ABSTRACT

Key words: European catfish, refrigeration, freezing, smoking, qualitative evaluation

A Latin aphorism, „*multa paucis – much in less*", usually utilised especially in literary circles, captures in a complete way the qualitative value of fish meat. Less are foods which, related to mass unit, succeeded to be superior to fish from the point of view of nutritive values, conferred by content in proteins, amino acids and fatty acids, vitamins and mineral salts.

One of fish breeds which offer a strong fingerprint in the consumers' olfactory memory is European catfish (*Silurus glanis*). Having in view that this breed is, by excellence, ichthyophagous, difficult to be reared in large quantities, in classical aquaculture farms, its availability on market is a modest one in comparison with other breeds, fact which indirectly affect consumers' preferences. To eliminate this drawback, the great majority of the studies aimed on solving the quantity problem associated to breed, neglecting, in a certain way, the qualitative aspects.

From our information, till now, in Romania, weren't effectuated studies regarding the quality of meat gathered from these breed. So the goal of the current paper is to present, for the first time in Romania, a complete image, based on a high objectivity degree, of European catfish meat quality which was reared in two different environments. Practically, the study aim to highlight the influence of preservation and storage on sensorial, physical-chemical and microbiological features of meat gathered from *Silurus glanis* breed.

To reach the proposed target was necessary formulation and reaching of more general and specific goals, carried out in those four experimental series, as following:

First series of experiences – Knowledge of the environmental, morph-productive and quantitative features of the studied breed;

Second series of experiences – Dynamics evaluation of European catfish meat quality preserved and stored under refrigerated form;

Third series of experiences - Dynamics evaluation of European catfish meat quality preserved and stored under frozen form;

Fourth series of experiences - Dynamics evaluation of European catfish meat quality

preserved by smoking and stored in refrigeration conditions.

Because fish meat quality could be influenced by internal factors (breed, race, age, sex etc), and also by external factors (environmental conditions) the obtained results for **first series of experiences** provided information of a great importance for understanding and processing of the data utilised in the next experimental series.

The biological material studied in the current paper has two provenience sources, represented by natural environment, Prut River (river segment afferent to Iaşi County), on one hand, and by Acvares fishery farm, on the other hand. Relief of both locations is characteristic to floodplain areas, with influences from Moldavian Plateau. Climate is moderate temperate continental, precipitation regime being moderate due to area position outside Carpathian arch which prevents air flows of oceanic origin.

Water physical-chemical parameters are quite similar in both locations, having in view that the main water supply source of fishery farm is represented by Prut River. So, function of studied location, water pH varied between 7.1 and 7.9, dissolved oxygen presented concentrations between 4.09 mg/l and 10.12 mg/l, while temperature oscillated between 9.2°C and 25.5°C during yearly period March – October 2013.

After were established the environmental features, research were carried out on the studied breed in this paper, namely European catfish (*Silurus glanis*). So through corporal and morph-metric determinations were enlightened similarities and differences between individuals from the same breed, but with different sources of provenance. In according with literature, but also with the availability on market, were studied individuals with a corporal mass of around 2000 g. Corporal determinations show that weight of biological material selected for the further experimental series varied between 1304.78 g and 2110.15 g. Morph-metric determinations represented by total length, standard length, length of head, thickness, height and maximal circumference of body indicate the existence of some differences with statistical signification for heads' dimension, total length and maximal height of body between the batches related to those two different rearing environments.

At the end of somatic measurements were calculated a series of corporal indexes aiming to deduce the corporal format, fish maintenance state, as well as their adaptability to assured environment conditions. So the calculated profile index for each batch recorded a mean of 5.40±0.23, while at fishes gathered from wild environment was obtained a mean value of 6.70±0.25, which prove the fact that in rearing unit is realised a selection for European catfish population.

Fulton coefficient obtained mean values between 0.90±0.08 (La) and 0.87±(0.08) (Lc) (*fig. 5.10*), minimum for both batches being 0.75 and maximum of 1.08.

Calculation of Kiselev index indicated a mean value of 1.90±0.04 for catfishes from batches „La", while at individuals from batch „Lc" recorded a mean of 1.89±0.13 for this index.

Mean values for thickness index were 64.56±3.38 for aquaculture fishes and of 71.63±7.32 for wild fishes. Associating those values with the ones for profile index could conclude that between those two populations exist differences regarding corporal format, because for similar values of corporal mass and body standard length, maximal total length of fishes from Prut River is significantly reduced, without having negative repercussions on thickness of fish musculature.

Carnosity index presented mean values of 19.52±0.84 for fishes from batch „La" and 20.70±1.30 for fishes belonging to batch „Lc". This values show a greater rate of head related to fish standard length for wild fishes face to the ones reared at aquaculture farm.

Because in the case of the current research we tried to present fish quality from alimentary perspective, establishment of proportions between anatomical regions function of their economical value was a very important determination. So for fishes reared at Acvares aquaculture farm, carcass represented 89.55±0.20%, trunk 64.96±0.43%, and fillets 46.23±0.12% face to their life weight. Fishes capture in Prut River obtained an outturn in carcass of 61.08±0.25, and in fillets of 45.11±0.42%. At the opposite pole, less appreciated by consumers were situated head, fins, gills, backbone and skin. Rate of those anatomical portions in total corporal mass could be expressed as follows, for the both batches: head > backbone > skin > fins > gills. Summing the mean values of those organs, could be observed that from the initial corporal mass of the studied biological material, 39.69% (La), respectively 43.91% (Lc) is represented by anatomical regions which, usually, consumer didn't use. If at these rates is added the weight of visceral mass, which varied between 9.01% and 9.24%, it can be said that at European catfish muscular tissue represent around 1/2 from its live mass.

The following experimental series were focused on application of three preservation methods applied to skinless fillets, as well as on their influence on meat quality from sensorial, physical-chemical and microbiological perspective.

So the **second experimental series** consisted in evaluation of quality dynamics for European catfish meat preserved and stored under refrigeration form during 15 days. To reach the goal were established six sessions of evaluation (every three days), when the biological material was analysed from sensorial, physical-chemical and microbiological point of view.

To apply sensorial analysis was utilised qualitative appreciation method by scoring adapted after *Quality Index Method*, on a scale between 0 and 14 penalty points, where reaching of half score (7 points) indicated the maximal limit for quality acceptability for the evaluated product. Analysed sensorial attributes were: texture, presence of blood (tracks), smell, colour,

brightness and consistency. During those six evaluation sessions penalty point had an ascendant trend, directly proportional with storage period. If in 1^{st} interval of storage the samples from both batches obtained the maximal quality score (0 penalty points) in the last storage day (6^{th} interval) their quality was appreciated with 13.5 penalty points from a total of 14 points. Storage period coincided with the third storage interval when the evaluated samples cumulated 5.00, respectively 4.17 penalty points, function of provenance source of biological material.

Indicators for freshness state of European catfish meat stored under refrigerated form were pH, NH_3, as well as reactions Eber, Nessler and H_2S. In correlation with sensorial analysis all those determinations qualified samples as being „*relatively fresh*" in the 3^{rd} storage interval and for the next interval to be qualified as „*altered*".

Establishment of total viable count (TVC) represented a quantitative determination of micro-flora which develops in stored samples under refrigerated form. The obtaining of a quantity which varied between 3.82±0.31 $\log_{10}$ ufc/g^{-1} (La_1) and 4.10±0.23 $\log_{10}$ ufc/g^{-1} (Lc_1) after slaughtering of biological material show that hygienic-sanitary norms were respected in processing process of fish meat. In according with the limits cited in literature obtaining of a microbiological charge between 5 and 7 $\log_{10}$ ufc/g^{-1}, represent the maximal admitted quantity in fish meat destined to be consumed. In according with our analysis those values were reached between 2^{nd} and 3^{rd} storage intervals, which confirm, one more time, the truthfulness of the results enlightened by the other methods utilised in evaluation of freshness level of samples stored under refrigerated form.

Establishment of chemical composition of muscular tissue for the studied breed enlightened the fact that both moisture, as well as dry matter recorded a descendant trend during storage. So, function of provenance source of biological material, water from product was diminished between 6.72% and 6.90%,protein quantity decreased between 4.55% and 4.91%, lipids quantity between 0.76% and 1.00%, while ash quantity decreased between 0.07% and 0.10% face to the initial values, after 15 days of storage. Those significant depreciations of the dry matter constituents, shown the fact that store of product under refrigerated form imply not only a quantitative depreciation, but especially a qualitative one.

Using the same evaluation methods like in case of refrigeration, **third series of experiments** enlightened the influence of preservation by freezing on quality of European catfish meat, stored under this form for 12 months. So, evaluating the sensorial characteristics represented by texture, succulence, smell, colour and consistency, sensorial analysis establish as a maximal acceptability period for consumption of European catfish meat preserved by freezing, a period of 10 months from the start moment of process, moment in which samples gathered

from aquaculture farm cumulated 7.00 penalty points, while biological material gathered from Prut River cumulated 6.67 penalty points.

The same maximal storage period was indicated through analysis of meat pH, which obtained mean values in 5th storage interval between 6.79 and 6.80 function of provenance source of biological material. Instead, at analysis of NH_3 quantity (mg/100g) founded in stored samples, weren't observed over-passes of the maximal level recommended by literature (> 25 mg/100g), having in view that during the last storage interval this indicator varied between 22.74±1.83 mg/100g, respectively 23.30±0.72 mg/100g. However, through interpretation of Eber, Nessler and H_2S reactions, was observed a state of „*relatively freshness*" after 10 months of storage for samples under frozen form.

Evaluation of total microbiological charge (TVC/g) in those six storage intervals didn't show over-passes of the acceptability maximal level for unprocessed fish products, having in view that at the end of those 12 months TGN reached maximal values between 5.01±0.10 $\log_{10}$ ufc/g (La_6) and 5.08±0.14 $\log_{10}$ ufc/g (Lc_6).

Dynamics of the main constituents of chemical composition, shown that effects of freezing as storage form for fish meat reverberate on quantity and implicit on quality of evaluated samples. So after 12 months of storage, at defrosting, samples lost water between 12.16% and 12.37% face to initial quantity, while the main constituents of dry matter suffer losses, as follows: ash < 0.13% - 0.24%; proteins < 6.15% - 6.86%, lipids < 1.34% - 1.85% face to quantities founded in the product obtained just after slaughtering.

The 4th experimental series deals with the results regarding quality dynamics for European catfish meat preserved by smoking and stored in refrigeration conditions. Qualitative evaluation of final product was enlightened using the same criteria detailed in the frame of previous experimental series.

European catfish fillets processed by cold smoking were evaluated by a team composed by six members, utilising a hedonic scale with simple score, between 9 and 1 qualitative points. By summing the mean points for each sensorial feature, as by applying of some importance and transformation coefficients, global quality of product was establish based on the qualitative evaluation scale for foods (0-20 points).

The evaluated sensorial features were: general aspect, colour, smell, taste and consistency. In according with the interpretation offered by score scale for global quality appreciation of fish preserved by smoking, this one was considered as being „*very good*" at beginning of storage period, „*good*" after 15 days and „*satisfactory*" for the next 3 storage intervals. Total mean score for 5th storage interval, which sum 11.3 points (La_5), respectively 11.4 points (Lc_5) is placed at the inferior limit of scoring scale for qualitative evaluation, for

qualification *satisfactory*, which show the fact that product still can be consumed, but couldn't be delivered anymore. Those 6.1 points (La_6), respectively 6.3 points (Lc_6) fulfilled by the batches from last storage interval shown that analysed samples are inadequate from qualitative point of view, being classified as „*altered*".

Even if in case of fish meat processed under a form of superior capitalization, pH didn't represent a concluding indicator for freshness state, enlightening of the obtained values for this parameter have an important role, because meat acidity is in a close connection with other qualitative indicators such as: tenderness, succulence, colour, water retain capacity and microbial stability. Samples gathered from Acvares aquaculture farm reached mean values for pH between 6.31±0.12 and 6.38±0.07, while for batches with individuals of European catfish captured in Prut River were recorded variations for this index between 6.32±0.09 and 6.39±0.07. These values are characteristic for smoked products, with low water content.

Instead, actual legislation and literature consider the values of nitrogen compounds as an indicator for appreciation of freshness state for fish meat processed by smoking recommending the existence of a maximal quantity of 65 mg NH_3/100g in the product destined for consumption. Mean values for NH_3 had an ascendant trend during time passing. So, those one varied between 34.30±1.54 mg/100g and 40.80±3.03 mg/100g for fishes reared in anthropic system, respectively between 32.42±2.45 mg/100g and 40.47±1.50 mg/100g for fishes gathered from wild environment. Minimal quantity of NH_3 was founded inside batch Lc_1 (29.87 mg/100g), and the maximal one inside batch La_6 (48.15 mg/100g). Rating the obtained values at the limits indicated in literature was observed the fact that, in according with this indicator, evaluated product was conformable during whole storage period. Instead **reactions Eber, Nessler and H_2S** show a relatively fresh product after 35 days from slaughtering moment and altered in the last storage interval.

Quantitative evaluation of total viable count (TVC/g) highlight the fact that even after application of preservation method, bacterial micro-flora from the samples' surface recorded a decrease face to fresh meat, due to bactericide action exercised by smoke compounds, after 30 days of storage of smoked meat in refrigerated conditions were cumulated quantities which are equivalent with the maximal limits cited in literature for this indicator.

In contrast with the other two previous evaluated methods for preservation (refrigeration and freezing) analysis of macro-elements which are included in chemical composition of European catfish meat processed by cold smoking, enlighten the fact that while water content from product decrease with around 20% face to un-processed meat, dry matter is proportionally concentrated representing around 40% from final product.

At the end of preservation process, water content in samples varied between

60.78±1.94% (La_1) and 59.72±1.60% (Lc_1) and at the end of storage period this content to decrease 57.87±1.86% in case of aquaculture samples, respectively at 56.91±2.02% in case of the ones gathered from Prut River.

The main constituents of dry matter obtained the following mean values at the end of preservation process: ash = 2.21±0.06% (La_1) – 2.17±0.07% (Lc_1), proteins = 27.20±1.42% (La_1) – 28.60±1.38% (Lc_1), lipids = 9.82±0.19% (La_1) – 9.52±0.41% (Lc_1). After 35 storage days of final product all those three elements recorded losses, reaching the following mean values face to the initial quantity: ash = 1.81±0.17% (La_6) – 1.97±0.13% (Lc_6), proteins = 26.50±0.59% (La_6) – 27.70±1.07% (Lc_6), lipids = 8.88±0.36% (La_6) – 8.53±0.43% (Lc_6). In comparison with the other two preservation methods utilised in the current study this reduced degradation rhythm of the final product is due to the great water losses during application of preservation method, when processes specific to the method (drying, salting), as well as the itself smoking influence in a great manner only water content and not the other tissue constituents, which are predisposed to degradation together with installation of altering processes.

The obtained results presented in the current study give us the possibility to say that both applied preservation methods, and especially storage period influence in a decisive and different way the studied biological material, both under quantitative aspect, as well as under qualitative aspect.