

Sensory and histological comparative investigation of frozen and salted-half dried fish

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Introduction

Fish is a food decaying quickly. This is due to the high water content of fish and in connection with this to the proteolytic effect of microorganisms. For their activity the microorganisms need water. On removing a large portion of water from fish, the life conditions of microorganisms are annihilated or limited. The drying and salting of fish serves just for that purpose. On salting fish prior to its drying, greater amounts of salt are concentrated in the cells and inhibit the further decay of fish.

On freezing the fish, though no water is being removed, similarly the life conditions of microorganisms are deteriorated or suspended by freezing the water in the cells. In this crystalline state water is no longer a suitable medium for the life activity of the microorganisms.

The evaluation of the storage technique of both the dried and the frozen fish is determined by its rehydration and its state after thawing. Our present investigations included comparative tests concerning the properties and tissue structure of fish frozen at -30°C and stored at -5°C , after its thawing and of salted-half dried fish after its rehydration, and of both varieties after their boiling.

Survey of literature

The juice loss taking place on the thawing of fish frozen in the pre-rigor state, rigor state and post-rigor state has been investigated by *Kazuo* and *Takeo* (1). They found that muscles frozen in the pre-rigor state i. e. prior to cadaveric rigidity lose great amounts of liquid after their thawing. This juice loss is however smaller in meat that has been frozen in the rigor state and even more in that which has been frozen after the rigor state and thawed subsequently. In the case of muscles frozen in the post-rigor state, contraction cannot take place after thawing, quite in contrast to muscles where the cadaveric rigidity takes place only after thawing. On the basis of these considerations the loss of greater amounts of juice has been attributed to the pressure due to muscle contraction on the effect of rigor taking place after thawing.

Similar experiments were carried out by *Khan and Lentz* (2) on investigating the muscles of poultry where identical results were obtained.

Muscle samples quick-frozen at -40° have been stored for 6 months at -30° , -20° , -15° and -5° by *Goma and Biró* (3). During the storage period sensory tests were carried out monthly after thawing and boiling. The investigations included the determination of the tenderness, juiciness and chewing value of the meat samples. It was found that muscle samples stored at -15° and -20°C showed lower chewing values and contained more juice in their tissue than the samples stored at -5° and -30°C .

In respect to histological alterations after thawing the opinion has been generally accepted that recrystallization occurs in the frozen muscle during its storage. In the muscle tissue which is subjected to quick-freezing at the low temperature of deep-freezing small intercellular ice crystals are formed. On storing muscles at relatively higher temperatures such as -5° and -10°C already greater extracellular ice crystals develop or the intracellular ice crystals increase. On the effect of each of these factors a definite cell lesion occurs (4, 5, 6, 7).

On studying the muscle tissue of smoked fish *Bromley* (8) found that during the hot smoking gaps are formed between the fibrils and thus the fibrils are located more loosely.

Dessouki et al. (9) observed that after the hot smoking procedure the muscle cells in the muscles of smoked fish were compressed and exhibited a wavy texture. Also ruptures of the cell wall were perceivable.

Ramsbottom et al. (10) established between the colour of meat and the way of freezing the following relationship: meat samples frozen at -23.9°C in air showed a colour approaching that of fresh meat slices whereas the meat slices quick-frozen at -78.9°C exhibited even lighter colour. Meat samples frozen slowly at -6.7°C had, in turn, an appreciably darker colour than those mentioned above.

Material and method

The fish variety "Bolti" found in Lake *Nasser* above the Aswan dam was chosen for our experiments. After catching, fish was stored for two days in ice until the laboratory investigations were performed. Six fish of a total weight of 20 kg (of which the net muscles weighed 12 kg) were processed. Six kg of the net muscles were distributed to 12 half-kg pieces and the pieces separately sealed in polyethylene bags, subsequently frozen for 24 hours at -30°C and then placed in a store at -5°C .

The residual six fish were kept for 48 hours in brine then half-dried in a drying device at 35°C , airtightly sealed in polyethylene bags and placed in cardboard boxes.

Prior to beginning the storage period, and subsequently in monthly intervals, samples were withdrawn. The frozen samples were thawed in a frigidaire at $+2$ to $+3^{\circ}\text{C}$ within 24 hours. The juice dropping off during thawing was collected and measured. After thawing, 250 g pieces of the sample were chopped and placed separately in a bored-through glass tub, the corresponding portion of juice dropped during thawing poured back onto the fish, loaded by 0.087 kg/cm^2 weight and allowed to drop for 5 hours. Of the dried samples, two samples of 150 g each were withdrawn and chopped (this corresponded to 250 g of the raw weight). In separate vessels they were soaked for 15 hours. Subsequent to rehydration and weighing they were then allowed to drop under pressure, similarly in bored-through glass tubs. The effect of the storage period and the way of preservation on the loss on dropping and on the original weight was investigated.

Sensory tests were carried out with the fish prepared as fried fish. At the evaluation the chewing value, the juice-richness and the amount of residue on chewing were taken into account.

Chewing value indicates the number of chewings needed to obtain a well-chewn consistency. Scattering is here obviously rather high, thus the evaluation was carried out by means of variance analysis.

Juice-richness was qualified by scores as follows:

Very dry	4 scores
Slightly dry	3 scores
Slightly juicy	2 scores
Moderately juicy	1 score
Juice-rich	0 score

The colour was classified according to the score system suggested by *Ramsbottom* et al. (10). The colour of the frozen, stored and thawed fish and, respectively, of the salted-half dried and rehydrated fish was compared with the colour of fresh fish according to the quality groups as follows:

Excellent	10 scores
Very good	9 scores
Good	8 scores
Moderately good	7 scores
Adequate	6 scores
Still acceptable	5 scores
Moderately bad	4 scores
Bad	3 scores
Very bad	2 scores
Extremely bad	1 score

The results were evaluated by means of variance analysis.

For the histological investigations at first samples were withdrawn after the two-day storage in ice, then after freezing at -30°C , then in the frozen state after the two-month storage at -50°C and lastly after thawing. From the salted-half dried fish, samples were withdrawn in its original state and after its rehydration. For the fixation of the frozen samples at the storage temperature the Carnoy type fixation liquid, whereas for that of the thawed sample the Helly type fixation liquid (11) was used.

Results

Investigation of juice loss and consistency.

The quantity of juice dropping off after thawing and after the rehydration of the salted-half dried fish increases with the length of the dropping period according to a curve corresponding to the hyperbola of saturation. Therefore the juice quantity (y) pertaining to endless time and the constant " a " were evaluated.

The relationship found can be described by the equation

$$y = y_{\infty} \frac{x}{x + a}$$

where y is the quantity of juice dropped off, and
 x the dropping period.

The values of y_{∞} and of "a" are obtained by plotting graphically the straight

$$y = \frac{ay}{-x} + y_{\infty}$$

On this basis the juice dropping values are plotted in Figures. Fig. 1 shows the monthly values of fish samples stored for 3 months at -5°C , Fig. 2 those of samples stored for 4 months at -5°C , while Fig. 3 the monthly juice dropping values of salted-half dried fish after its rehydration. No unequivocal relationship could be established between the period of storage and the quantity of juice dropping off from the frozen fish or the salted-half dried fish, either. However, significant differences were found in the relationship between the way of storage and the juice loss in that the values of y_{∞} and constant "a" proved to vary in dependence of the way of storage. The way of preservation is directly proportional

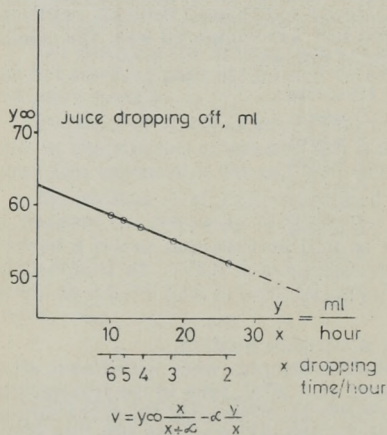


Fig. 1

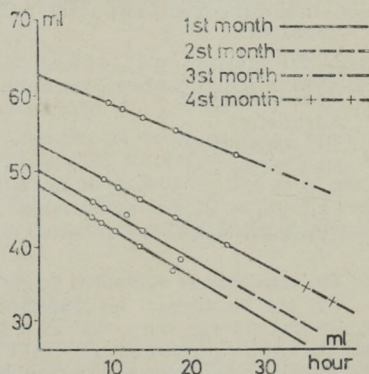


Fig. 2

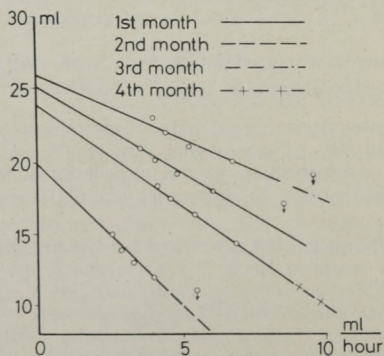


Fig. 3

Mean values of various consistency tests

Type of test	Fresh fish	Frozen fish stored at -5°	Salted-half dried fish
Juice-richness	0.25	1.0	2.0
		2.0	2.0
		2.0	2.0
		2.0	2.0
Mean of 4 months	0.25	1.75	2.0
Chewing value	34.25	36.75	43
		52.25	39
		47.75	41
		46.25	45
Mean of 4 months	34.25	45.75	42
Chewing residue	1.0	2.0	1.5
		2.0	2.0
		2.0	2.5
		2.0	2.0
Mean of 4 months	1.0	2.0	2.0

to the value of y_{∞} and inversely proportional to the constant "a". This relationship can be unequivocally established by comparing the diagrams presented in Figures 2 and 3.

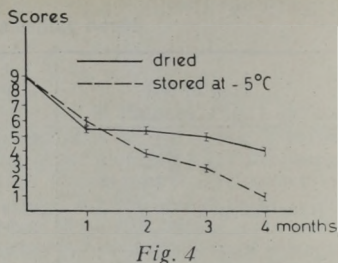
At the investigation of the consistency of fried fish samples prepared from fish stored at -5°C after thawing and, respectively, from salted-half dried fish we experienced that no significance differences existed between the two methods of fish preservation from the aspect of juice-richness, chewing number and chewing residue, quite independently of the length of the storage period. Significant differences were observed only between the preserved and the fresh fish samples (Table 1).

Changes in the colour of fish samples during storage

The changes in the colour of fish frozen and stored at -5°C and thawed, on one hand, and of salted-half dried fish on the other hand, are shown in Fig. 4 on the basis of samples withdrawn in monthly periods. In both methods of preservation essential colour changes were experienced after the first month of storage. Namely, fish stored on frozen state has been qualified as "adequate" after one month of storage whereas the dried fish obtained the score "still acceptable". Fish samples stored frozen at -5°C showed further gradual deterioration of colour. The 6-score evaluation of the first month decreases to 4 scores ("mode-

rately bad") at the end of the second month and to 3 scores in the third month. By the end of the fourth month the sample obtained only one score ("extremely bad") at the evaluation.

In the salted-half dried fish sample only a slow change of colour was observed after the first month of storage. In the third and fourth months some slight deterioration of colour was perceivable, and in the fourth month the samples got a qualification of "moderately bad" (4 scores).



Alterations in the tissue

Prior to evaluating the histological alterations the histological state of tissues which existed before the storage must be fundamentally taken into account. During the 48 hours elapsed at $+1^{\circ}\text{C}$ after the catching of fish the biochemical reactions which played morphologically a role in inducing and terminating the cadaveric rigidity took already place in fish. The muscle tissue showed therefore the histological picture of muscle cells already resolved from cadaveric rigidity, being in a relaxed state (Fig. 5). Muscle fibres are intact according to the normal histological appearance, their shape is regular. Prior to the storage at -5°C the fish was frozen at -30°C for 48 hours. Accordingly, the ice crystals were formed in the muscle fibres and between them. In the histological diagrams mainly the cell-destructing effect of ice crystals located outside the

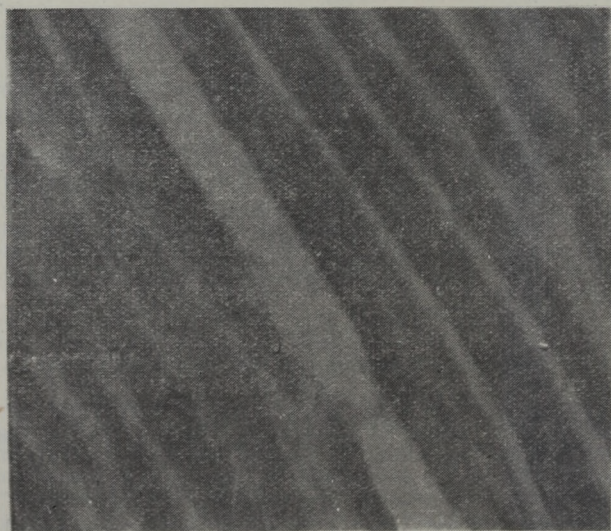


Fig. 5

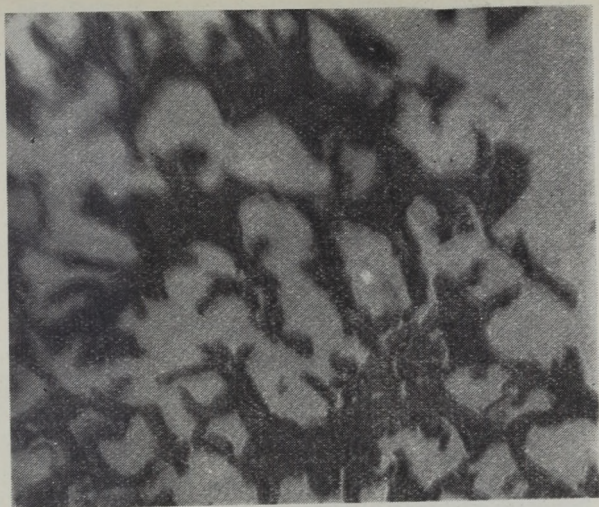


Fig. 6

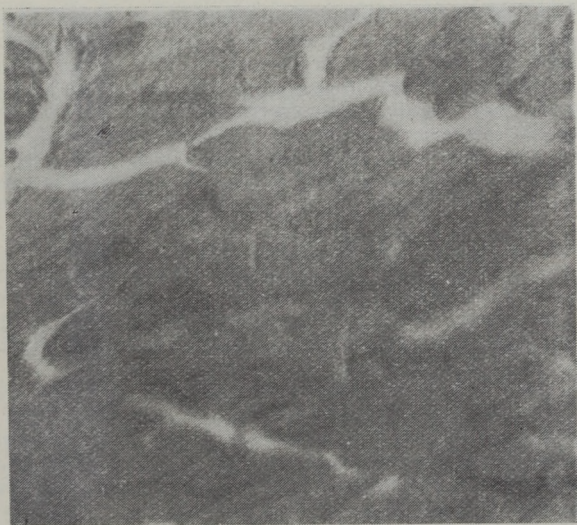


Fig. 7

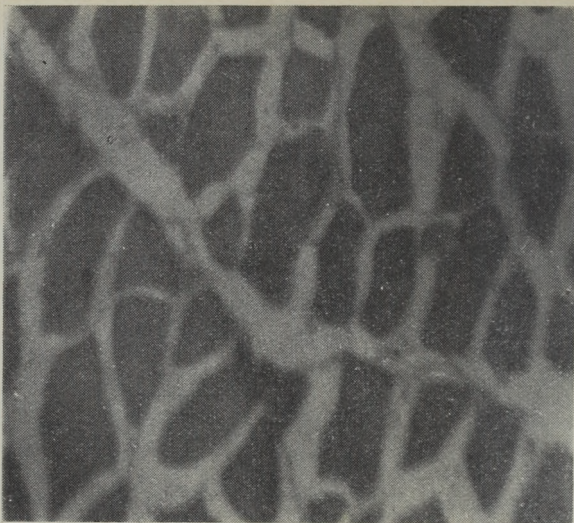


Fig. 8

muscle fibres, in extracellular position, prevailed. The same was observed also during the 4 months of storage (Fig. 6).

At the thawing after the storage at -5°C the histological picture increased to a great extent in comparison to the frozen state but the destruction of muscle fibres, cells remained also further quite characteristic. In the salted-half dried fish samples the water diffused off the cells on the effect of the osmotic pressure, the cell mass had concentrated. This process progressed still more during the drying procedure. Therefore the cells show slightly compressed, shrunk forms (Fig. 6). After the rehydration of the salted-half dried fish samples the cells are relatively intact and they remained regular. After the water-uptake of cells the histological picture resembled to a great extent that of the fresh samples (Fig. 7).

On summarizing the results, it can be stated on the basis of the experimental data that the initial properties of the preserved fish are altered in both preserving methods. We found that the mean weights of samples withdrawn after the fourth month of storage did not show great deviations from each other. On employing both methods of preservation the weights measured after rehydration did not exhibit essential differences.

The palatability of fish is affected by a great number of factors. From the aspect of the consumer, after the effect of odour and colour, the palatability value is determined decisively by the taste and consistency properties of fish. Of the consistency properties the tenderness or bad chewability of fish can be felt to the most extent. Besides the bad chewability the juice-richness is an essential sensory-perceivable property.

Fish samples treated by both preserving methods were subjected to consistency tests after preparing fried fish samples from the fish. The quality was

evaluated by high scores, observing however no significant differences between them.

On the basis of our experiments it can be stated that the salted-half dried fish exhibited both from the aspect of colour and from that of the economy of storage better results than fish stored at -5°C . It must be mentioned however that the sensory tests of both preserving methods did not differ from each other.

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A FAGYASZTOTT ÉS SÓZOTT-FÉLIG SZÁRÍTOTT HAL ÉRZÉKSZERV ÉS SZÖVETANI ÖSSZEHOSONLÍTÓ VIZSGÁLATAI EGYIPTOMBAN

Mahfooz Goma, Mohamed Abd Allah és Ferial Abosallim

Fagyasztott állapotban -5°C -on tárolt és sózott-félig szárított állapotban tárolt halakon végeztek érzékszervi és szövettani vizsgálatokat. Megállapították, hogy a sózott-félig szárított halaknak rehidratizálásuk után kedvezőbb volt a színe, mint a fagyasztott halmintáké. Egyéb érzékszervi tulajdonságok tekintében nem volt különbség észlelhető a kétféle módon tartósított halminták között.

ОРГАНОЛЕТИЧЕСКИЕ И ГИСТОЛОГИЧЕСКИЕ СРАВНИТЕЛЬНЫЕ

Махфуоз Гома, Мухамед Абд Алах и Фериял Абосаллим.

Проводили органолептическую оценку и гистологические испытания замороженных рыб храненных при температуре -5°C и рыб храненных в соленом — полусушенном виде. Установили, что соленные полусушенные рыбы после регидратации приобрели более приемлемый цвет чем замороженные рыбы. С учетом прочих органолептических свойств, не наблюдали существенной разницы между рыбами консервированных по двум методам.

VERGLEICHENDE SENSORISCHE UND HISTOLOGISCHE UNTERSUCHUNGEN VON GEFRORENEM UND VON GESALZTEM- HALBGETROCKNETEM FISCH IN ÄGYPTEN

Mahfooz Goma, Mohamed Abd Allah und Ferial Abosallim

Sensorische und histologische Untersuchungen wurden mit in gefrorenem Zustand bei -5°C gelagerten Fischen und in als gesalzte-halbgetrocknete Produkte gelagerten Fischen durchgeführt. Es wurde gefunden, dass die gesalzen-halbgetrockneten Fische nach ihrer Rehydratation eine günstigere Farbe besaßen als die Farbe der gefrorenen Fische. Bei anderen sensorischen Eigenschaften wurden zwischen den durch die untersuchten beiden Konservierungsverfahren behandelten Fischprodukten keine Unterschiede beobachtet.

COMPARATIVE SENSORY AND HISTOLOGICAL INVESTIGATIONS OF FROZEN FISH AND OF SALTED-HALF DRIED FISH IN EGYPT

Mahfooz Goma, Mohamed Abd Allah and Ferial Abosallim

Sensory and histological investigations were carried out with fish stored in a frozen state at -5°C and with fish stored as salted-half dried product. It was found that salted-half dried fish showed, after its rehydration, a colour more favourable than the colour of the frozen fish samples. In other sensory properties no differences were perceptible between fish samples preserved by the examined two methods.

L'EXAMEN COMPARÉ SENSORIQUE ET HISTOLOGIQUE DU POISSON CONGELÉ ON MARINÉS ET MI-SECHÉ EN ÉGYPTE

Mahfooz Goma, Mohamed Abd-Allah et Ferial Abosallim

On a effectué des examens sensoriques et histologiques sur des poissons entreposés en état congelé on mariné et mi-séchés, à -5°C . On a établi qu'après réhydratation la couleur des poissons marinés et mi-séchés était meilleure que celle des poissons congelés. Quant au reste des caractéristiques sensoriques il n'y avait pas de différence entre les poissons conservés par les deux méthodes.