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## The run of changes in nitrogen compounds in the muscle tissue of ducks frozen without cooling (model studies)

T. SMOLIŃSKA, T. TRZISZKA, W. KOPEĆ

Institut of Food Storage and Technology, Agricultural Academy, Wrocław, Poland

### Introduction

Numerous studies show that the most extensive changes in the frozen muscle tissue are observed in the protein fraction [1,3,4]. They consist mainly of disorganization processes of molecules structure. The character of denaturation changes is determined by a creating factor. Denaturation changes caused by the effect of low temperatures manifest themselves by changes in the structure of muscle tissue as well as concern nitrogen fractions.
Proteolytic changes of proteins affect physicochemical and organoleptic properties of meat. Dynamics and scope of proteolytic changes is always a resultant of the degree of intensity of biochemical transformations in muscle tissue before and immediately after slaughter of the animal.

The studies undertaken aimed at examination of the dynamics of proteolytic processes in breast muscles of duck subjected to different systems of freezing. The studies were based on determination of changes occurring in proteins on the basis of their degree of degradation in particular stages of the research as well as determination of changes in the fraction of myofibrilar and sarcoplasmatic proteins on the basis of electrophoretic picture.

### Material and methods

The research material consisted of broiler duck carcasses uniformed with regard to age (9 weeks), origin, weight and selected on the basis of the value of pH 6.5 - 6.6 in the breast muscle at 22 min. p.m. [5]. Three different variants of freezing were adopted:

1. Industrial freezing:
   - duck carcasses were subjected to cooling and freezing in accordance with the Polish Industrial Standards [9].
   The process of freezing to $-38^{o}C$ was begun in 90 min. p.m., at the initial temperature in the breast muscle of $+8^{o}C$. The process of freezing was continued for 6 hours.
2. Freezing of duck carcasses when warm. The same procedure as in variant 1, with the cooling process omitted. The process of freezing was begun in 45 min. p.m., at the initial temp. in the breast muscle of $+32^{o}C$. The freezing was continued to $-12^{o}C$ for 7 hours.
3. The model freezing of carcasses in solid $CO_2$ by the contact method. The freezing process was begun 45 min. p.m. at the initial temp. of $+32^{o}C$ in the breast muscle. The freezing was continued to $-12^{o}C$ for 3 hrs.

The carcasses frozen in these variants were then subjected to cold storage in $-20^{o}C$ for 3 and 6 months. For control tests were taken carcasses not frozen, i.e. warm carcasses 30 min. p.m. and cooled carcasses 75 min. p.m.
Before the tests began the frozen material was defrozen in $4^{o}C$ until $0^{o}C$ was achieved in the breast muscle. Samples for tests were prepared from both breast muscles. The tests covered content of total nitrogen by Kjeldahi procedure, content and changes of amine nitrogen [2], content and changes referring to sarcoplasmatic and myofibrilar proteins [7], and changes in particular fractions of sarcoplasmatic proteins on the basis of electrophoretic separation [8]. The electrophoretic analysis was carried out for variants 1 and 2.

### Results and discussion

Results obtained in the experiment are shown in tab.1,2 and diagram 1.

Total nitrogen, amine nitrogen.

The initial level of total nitrogen, before the freezing and cooling processes was in average about 20% with relation to dry matter. In general we may state that amount of total nitrogen did not change regardless of the system and the time of freezing applied. Changes occurred only during the period of storage. It was found that up to the 3rd month of storage for the variants of ducks frozen with cooling and without cooling a statistically significant decrease of total nitrogen had taken place. In the further

period of the experiment, i.e. between the 3rd and 6th month of storage, for all three variants the decrease of total nitrogen was statistically significant at ( = 0,01). A comparison between the studied variants did not show any significant statistical differences.

Presented results point to a constant increase of amine nitrogen and both time and the variant of freezing affected the process of its accumulation. As soon as 3 months of storage in all the variants the amount of amine nitrogen doubled as compared to the initial tests. The slowest accumulation of amine nitrogen took place in the group of ducks frozen without cooling and this content differed significantly from the remaining findings. Obtained results are in conformity with Khan's [3] research who showed that in the breast muscles of hens frozen and stored amine nitrogen increased by 1-2%.

Sarcoplasmatic and myofibrilar proteins.

The freezing process for ducks frozen without cooling did not affect significantly quantative changes in sarcoplasmatic proteins, whereas the freezing had a significant effect for the variant of ducks frozen with cooling ( = 0,05). Cold storage for 3 and 6 months causes changes statistically significant in sarcoplasmatic proteins regardless of the freezing system applied. The observed quantative changes in sarcoplasmatic proteins allow to assume that activity of proteolytic enzymes was not inactivated by the effect of low temperatures and change of pH in the muscle tissue. The effect of proteolysis presented in literature [1,3,4] heightens as the period of cold storage lengthens.

In the studies carried out no significant effect of the freezing process on changes in myofibrilar proteins was found. Yet, in the course of the cold storage denaturation changes deepened proportionally to the lengthened period of storage.

Electrophoretic analysis

The changes of proteolysis and denaturation which took place in the course of freezing and cold storage manifest themselves not only by the change of the content of the components but also by a different electrophoretic separation.

As the research by (Smolińska et al.[1979]) shows uniformity of proteins determined by electrophoretic method changes with the change of pH in the environment, the change of ion strength or the effect of dilvents. Nonuniformity is manifested by appearance of several fractions each of which has a different molecular mass. The electrophoretic analysis of proteins showed that within myofibrilar proteins the basic fractions were obtained in the range of 13-150.000 daltons.

In the course of freezing and cold storage denaturation processes in myofibrilar proteins were not too intensive.

Comparing the results of electrophoretic and densitometric analysis practically no differences between the muscle tissue of duck frozen when warm and frozen after cooling had been found.

Sarcoplasmatic proteins showed increased electrophoretic mobility of globuline and albumine fractions. Three groups of fractions were obtained in the range of molecule mass from 10.000 to over 86.000 daltons.

Particularly in the period of cold storage an increased dynamics of changes within specific groups of fractions could be observed, greater than immediately after the freezing process. This is confirmed by results obtained from quantative findings of sarcoplasmatic proteins.

Greater dynamics of changes within globuline fractions was observed in the breast muscles of ducks frozen when warm. A smaller share of peptide fraction was found in the period of storage, so we can conclude that the dynamics of proteolysis processes is greater in this group.

Run of changes in nitrogen compounds of duck breast tissue subjected to freezing after cooling [%]

Table 1

| Nr | Duck carcasses | | Total protein | Amine nitrogen | Sarcoplasmatic* protein | Myofibrylar* protein |
|---|---|---|---|---|---|---|
| 1 | After cooling (75 min. p.m.) | $\bar{x}$ | 20,06 | 2,37 | 28,04 | 53,20 |
| | | s | 0,17 | 0,04 | 2,44 | 6,23 |
| 2 | After freezing (24 h p.m.) | $\bar{x}$ | 19,92 | 2,42 | 26,72 | 52,77 |
| | | s | 0,22 | 0,08 | 3,45 | 6,38 |
| 3 | After 3 months of cold storage | $\bar{x}$ | 19,30 | 4,14 | 23,02 | 52,12 |
| | | s | 0,15 | 0,04 | 3,09 | 5,07 |
| 4 | After 6 months of cold storage | $\bar{x}$ | 18,57 | 6,82 | - | - |
| | | s | 0,11 | 0,14 | - | - |

* recalculated into dry matter

Run of changes in nitrogen compounds of duck breast tissue subjected to freezing with cooling [%]

Table 2

| Nr | Duck carcasses | | Total protein | Amine nitrogen | Sarcoplasmatic* protein | Myofibrylar* protein |
|---|---|---|---|---|---|---|
| 1 | Warm (30 min. p.m.) | $\bar{x}$ | 20,14 | 2,30 | 28,95 | 53,90 |
| | | s | 0,41 | 0,08 | 1,10 | 6,54 |
| 2 | After freezing (24 h p.m.) | $\bar{x}$ | 19,95 | 2,36 | 27,56 | 53,30 |
| | | s | 0,07 | 0,09 | 1,72 | 6,21 |
| 3 | After 3 months of cold storage | $\bar{x}$ | 19,13 | 4,01 | 23,48 | 52,11 |
| | | s | 0,01 | 0,07 | 3,57 | 2,62 |
| 4 | After 6 months of cold storage | $\bar{x}$ | 18,39 | 5,92 | - | - |
| | | s | 0,33 | 0,13 | - | - |

* recalculated into dry matter

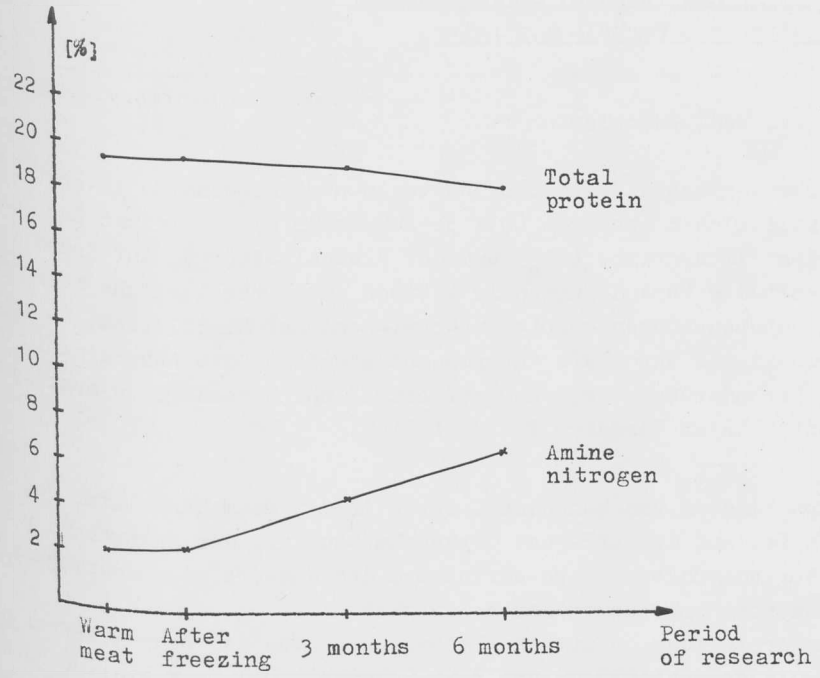


Diagram 1. Run of changes of total protein and amine nitrogen in muscle tissue subjected to freezing when warm. The model freezing in solid $CO_2$.

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