XXI. EUROPÄISCHER KONGRESS DER FLEISCHFORSCHUNGSINSTITUTE

ALLUNIONS-FORSCHUNGSINSTITUT DER FLEISCHINDUSTRIE DER UdSSR

STUDIUM DES MECHANISMUS DER EINDRINGUNG VON POKELUNGSSTOFFEN IN DAS MUSKELGEWEBE BEI DER STRAHLUNGSINJEKTION DER LAKE

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ZUSAMMENFASSUNG

In der vorliegenden Arbeit wird das experimentelle Material vorgeführt, das auf Grund der Analyse des Untersuchungskomplexes (darunter auch Röntgenkontrastaufnahmen) erhalten wurde. In diesem Material wird die Dynamik der Eindringung und der Verteilung der Lake gezeigt, die mit Hilfe des nadellosen Injektors in das Muskelgewebe eingeführt wird.

Die Untersuchungsergebnisse ermöglichten es, die Abhängigkeit der Lakeeindringung (Eindringungstiefe, Form und AusmaBe der primären Ansammlungszonen) von geometrischen Kennwerten der Injektorsdüse und hydraulischen Charakteristika des Vorganges festzustellen.

Es wurde nachgewiesen, daB die Reifungsdauer der Rohstoffe vor der Injektion sowie die Methode der Kältebehandlung die Form und die AusmaBe der entstehenden primären Lakeansammlungszonen sowie die Eindringungstiefe, die sich von 10 bis 65 mm verändert, wesentlich beeinflussen.

Das erhaltene experimentelle Material dient als Grundlage bei der Ausarbeitung des technologischen Schemas der Produktion von Erzeugnissen aus Schweinefleisch.

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A STUDY INTO THE MECHANISM OF CURING INGREDIENTS PENETRATION INTO MUSCLE IN CASE OF BRINE JET-INJECTION

A.S.Bolshakov, V.G.Boreskov, V.S.Sarytcheva

In the recent years, great attention has been paid to the problem of improving and accelerating meat curing in ham production.

One of the methods, allowing to accelerate the penetration and to contribute to the even distribution of curing ingredients, is brine jet-injection by means of a needleless injector.

Physico-chemical and histological studies of jet-injected samples (1, 2) showed that curing ingredients distribution just after brine injection into muscle was uniform and took shorter time as compared to the conventional procedure. In the latter case, the brine is, as a rule, accumulated in the interlayers of loose connective tissue, thus moving muscle bundles and individual fibers apart. It does not penetrate into muscle fibers, this being indicated with the absence of any vizible changes in their structure and configuration. With jet-injection under the pressure of about 2.5 to 3.0 x 10^7 Pa, the brine penetrates not only into connective tissue interlayers, but also muscle fibres. This is confirmed with fibers swelling, structural homogenization, and an increased proportion of firmly bound water.

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SUMMARY

The experimental data are presented, obtained through the analysis of a complex of studies (contrast X-radiography) and revealing the dynamics of the penetration and distribution of the brine introduced into the muscle with a needleless injector.

The results allowed to establish a relation of the pattern of brine penetration (penetration depth, the shape and size of the initial accumulation zones) to injecting nozzle geometry and process hydraulyc characteristics.

Raw meat ageing time prior to injection, as well as a refrigeration method were established to effect significantly the shape and size of the initial zones of brine accumulation formed, and brine penetration depth varying from 10 to 65 mm.

The experimental data obtained serve the basis for the development of a technology of pork products manufacture.

XXI ЕВРОПЕЙСКИЙ КОНГРЕСС РАБОТНИКОВ НИИ МЯСНОЙ ПРОМЫШЛЕННОСТИ

Всесоюзный научно-исследовательский институт мясной промышленности СССР

ИЗУЧЕНИЕ МЕХАНИЗМА ВНЕДРЕНИЯ ПОСОЛОЧНЫХ ВЕЩЕСТВ В МЫШЕЧНУЮ ТКАНЬ ПРИ СТРУЙНОМ СПОСОБЕ ИНЪЕЦИРОВАНИЯ РАССОЛА

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АННОТАЦИЯ

В работе представлен экспериментальный материал, полученный на основе анализа комплекса исследований (в частности рентгеноконтрастной съемки), раскрывающий динамику внедрения и распределения рассола, введенного в мышечную ткань при помощи безыгольного инъектора.

Результаты исследования позволили установить зависимость характера внедрения рассола (глубины проникновения, формы и размера начальных зон накопления) от геометрических параметров сопла инъектора и гидравлических характеристик процесса.

Установлено, что продолжительность созревания сырья перед инъецированием, а также способ холодильной обработки оказывают существенное влияние на форму и размеры образующихся начальных зон накопления рассола, на глубину его проникновения, которая колеблется от 10 до 65 мм.

Полученный экспериментальный материал служит основой для разработки технологической схемы производства продуктов из свинины.

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To decide on the commercial application of this method of brine injection to accelerate cure distribution throughout the muscle, it is necessary to know the regularities of curing ingredients penetration into and distribution throughout the tissues.

Methods

Objects of the study were l.dorsi muscles dissected from pork and beef cooled at +2°C for 3, 5, 7 and 10 days or thawed after pre-freezing at -18°C for 24hr post 3 day cooling. Thawing was performed at +18°C, R.H. 80%, for 24hr.

An objective evaluation of any method of brine injection is, obviously, based upon the pattern of curing ingredients penetration into and distribution throughout the muscle. Undoubtedly, the character of curing liquid distribution, the shape of the accumulation zone and penetration depth depend upon the hydraulic parametres of the injection process and tissue physico-mechanical properties. X-graphy and X-cinematography used by us as control methods rendered it possible to follow the process of brine penetration and to get a reliable picture of its distribution throughout intact muscle as related to time (3,4). Penetration depth and the shape of a brine accumulation zone were found by means of the examination of X-radiographs with their scale considered.

For the experiments a "Phillips" X-cinematographic apparatus was used, which has the shooting speed of 16 shots per min. Radiographic studies were carried out 0, 24, 48 and 72 hr post holding of the samples. Technical conditions for samples radiographying in two planes (top and lateral views) were constant and universally accepted for taking images of soft tissues.The technical data of the analysis were as follows: voltage in the tube - 49 kvolts, exposition time - 0.25 sec., focus distance - 70 cm.

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As a X-contrast substance, 76% verographine solution was used.

Results and discussion

In the experiments we studied the pattern of curing ingredients penetration and distribution throughout the muscle in case of jet introduction with an injector having a spring-type drive.

As for the mechanism of curing ingredients penetration by means of a jet method, of special importance during injection is the dynamics of pressure changes at the nozzle inlet (i.e. pressure in the working chamber of the injector). In spring-type injectors, the pressure at the beginning of a cycle increases sharply, thus supplying the maximum kinetic energy to the substance. The analysis of numerous X-grams and of the injection process allowed to determine that a part of jet energy of the first portion of the curing liquid is spent for passage formation, the rest of the energy being spent for liquid penetration and distribution both in-between connective-tissue interlayers and directly in the muscle. The pressure in the injector working chamber is reduced by the end of process when the passage has already been formed with the first portion of the liquid being injected.

The X-cinematographic analysis of jet injections clearly demostrated two stages in brine penetration into the muscle. At the first stage the point of a liquid jet reached the maximum depth almost immediately. At the second stage, with jet kinetic energy falling, the brine was distributed radially relative to the injection passage and in the plane which coincided with the direction of the connective-tissue interlayers (fascies) and of the muscle fibers in the injection zone.

Since pressure at the end of the cycle is less than at its beginning, each next portion of the brine penetrated to a smaller depth. This, probably, accounts for a specific shape of the

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zone of brine accumulation which is obvious in X-grams. This also explains the fact that, first of all, a part of the liquid injected into the muscle becomes vizible, and only after that - the passage is revealed.

0.4-0.5 sec. after injecting, a part of the injected liquid is seen which forms the initial zone of brine accumulation, it increasing for 4-5 sec.; after this time the shape and the size of the zone do not change. Therefore, brine penetration is completed, and the process of slow diffusive re-distribution of the curing ingredients starts, which lasts for hours or days rather than for seconds.

The analysis of the materials obtained allows to suggest that the shape and the depth of brine distribution throughout the tissues in case of the jet-injection method depend, firstly, on the dynamics of pressure changes during liquid flowing-out from the nozzle. Brine penetration depth grows with the pressure in the injector working chamber and with a decrease in the nozzle diametre.

The Table shows the penetration depth of curing ingredients as related to meat kind and ageing time prior to curing and to cold treatment kind.

It is seen from the Table that penetration depth was greatly influenced with cold treatment kind and intensity. Longer ageing caused a rise in penetration depth, this being, evidently, due to the autolytic changes in the muscle.

Meat structure damages during freezing also contributed to a higher penetration depth. The latter was higher in case of injection along muscle fibers as compared to that across the fibers.

The shape of brine accumulation zones depended on injection direction relative to muscle fibres; with perpendicular direction it was herring-bone-shaped, in case of a parallel one - oval-like.

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T a b l e

Changes in the depth of curing ingredients penetration (mm) in case of brine jet-injection as related to cold treatment and meat ageing time. (Needleless injector BI-2, P=3.0x10^7 Pa, nozzle diametre is 0.2 mm)

Kind of meat and direction of injection		Meat cooled for(days): 3	5	7	10	Thawed meat
Pork; along muscle fibres	$\bar{x}$	41.3	43.4	48.5	56.2	65.1
	S	±3.61	±2.93	±3.24	±3.72	±4.16
	%	100	105,1	117.4	136.1	157.6
Pork; across muscle fibres	$\bar{x}$	31.8	34.3	37.7	42.6	48.3
	S	±2.74	±3.29	±3.11	±3.81	±3.57
	%	100	107.9	118.6	133.9	151.9
Beef; along muscle fibres	$\bar{x}$	42.7	46.8	52.2	59.6	68.4
	S	±3.48	±3.20	±3.69	±4.43	±4.80
	%	100	109.6	122.2	139.6	160.2
Beef; across muscle fibres	$\bar{x}$	33.8	36.5	40.3	45.7	49.9
	S	±2.44	±3.05	±2.89	±3.62	±3.92
	%	100	107.9	119.2	135.2	147.6

The experimental data can be used to develop a design of a needleless injector and brine pumping procedures in ham production.

Conclusions

1. A possibility of applying an X-cinematographic method to analyze needleless injection of brine in the process of curing has been demonstrated.

2. The pattern of brine penetration and distribution has been established for jet-injection method.

3. Brine penetration depth and the shape and size of brine accumulation zone have been shown to be influenced with the hydrodynamic parametres of the process (pressure in the working chamber, nozzle diametre), as well as with muscle physico-mechanical properties (cold treatment kind and intensity, injection direction relative to muscle fibers location, kind of meat).

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