

## REFRIGERATION, FREEZING AND THAWING

P7.

STUDIES ON THE CHANGES IN THE RETINOL AND THIAMIN CONTENTS  
OF PORK LIVER AND MUSCLES AFTER SHARP FREEZING AND LONG  
COLD STORAGE

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## Summary

The retinol and thiamin contents in the liver and Longissimus dorsi and Gluteus medius muscles of Bulgarian White pigs have been determined quantitatively, as follows:

- (a) immediately post mortem,
- (b) monthly, with sharp freezing at  $-38^{\circ}\text{C}$  and storage at  $-20^{\circ}\text{C}$  for 3 months.

Changes in the contents of both vitamins have been noted in the process of cold storage of the samples:

- (a) retinol - up to 7,1% for the liver, and up to 7,5-8,1% for the muscles;
- (b) thiamin - up to 9,3% for the liver, and up to 7-7,9% for the muscles.

ÉTUDE SUR LES MODIFICATIONS DE LA TENEUR EN RÉTINOL ET  
EN THIAMINE DANS LE FOIE ET LA MUSCULATURE DE PORCS AP-  
RÈS UNE CONGÉLATION RAPIDE ET UN STOCKAGE FRIGORIFIQUE  
CONTINU

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## Résumé

On détermine quantitativement la teneur en rétinol et en thiamine dans le foie et les muscles longissimus dorsi et gluteus medius de porcs - race blanche bulgare, comme suit:

- a/ immédiatement après l'abattage des animaux
- b/ chaque mois après une congélation rapide à  $-38^{\circ}\text{C}$  et un stockage à  $-20^{\circ}\text{C}$  au cours de 3 mois.

On remarque une modification de la teneur des deux vitamines dans le procès de manutention des échantillons en conditions frigorifiques:

- a/ rétinol - jusqu'à 7,1 % pour le foie et jusqu'à 7,5-8,1% pour les muscles
- b/ thiamine - jusqu'à 9,3 % pour le foie et jusqu'à 7-7,9% pour les muscles

UNTERSUCHUNGEN ÜBER DIE VERÄNDERUNGEN IM RETINOL- UND  
THIAMINGEHALT IN DER LEBER UND MUSKULATUR VON SCHWEI-  
NEN NACH EINER SCHOCKGEFRIERUNG UND DAUERNDER  
GEFRIERLAGERUNG

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## Zusammenfassung

Es wurde der Retinol- und Thiamingehalt in der Leber und in den Muskeln Longissimus dorsi und Gluteus medius von Schweinen der weißen bulgarischen Rasse quantitativ bestimmt:

- a/ unmittelbar nach der Schlachtung der Tiere
- b/ monatlich nach einer Schockgefrierung bei einer Temperatur von  $-38^{\circ}\text{C}$  und einer 3-monatlichen Gefrierlagerung bei  $-20^{\circ}\text{C}$ .

Es wurde eine Veränderung im Gehalt beider Vitamine während der Gefrierlagerung der Proben festgestellt:

- a/ Retinol- bis 7,1% in der Leber und bis 7,5 - 8,1% in den Muskeln
- b/ Thiamin- bis 9,3% in der Leber und bis 7 - 7,9% in den Muskeln.

ИССЛЕДОВАНИЯ ИЗМЕНЕНИЙ В СОДЕРЖАНИИ РЕТИНОЛА И  
ТИАМИНА В ПЕЧЕНИ И МЫШЦАХ СВИНЕЙ ПОСЛЕ ШОКОВОГО  
ЗАМОРАЖИВАНИЯ И ПРОДОЛЖИТЕЛЬНОГО ХОЛОДИЛЬНОГО  
ХРАНЕНИЯ

Н.Несторов и Н.Кожухарова

## Аннотация

Определяли количество содержания ретинола и тиамина в печени и в мышцах лонгисимус дорси и глутеус медиус от свиней - белой болгарской, как следует:

- a/ непосредственно после убоя животных
- b/ ежемесячно при шокном замораживании при  $-38^{\circ}\text{C}$  и при хранении при  $-20^{\circ}\text{C}$  в течение 3 месяца.

Отмечено изменение в содержании двух витаминов в процессе хранения проб при холодильных условиях:

- a/ ретинол - до 7,1% для печени и до 7,5-8,1% для мышц.
- b/ тиамин - до 9,3% для печени и до 7-7,9% для мышц.

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Losses in the vitamin content of meat have been observed on prolonged cold storage. Those losses are particularly great with improper storage. It has been found that, after a year's storage of meat at  $-18^{\circ}\text{C}$ , thiamin decreases by 20 to 40 % (1). Rice et al. (2) indicate that, on storage at  $4^{\circ}\text{C}$ , thiamin losses in non-committed pig muscle after two weeks are lower than 10%, and in ground muscle from the lumbar region, after 56 days the vitamin has gradually decreased by 11%.

According to Krylova and Lyaskovskaya (3), upon the storage of liver at  $-20$  to  $-25^{\circ}\text{C}$ , retinol suffers only insignificant losses, and at  $-10,5^{\circ}\text{C}$ , its content decreases by only 9% in nine months. Retinol decreases quickly and nearly disappears in freeze-dried liver (4).

There are insufficient data on thiamin and retinol losses in individual pig muscles and liver, stored for a long time after sharp freezing. In the present work, the authors conducted studies on the losses of those two vitamins in pig liver and Longissimus dorsi and Gluteus medius muscles, stored for 3 months at  $-20^{\circ}\text{C}$  after sharp freezing at  $-38^{\circ}\text{C}$ .

## MATERIAL AND METHODS

The liver, m. Longissimus dorsi, and m. Gluteus medius of 7 White Bulgarian pigs were studied. The animals were slaughtered after 24 hours' starving. On their removal from the carcass, the muscles were trimmed from the fat. Samples were taken 4 hours post mortem and were frozen at  $-38^{\circ}\text{C}$  for 2 hours. The samples under investigation were stored at  $-20^{\circ}\text{C}$  for 3 months. The material needed for analysis was taken monthly in the course of 3 months.

Thiamin was determined fluorometrically (thiochrome method) (5, 6).

Retinol was determined by the method of Carr-Price (6,7).

The results obtained were processed for reliability by the

method of Student (8).

## RESULTS AND DISCUSSION

The mean results from the values found for thiamin content in liver and the two muscles, stored at  $-20^{\circ}\text{C}$  for 3 months, are shown in Table 1, and the mean per cent. losses, in Figure 1.

Table 1.\*

| Product                 | Immediately<br>post mortem,<br>mg% | After 1 mo.<br>of storage,<br>mg% | After 2 mo.<br>of storage,<br>mg% | After 3 mo.<br>of storage,<br>mg% |
|-------------------------|------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| Liver                   | 0,54                               | 0,51                              | 0,49                              | 0,49                              |
| M. Longissimus<br>dorsi | 0,76                               | 0,73                              | 0,71                              | 0,70                              |
| M. Gluteus medius       | 0,84                               | 0,80                              | 0,79                              | 0,78                              |

\* For liver:  $P > 0,001$ ;  $r$  - in the range of +22 to -4;  
for m. Long. d.:  $P > 0,01$ ;  $r$  - in the range of 0,01 to 0,5;  
for m. Glut. m.:  $P > 0,001$ ;  $r$  - in the range of 0,03 to 0,1.

Table 2 contains the mean values for retinol content in liver and the two muscles studied, expressed in IU per 100 g of fresh material, and Figure 2 shows the per cent. losses of that vitamin during the storage of samples at  $-20^{\circ}\text{C}$  for 3 months.

Table 2.\*

| Product                   | Immediately<br>post mortem | After 1 mo.<br>of storage | After 2 mo.<br>of storage | After 3 mo.<br>of storage |
|---------------------------|----------------------------|---------------------------|---------------------------|---------------------------|
| Liver                     | 27336                      | 26522                     | 25932                     | 25224                     |
| M. Longissi-<br>mus dorsi | 825,6                      | 787,8                     | 758,9                     | 756,3                     |
| M. Gluteus<br>medius      | 569,8                      | 541,5                     | 538,9                     | 522,5                     |

\* For Liver:  $P > 0,001$ ;  $r$  - in the range of 1 to 1,17  
For m. Long. dorsi:  $P > 0,001$ ;  $r$  - in the range of 0,39 to 1,0  
For m. Glut. med.:  $P > 0,01$ ;  $r$  - in the range of 0,86 to 2,4.

The data shown in Tables 1 and 2 and the dynamics of per cent losses in Fig. 1 and 2 make it obvious that both vitamins lose in content with 3 months' cold storage of the samples.

Thiamin loss during storage is greater in liver than in the muscles. The curve of thiamin loss is steeper in the first month than in the following two months, what could be explained by the great amount of juice that has dripped at the production stage, when also a change in pH values appears in the liver. Immediately post mortem, pH amounts to 7,3 - 7,1, while in only 24 hours it is changed to 6,4 - 6,5, what we presume to be one of the factors responsible for thiamin degradation. Another possible factor is accelerated autolysis taking place rather deeply in the liver, what could not but influence thiamin content.

Thiamin loss in m. Gluteus medius is considerably smaller; in the first month, under the conditions of our studies, it has a steeper curve, and in the second and third month of storage, its curve is already almost parallel to the one showing thiamin loss in m. Longissimus dorsi, stored under the same conditions.

The gradual retardation of the loss in thiamin content in all the three samples studied is due not only to the low storage temperature of the products, but probably also to the surface microflora on the studied samples. That supposition of ours is to be proved experimentally.

Retinol loss in the liver and two muscles during their cold storage under the conditions of our experiment, is a little different from thiamin loss. Generally, compared to thiamin, retinol per cent. losses are a little lower in the first month, but in the end of the experimental period they are in the range of a difference of 0,2 to 0,5 % for the muscles and 2,2% for liver. In the first month of cold storage, the loss in retinol content is the lowest in liver, compared to those for m. Gluteus medius and m. Longissimus dorsi. In the end of the experimental period, retinol losses in the three samples studied, related to one another, are around and below 1 %.

The quantitative loss of fat-soluble retinol in the studied samples could be explained by the oxidation of fats and the degradation of natural antioxidants. Those oxidation processes do not stop even at the low negative temperatures (3, 9). At low temperatures, with non-controlled humidity, meat and liver lose in water

content, what contributes to the decrease of the studied vitamins contained in them.

The studies carried out confirm that the storage of pork liver and meat at  $-20^{\circ}\text{C}$  after sharp freezing leads to comparatively small losses in thiamin and retinol content. Here, probably, the effect of sharp freezing is responsible to a great extent. In other studies of ours we have observed that, upon the storage of liver for 20 days at  $-4^{\circ}\text{C}$  and  $-15^{\circ}\text{C}$  without previous sharp freezing, retinol has decreased by 29 and 23 %, respectively, and in 40 days under the same conditions, by 62 and 51 %, respectively (10). This gives us grounds to maintain that, with a view to a higher biological value of the meat stored for three months at a temperature of  $-20^{\circ}\text{C}$ , it is necessary to include sharp freezing as a technological process for the lots of meat and liver, which are to be stored for a longer time under refrigeration.

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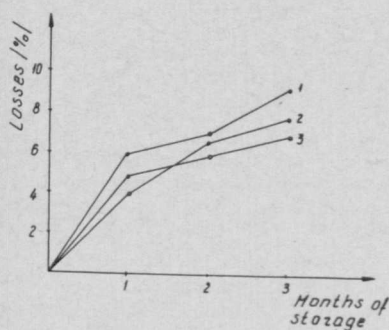


Fig. 1.

1. Liver. 2. M. Longissimus dorsi. 3. M. Gluteus medius.

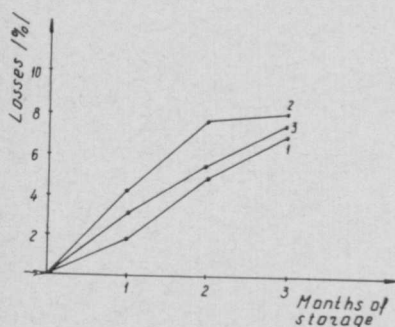


Fig. 2.

1. Liver. 2. M. Longissimus dorsi. 3. M. Gluteus medius.

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