meat freshness. (table 1 and figure 2) The evolution of this indicator during the refrigeration period had an ascendant dynamic in all species studied.
Starting from low values in the determination from the fresh eviscerated meat (carp 8.21 ± 0.21 mg NH_3 %, pike 13.00 ± 0.08 mg NH_3 % and catfish 8.8 ± 0.09 mg NH_3 %) the value of these indicators after 24 hours of refrigeration was between 16.2 and 21.56 mg NH_3 % and after 48 hour was still under the admitted limit which is 35 mg NH_3 % In all cases after 72 hours of refrigeration the value of these indicators were above limit.
The total volatile basic nitrogen value in the meat from two studied species (carp and catfish) was slightly above the admitted limit after 72 hours even if the sensorial changes of the putrid alteration weren't present. In the pike meat after 72 hours of refrigeration the recorded total volatile basic nitrogen value was 45 mg % but in this case sensorial changes weren't recorded.
From the presented data was not established a correlation between the moment of the sensorial alteration and the indicators of freshness. Nevertheless it seems that the limit value of 35 mg NH_3 % is quite bigger, as in the case of pH.

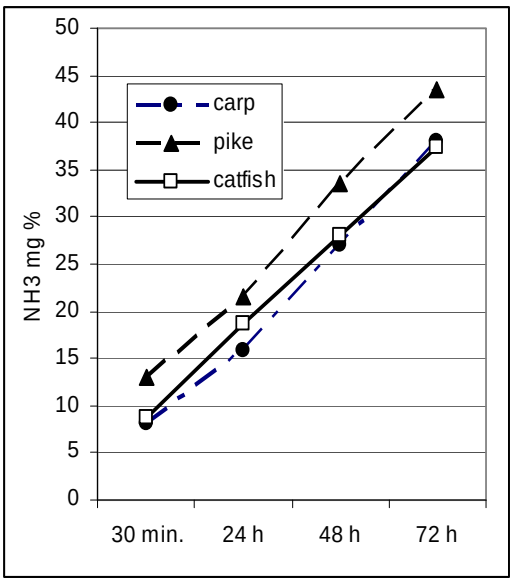

Figure 2 The evolution of total volatile basic nitrogen indicator of fish meat freshness from three different species

Table 2 shows the microbiological indicators for the salubrity obtained in this study from the three fish meat species (the total number of mesophilic germs and the total number of psychrophilic germs).
Before the refrigeration all studied species had a low level of contamination, within in the value limit of the salubrious meat (under 4 logs - SR EN ISO 4833/2003). [12]
During the refrigeration period the evolution of mesophilic bacteria in the fish meat was different dependant on the specie and the refrigeration time. After 24 hour of refrigeration were obtained values near to those initial presented. After 48 and 72 hours these values were increased.
From the data presented in table 2 it can be observed that in all examined species, indifferent to the refrigeration period, the contamination with psychrophilic germs was higher than with mesophilic germs.
Psychrophiles are bacteria with maximum growth temperature around +20 ºC and optimum temperature at +15ºC.[4] Psychophiles

Table 2. The evolution of bacteriological indicators for fish meat salubrity in the refrigeration period from three different species

Species	Indicators	Time determination after :			
		30 min.	24 hours	48 hours	72 hours
Cyprinus carpio (carp)	Mesophilic germs log (cfu/g) (n=20)	2.04 ± 0.20	2.06 ± 0.13	2.64 ± 0.12	3.16 ± 0.21
	Psychrophilic germs log (cfu/g) (n=20)	2.12 ± 0.22	2.24 ± 0.14	2.96 ± 0.18	3.78 ± 0.16
Esox lucius (pike)	Mesophilic germs log (cfu/g) (n=26)	2.16 ± 0.23	2.20 ± 0.30	3.26 ± 0.21	6.76 ± 0.02
	Psychrophilic germs log (cfu/g) (n=26)	2.26 ± 0.18	2.38 ± 0.14	3.46 ± 0.19	4.82 ± 0.16
Silurus glanis (catfish)	Mesophilic germs log (cfu/g) (n=24)	2.07 ± 0.12	2.11 ± 0.13	2.85 ± 0.18	3.26 ± 0.20
	Psychrophilic germs log (cfu/g) (n=24)	2.20 ± 0.19	2.22 ± 0.11	3.10 ± 0.16	3.88 ± 0.12

microflora of the meat during refrigeration has the some composition with which found in the fish environment.

The evolution of the total number of mesophilic and psychophilic germs is more evident in the case of pike meat. After 72 hours of refrigeration its values increased to above to the 4 log.

Conclusions

The last pH value in the meat from all three fish species is around 6.0 but the muscle rigidity is for a short period, under 24 hours.

The studied physical and chemical indicators of freshness have an ascendant evolution during the period of 72 hours of refrigeration.

In the pike meat all the studied indicators had a more obvious evolution in comparison with those from carp and catfish meat.

The bacteriological indicators for meat salubrity after 24 hour of refrigeration had the nearest values with those recorded at first examination but are continuously growing after 48 and 72 hours.

The contamination with psychophilic germs is superior to the contamination with mesophilic germs.

The bacteriological indicators from pike meat are above the value of 4 logs.

There is not an established correlation between the sensorial alteration and the physical, chemical and bacteriological indicators.

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