H5.

NITRITES AND NITROSAMINES IN PROCESSED MEATS

Influence of mechanical treatment of cured muscles on some characteristics of pasteurized canned pork

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Curing of pork at mechanical treatment has attained a complete affirmation in the production of canned meat. However, there are no literature data on the changes in thus treated muscles. In order to give our contribution to the explanations of the influence of mechanical treatment of cured muscles on some characteristics of pork in the mentioned product we have carried out two experiments. 10% brine was injected in pig m. biceps femoris, in both experiments, and then treated by stirring in a vessel (I exper.) or tumbling in a drum (II exper.). In I experiment muscles were tumbled twice for 10 min, per one hour, during 24 hours, i.e. they were totally stirred for 480 min, and in II experiment they were continually tumbled for 360 min. Samples were taken from the vessel every two hours of stirring and from the drum 120, 180, 240 and 360 min. 200 g of a cured muscle was then pasteurized in a can. In the cans we have determined (a) the amount of released juice and (b) tenderness of content (I and II exper.) as well as (c) pH (I exper.). In the second experiment samples were also histologically examined.

According to the obtained results (n=14) it is evident that the prolongation of stirring of cured muscles up to 320 min influences the decreasing of released juice in cans, and the prolongation beyond 460 min increases it again (graph 1,I). Stirring of the cured muscles influences similarly the tenderness of can content. Namely, prolongation of stirring up to 320 min gives more tender can content produced from these muscles, while any further prolongation of stirring causes a slight decrease of tenderness (graph. 2,II). These characteristics are similarly effected by drum tumbling (graph. 1 and 2,II).

Duration of stirring of cured meat has no significant influence on pH of the can content produced from that meat, though a slight increase has been observed at stirring prolongation.

In m. biceps femoris from pasteurized cans after curing by tumbling 120, 180, 240 and 360 min the gradients of changes of structure have been found. These changes were pronounced in swelling and loosing the structure of sarcomere segments and at prolongation of muscle tumbling the fibers began to break transversaly and split longitudinally more and more. The former breakages are frequent and more expressed. By prolongation of curing by tumbling the structural changes increase in frequency and extension so that the sarcomeres structure degradate completely after any longer tumbling. A segments are slowely broken and it seems that brine salts change more rapidly the actin filaments and Z membranes, having at the same time a slower influence on actomyosin alteration.

Effets du traitment mécanique des muscles saumures sur quelques proprietes des boites pasteurisées

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L´action de saumurer la viande de porc avec le traitement mécanique s´est affirmée pleinement dans la production des boites de viande pasteurisées. Mais malgré cela il n´y a pas de données sur les modifications dans les muscles tellement traités.

Ayant pour but de contribuer à l´explication des effets du traitement mécanique de la viande saumurée sur quelques proprietés des muscles dans le produit, nous avons fait deux épreuves. Dans toutes les deux épreuves nous avons injecté dans le m. biceps femoris des porcs 10% de saumure et les avons traités ensuite par le remuement dans les récipient(I expér.) ou par le renversement au tambour (II expér.). A la premiere expérience les muscles sont remués deux fois 10 min.^{v}pendant 24 heures ou en tout 480 min., et a la deuxieme renversés continuellement 360 min. Les échantillons des récipients sont enlevés toutes les deux heures de remuement et du tambour apres 120, 180, 240 et 360 min. Chaque 200 g de muscles sont fermés en boites et pasteurisés. En boites nous avons déterminé (a) la quantité de jus séparé et (b) la tendresse du contenu (I et II expér.) ainsi que (c) pH (I expér.). A la deuxieme expérience les échantillons sont aussi controlés histologiquement.

Sur la base des résultats obtenus (n=14) on constate que le remuement prolongé des muscles saumurés durant 320 min. en tout cause la diminution de jus séparé en boites, et la prolongation au-dessus de 460 min. en fait de nouveau l´augmentation (graph. 1,I). Le remuement des muscles saumurés agit pareillement sur la tendreté du contenu des boites. Notamment, par le remuement prolongé des muscles saumurés jusqu´à 320 min. a pour conséquence que le contenu des boites fabriquées de ces muscles devient plus tendre et le remuement ultérieur le fait baisser un peu (graph.2, I). Sur ces propriétés-ci agit pareillement le renversement au tambour (graph. 1 et 2,II).

La durée de remuement de la viande saumurée n´a pas d´effet important sur pH des contenus fabriqués de cette viande, bien que l´augmentation insignifiante soit manifestée avec le remuement prolongé.

Le controle des préparations histologiques fait constater que m. biceps femoris des boites fabriquées de la viande saumurée par le renversement 120, 180, 240 et 360 min. est modifié. Ces modifications se manifestent en gonflement et relachement de la structure des ségments de sarcomere, et par le renversement prolongé le muscle commence de se détacher transversalement et longitudinalement. Les détachements transversaux sont beaucoup plus nombreux et plus évidents. La prolongation de saumurer par le renversement cause aussi les modifications de structure plus fortes, par conséquent la structure de sarcomere se détruit completement apres le renversement assez long.

v - pour chaque heure

Die Wirkung der mechanischen Bearbeitung gepökelter Muskeln auf einige Eigenschaften von pasteurisierten Konserven

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Das Pökeln von Schwienefleisch, nebst seiner mechanischen Bearbeitung, hat sich in der Herstellung von pasteurisierten Fleischkonserven vollkommen durchgesetzt. Trotzdem bestehen in der Literatur keinerlei Daten über die Veränderungen, die im auf diese Weise bearbeitetem Muskel vor sich gehen.

Mit dem Ziele, zur Aufklärung der Wirkung der mechanischen Bearbeitung von gepökeltem Fleisch auf einige Eigenschaften des Muskels im Produkt, beizutragen haben wir zwei Versuche durchgeführt. In beiden Versuchen spritzen wir in den m.biceps femoris von Schweinen 10% Pökellake ein, und behandelten sie dann mittels Mischen im Behälter (1. Versuch) bezw. mittels Umlagern in der sich drehenden Trommel (2. Versuch). Im ersten Versuch wurden die Muskeln^{v}2-mal je 10 minuten während 24 Stunden, also insgesamt 480 min gemischt, im zweiten Versuch bei kontinueller Drehung der Trommel durch 360 min umgelagert. Proben aus dem Behälter entnahmen wir nach jeweils zwei Stunden Mischens, aus der Trommel nach 120, 180, 240 und 360 min. Je 200 g Muskel verschlossen wir in Blechdosen und pasteurisierten anschliessend. In den Konserven bestimmten wir (a) die Menge des abgelassenen Saftes, und (b) den Zartheitsgrad des Doseninhaltes (im 1. u 2. Versuch), sowie (c) den ps-Wert (im 1. Versuch). Im 2. Versuch wurden die Proben auch hystologisch untersucht.

Aufgrund der erzielten Ergebnisse (n=14) ersieht man, dass durch Verlängerung des Mischens der gepökelten Muskeln auf 320 min die Menge des in den Konserven abgelassenen Saftes zurückgeht, jedoch bei Verlängerung des Mischzeit über 460 min wieder zunimmt (Diagramm 1,I). Das Mischen der gepökelten Muskeln wirkt sich in ähnlicher Weise auch auf den Zartheitsgrad des Konserveninhaltes aus. Das Verlängern des Mischens der gepökelten Muskeln bis zu 320 min wirkt sich nämlich auf den Doseninhalt der von diesen Muskeln hergestellten Konserven in der Weise aus, dass er weicher wird, während beim weiteren Verlängern des Mischen der Zartheitsgrad des Doseninhaltes in unbedeutendem Ausmasse zurückgeht (Diagramm 2,I). Eine ähnliche Wirkung zeitigt auch das Umlagern des Fleisches in der Trommel auf die erwähnten Eigenschaften (Diagramme 1. und 2,II).

Bei Durchsicht der hystologischen Präparate kann man ersehen, das sich der m.biceps femoris in den aus gepökeltem Fleisch hergestellten Konserven nach 120,180,240 und 360 min Umlagerns in der Trommel verändert hat. Diese Veränderungen kommen in der Quellung und Auflockerung der Struktur der Sarkomär=Segmente zum Ausdruck, während bei weiterer Verlängerung der Umlagerdauer der Muskel immer mehr zu reissen beginnt, u.zw. sowohl quer, als auch längs der Fasern. Die Querrisse sind zahlreicher und stärker ausgeprägt.

v - jeder Stunde

Воздействие механической обработки засолом мышц на некоторые свойства пастеризованных консервов

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Засол свиного мяса при механической обработке вполне подтвержден в производстве пастеризованных мясных консервов. Однако,несмотря на это, в литературе еще нет данных об изменениях, происходящих в такой обработанной мышце.

С целью помочь объяснению воздействия механической обработки засоленного мяса на некоторые свойства мышц в производстве, нами были проведены два опыта. В обоих опытах в m. biceps femoris свиней мы впрыскивали 10% рассола и обрабатывали их перемешиванием в посуде (I опыт) или переворачиванием в барабане (II опыт). В I-ом опыте мышцы перемешивались два раза по 10 минут^{x}в течение 24 часов или всего 480 минут, а во II-ом опыте - непрерывным переворачиванием в течение 360 минут. Образцы из посуды брались через каждые два часа размешивания, а из барабана - после 120, 180, 240 и 360 минут. По 200 г мышц мы укладывали и закрывали в жестянках,и пастеризовали. В консервах мы определяли (а) количество выделенного сока и (б) нежность продукта (I и II опыт),как и pH(в) (I опыт). Во II-ом опыте проводилось и гистологическое просматривание образцов.

На основании полученных результатов (n= 14) можно заключить, что продолжительность перемешивания засоленного мяса в течение 320 минут вызывает уменьшение выделяемого сока в консервах, а при продолжении перемешивания,свыше 460 минут - повышение (граф.I,I).Перемешивание засоленного мяса имеет похожее действие и на нежность мышц в консервах. А именно, продолжение перемешивания засоленной мышцы до 320 минут,оказывает влияние на ее нежность, она становится мягкой, а при дальнейшем перемешивании ее нежность значительно снижается (граф.2,I). Похожее действие на эти свойства получаем и при переворачивании мяса в барабане (граф.I и 2,II).

Время перемешивания засоленного мяса значительно не влияет на pH продукта, изготовленного из этого мяса, хотя он и проявляется в незначительном повышении при длительном перемешивании.

При просмотре гистологических препаратов видно, что m. biceps femoris из консервов, изготовленных из засоленного мяса, изменился при переворачивании в течение 120,180,240 и 360 минут. Такие изменения проявляются в набухании и ослаблении структуры сегментов саркомеры, а при продлении перемешивания мышцы начинают все больше и больше разрываться трансверсально и лонгитудиально. Трансверсальное разрывание появляется чаще и оно выражено резче. Продолжение засола переворачиванием вызывает и повышение изменений структуры таким образом,что структура саркомеры совершенно разрушается после продолжительного переворачивания. А сегменты медленнее разрушаются и,повидимому,соли рассола быстрее разрушат актинские филаменты и Z мембраны, а медленнее действуют на актомиозин.

[x]каждый час

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Procedure of pig muscles curing by mechanical treatment, i.e. by stirring or tumbling has acquired quite a reputation. It is by this procedure significantly shortened and the products obtained from such a cured meat are of better quality than those obtained from meat cured without mechanical treatment.

However, as far as we know, although this procedure has been accepted in practice, it is not yet explained to what kind of changes has the muscles been subjected.

Literature review

An anonymous author (1) described in 1971 only the preferences of mechanical meat treatment before curing, emphasizing that it accelerates curing. Michels and Theunissen (3) described the same year, the operations of a machnine for pork stirring immediately after brine injection and indicated the preferable quality of the canned meat produced from such a cured muscles than from those cured by the old procedure. Schuchlenz (4) has described the equipment for "24-hours meat massage under vacuum" as a very convinient for the production of a high quality canned hams. Galkov, et al. (2) have concluded, according to the results of their investigations, that the procedure of cured hams tumbling represents a new reliable method for "ultra-rapid" cannd ham production involving good quality. According to the investigations carried out in a semi-industrial conditions Stefanović and Tojagić (5) have concluded that "mechanical treatment accelerates considerably brine diffusion" as well as that better effects have been attained with mechanical treatmant of muscles after brine injection.

As far as we know, the influence of mechanical treatment of cured meat on some characteristics of a product has been not treated in literature, thus, we have decided to examine influence of the duration (a) of cured pork stirring in a vessel on the amount of released juice at pasteurization, i.e. on WHC, firmness and pH, as well as (b) of drum tumbling on the same characteristics and histological changes of meat, i.e. muscles.

MATERIAL AND METHODS

I e x p e r i m e n t

Material M. biceps femoris of white fleshy pigs weighing about 100 kg was used for these investigations. 10% brine of 18°Bé prepared with the commercial brine mixture "Tari complete WM" was injected in the muscles 24 hours post mortam with a multi stitch needles injector. About 800 kg of thus cured meat was afterwards transfered in the vessel for stirring, square shaped with centrally mounted axis with three arms. Meat was stirred twice for 10 min, per one hour, during 24 hours, i.e. it was totally stirred for 480 min.

Samples were takem from the vessel before stirring and then every 2 hours in the course of 24 hours treatment, whereas there were totally taken 13 samples per one stirring. A piece weighing 200 g was cut out from the center of a muscle and put in a can of 73 mm diameter. After closing the cans were pasteurized at 95°C/35 min to an internal temperature of 70°C. Cooled cans were, then, stored at 4°C. Assay has been repeated 14 times.

This experiment has been carried out in order to determine (a) the amount of released juice in a pasteurized can, (b) firmness and (c) pH of the can content.

Methods

The amount of released juice was calculated according to the weight of meat and juice. Firmness was measured by Warner Bratzler shear device and pH of the extract by pH-meter, Philips, type PR 3400/01 with glass and calomel electrodes.

II e x p e r i m e n t

In order to determine histological changes in the muscles cured with mechanical treatment, this examination has been repeated in semi-industrial conditions. The same muscle has been used for this assay, cured in the I experiment but treated by drum tumbling. About 12 kg of pork was tumbled continuously about 360 min. Samples were taken after 120, 180, 240 and 360 min of tumbling. Meat was canned in the same way as it was previously described.

This experiment has been carried out in order to determine (a) the quantity of released juice and (b) the content firmness, though, (c) histological slices and (d) homogenated samples were also examined.

Histological slices were cut about 5μ thick and stained by hematoxylin and eosin. Preparations were made in the Laboratory for Histology of the Agricultural Faculty of the University of Novi Sad.

Muscle samples homogenates were obtained by homogenization in Ultra Turax (Janke Kunkel KG IKA Werk).

RESULTS AND DISCUSSION

Experimental results obtained in both of the experiments are shown in three graphs and six figures.

Amount of released juice

According to the results obtained in the first experiment (graph. 1,I) it is evident that the amount of released juice decreases rapidly in the cans produced from meat stirred up to 120 min (for about 7%), considering only the duration of continuous stirring. The amount of released juice proceeds to decrease at meat stirring prolongation up to 320 min (for about 4%). In the cans produced from meat stirred up to 400, i.e. 440 min there were no basical changes in the amounts of released juice. However, stirring prolongation up to 480 min increases the amount of released juice for about 4%.

These data indicate obviously that the mechanical treatment of cured meat increases the WHC but also that the too long stirring involves an opposite effect.

From the results obtained in II experiment (graph.1, II) it is obvious that the amount of released juice is very small in the cans produced from meat tumbled 120 min but it increases in those produced from meat tumbled 190 min. However, at the prolongation of mechanical treatment the amount of released juice in cans decreases depending on the duration of this treatment. In this part of the experiment the amount of released juice is decreased similarly to I experiment.

Firmness

Values of the tenderness measurements of the can content from I experiment are shown in graph. 2.I. Comparing them with the results of the amount of released juice determinations it is evident that firmness was changed similarly to the changes of released juice amounts. Namely, the cans content produced from meat stirred up to 120 min becomes more tender, i.e. more soft. Such tenderness remains with slight variations in the samples produced from meat stirred up to 320 min. Prolongation of the duration of continuous stirring from 360 min on has no significant influence on the firmness of can content.

These results indicate that the prolongation of mechanical treatment of cured meat increases the tenderness of can content produced from this meat, as well as that after certain time this effect disappears. From the results obtained by firmness measurements in II experiment (graph. 2,II) it is evident that the prolongation of drum tumbling of the muscles cured more than 120 min does not influence on the increase of tenderness of can content. Thus, it may be concluded that drum tumbling of muscles cured 120 min involves maximal softening similar to the results obtained in I experiment.

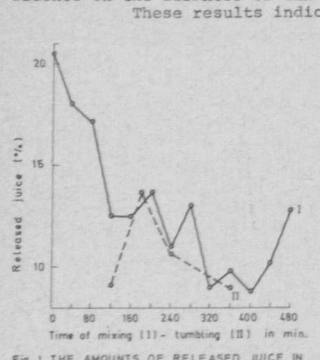

Fig. 1 THE AMOUNTS OF RELEASED JUICE IN CANNED PORK PRODUCED OF M.BICEPS FEMORIS CURED BY MIXING IN VESSEL (I) AND TUMBLED IN DRUM (II) DURING DIFFERENT TIME

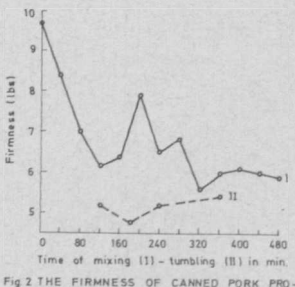

Fig. 2 THE FIRMNESS OF CANNED PORK PRODUCED OF M.BICEPS FEMORIS CURED BY MIXING IN VESSEL (I) AND TUMBLED IN DRUM (II) DURING DIFFERENT TIME

pH

From the results obtained by pH measurements of the can content from I experiment it is obvious that the prolongation of stirring of the cured muscles increases slightly pH (from 6.04 up to 6.19) but these changes prove to be rather insignificant.

Structure of muscle

By histological examination of m. biceps femoris from the cans produced from the muscles cured by drum tumbling it is noticed that the fibers are characterized by very distinct cross-striations at some areas in all samples disregarding the duration of mechanical treatment of muscles. This is quite normal as the muscles were cured after the full onset of rigor mortis. It has been also observed that near by the areas with very distinct cross-striation, there were also the areas of fibers with considerable degree of changes of structure. These alterations were expressed from the swelling and loosening of the segments in sarcomere, then in sarcomere breakage to the complete loss of the structure of sarcomere i.e. of the entire sarcomere. The continuity of A segment remains shaped for a longer period.

In the samples taken from the cans produced from the muscles cured at 2 hours tumbling these changes were pronounced in sarcomere segments swelling and loss of the structure in some smaller areas of particular fibers (Fig. 1). In the samples taken from the muscles cured at 3 hours tumbling these changes were far more expressed.

Fig. 2 shows a sporadically pronouned cross-striations "Solving of a fiber structure" is obvious on several areas and sarcomere breakage only in a few. The structure of sarcomeres in some areas is completely destructed (Fig. 3).

It the samples taken from the muscles cured by 4 hours tumbling disintegration of a structure is pronounced on larger areas and these alterations have been increased in frequency over the most parts of muscle fibers. Sometimes, some parallel muscle fibers were changed in the same way. Transverse fibers breaks are more frequent.

In the samples taken from the muscles cured by 6 hours tumbling the structure is in frequent areas transversely broken. Longitudinal fissures, i.e. miofibrils splittings (Fig. 4) were also observed in some areas. Therefore, in the places with more pronounced alterations the muscle resembles the rotten wood broken into rectangular fragments only by a slight pressure. Longitudinal fibrils splittings are also distinctly expressed. These breaks and splits originate, probably, from the force applied during the mechanical treatment of cured muscles. After longer curing the muscle

Fig.1. Longitudinal section of m.biceps femoris cured by injection and continuously tumbled for 2 h (x400)

fibers break easier as the structure of particular sarcomere is damaged by brine slats.

Changes determined for a muscle homogenate are similar to those detected by histological examination (Fig. 6).

Next characteristic of the changes of muscle structure is the disintegration of large areas of fibers or of the whole fibers, being thus transformed into granules (Fig.5). Due to these changes the fibers resemble the extended sacks filled with the content of defined form and darker coloured or of an undetermined form.

It is particularly interesting that the structure of A segment has been kept for a longer period. Structure of the are-as of sarcomere between A segments, i.e. between I segment and Z membrane is usually more broken and A segments remain as fibers transversaly connected over a number of miofibrils and "swim" free in that destructed mass of sarcomere. In a more degradated homoge-nate these areas of A segments were separated in the shape of "worms" and represent more shaped particles in an amorphous media. This finding indicate the supposition that brine salts, i.e. so-dium chloride and po-ly phosphates, dest-ruct at first actin miofilaments and Z membranes and later, i.e. more difficult actomyozin complex.

Histologically fo-und breaks of a stru-cture of muscle fibers and fiber splittings as the cause of these changes coincide with the determined incre-ase of WHC of muscles depending on the dura-tion of mechanical treatment and the in-crease of can content tenderness.

Fig.2. Longitudinal section of m.biceps femoris cured by injection and continuously tumbled for 3 h (x400)

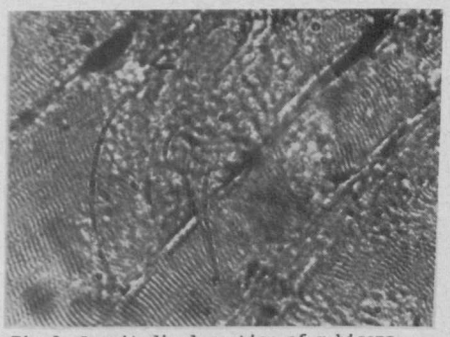

Fig.3. Longitudinal section of m.biceps femoris cured by injection and continuously tumbled for 3 h (x400)

Decrease of WHC of meat, i.e. the increase of the amount of released juice in cans produced from muscles cured by stirring up to 480 min could be explained as a result of too high breakage of proteins or of their denaturation caused by brine salts. This effect is not significantly expressed on the tenderness.

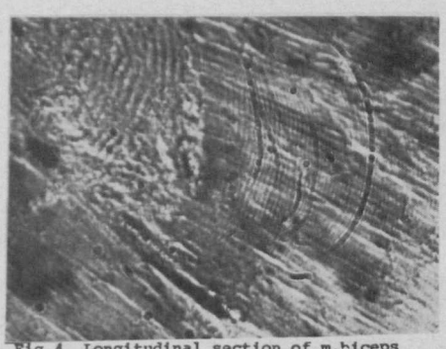

Fig.4. Longitudinal section of m.biceps femoris cured by injection and continuously tumbled for 6 h (x400)

Fig.5. Longitudinal section of m.biceps femoris cured by injection and continuously tumbled for 6 h (x400)

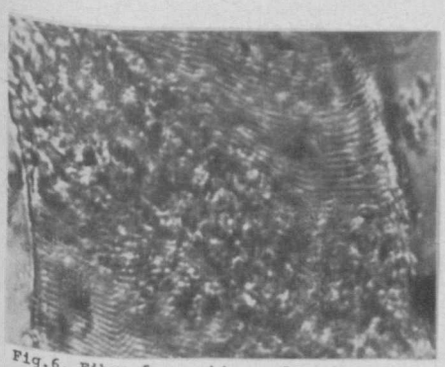

Fig.6. Fibre from m.biceps femoris homogenate (x630)

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