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DETERMINATION OF TECHNOLOGICAL PARAMETERS OF THE OPERATION OF A MULTI-NEEDLE INJECTOR FOR RAW MEATS

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Abstract

The features of the process of needle injection of raw meats with pickling brines are characterized. A multi-needle pneumatic brine injector with a pushing conveyor is described, as well as experiments on processing whole-muscle meat products with its help. The effect of the yield of pork loin, beef ham and pork neck upon the speed of the transporting rake was studied. The highest yield of loin was obtained at a feed rate of 0.012-0.0125 m/s, for ham – at 0.01-0.0115 m/s. The yield of the neck decreased with the decrease in the feed rate.

Keywords: raw meats, hydro-mechanical processing, needle injection, multi-needle brine injector, feed rate, yield

КӨП ИНЕЛІ ЕТ ИНЖЕКТОРЫНЫҢ ЖҰМЫС ЕТУДІҢ ТЕХНОЛОГИЯЛЫҚ ПАРАМЕТРЛЕРІН АНЫҚТАУ

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Аннотация

Ет шикізатын емдейтін тұзды ерітінділермен инемен айдау процесінің ерекшеліктері сипатталған. Итергіш конвейері бар көп инелі пневматикалық тұзды инжектор, сонымен қатар онымен тұтас ет ет өнімдерін өңдеу бойынша тәжірибелер сипатталған. Шошқа етін, сиыр ветчинасынан және шошқа мойынынан шығудың тасымалдау тарағының жылдамдығына тәуелділігі зерттелді. Карбонадтың ең жоғары шығымы 0,012–0,0125 м/с, ветчина үшін – 0,01–0,0115 м/с беру жылдамдығында алынды. Берілу жылдамдығының төмендеуімен мойынның шығуы төмендеді.

Түйін сөздер: шикі ет, гидромеханикалық өңдеу, инемен айдау, көп инелі тұзды инжектор, жем беру жылдамдығы, шығыс

ОПРЕДЕЛЕНИЕ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ РАБОТЫ МНОГОИГОЛЬНОГО ИНЪЕКТОРА МЯСНОГО СЫРЬЯ

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Аннотация

Охарактеризованы особенности осуществления процесса игольного инъецирования мясного сырья посолочными рассолами. Описаны многоигольный пневматический инъектор рассола с толкающим конвейером, а также опыты по обработке с его помощью мясных цельномышечных продуктов. Исследована зависимость выхода свиного карбонада, говяжьей ветчины и свиной шейки от скорости транспортирующей гребенки. Наибольший выход карбонада был получен при скорости его подачи 0,012–0,0125 м/с, ветчины – 0,01–0,0115 м\с. Выход шейки с уменьшением скорости подачи уменьшался.

Ключевые слова: мясное сырье, гидромеханическая обработка, игольное инъецирование, многоигольный инъектор рассола, скорость подачи, выход.

Introduction

The purpose of salting meat, that is, introducing sodium chloride and other curing substances into it, is to prevent microbiological spoilage of meat products, as well as to give them characteristic sensorial properties: taste, aroma, color, texture, etc. Two ways of the said salting have been traditionally used, namely rubbing of the curing substances into raw meats or pickling them by immersion into the curing brine. In the meat processing of today, these proven, but involving long-term processing, salting methods [1] are often replaced by new intensive methods: needle injection with curing brine [2, 3], meat tenderization by vacuum gravity-impact mechanical processing, the use of complex multicomponent brines, etc.

The needle injection lets it possible to intensify the process of curing raw meat significantly. The meat curing process requires the addition of a series of additives and essential ingredients for color and flavor. These elements form, together with the water, the brine to be introduced by injection into the meat in a homogeneous manner. An irregular distribution of brine causes a deficiency or excess of elements in different areas, causing irregularities in color, texture, spoilage and flavor [4]. With this method, the inner part of a meat cut is pierced with hollow needles, through which curing brine is injected. In its simplest form, a brine injector is an appliance in the shape of a gun with one or several hollow needles, into which curing brine is supplied by a pump. Such injectors are used in small production facilities, appliances of the similar design are also needed for needle curing of large cuts of meat, such as whole hams of pigs. At large enterprises, automatic injectors are used, these being equipped with needle blocks of several dozen of hollow perforated needles. The design of these machines makes the continuous supply of raw materials to the injection zone possible with the use of plate or push conveyors. The conveyor drives are synchronized with the drives of the needle blocks: during the piercing of cuts of meat with injection needles and the injection of brine, the feed conveyor is in standby mode. The supply of brine to the needles is carried out continuously or intermittently – depending on the type of pump used. In injectors intended for pickling boneless raw meats, the needles are rigidly fixed in the lowering needle blocks. The needles of the appliances used for the processing of meat and bone raw materials are equipped with mechanical springs or pneumatic dampers. Due to the said springs or dampers, the movement of injection needles stops when they come into contact with the bone tissue, thus their breakage is excluded. Significant intensification of the curing process by means of automated multi-needle injection is achieved due to the high diffusion rate of curing substances. Curing brine is injected from needles directly inserted into the deep of the meat, the side surfaces of them being equipped with orifices with a diameter of 1 mm for the purpose. The injection pressure, as a rule, is 2–4 kg/cm^2 [5].

The multi-needle brine injectors are usually equipped with electromechanical drives for raw material supply mechanisms, brine injection and reciprocating motion of the injection needle block. However, this design scheme is not uncontested. The scientists and designers of IFR NAAS have developed a line of mechanical brine injectors without the use of an electric drive. For research purposes, the Ya5-FShR manual injector equipped with 29 needles was designed and manufactured. The injectors of the next type, Ya5-FShL, are designed for use in small enterprises and equipped with the same number of injection needles. To drive the needle block and pump the brine in this design, a pneumatic actuator is used, however, the supply of raw meats to the injection working area remains manual. The purpose of the pneumatic injector Ya5-FSh1L (Fig. 1), equipped with 50 needles, is the injection of boneless meat raw materials in automatic mode. Two pneumatic actuators of this machine drive the

needle block, feed raw materials using a pushing conveyor with a transporting rake, and also pump the brine to the orifices of the injection needles [6].

Properly implemented hydro-mechanical processing of raw meats, as a rule, involving the sequential execution of needle injection and massaging (tumbling) of the meat raw materials in drum devices, can effectively intensify the process and increase yield [7].

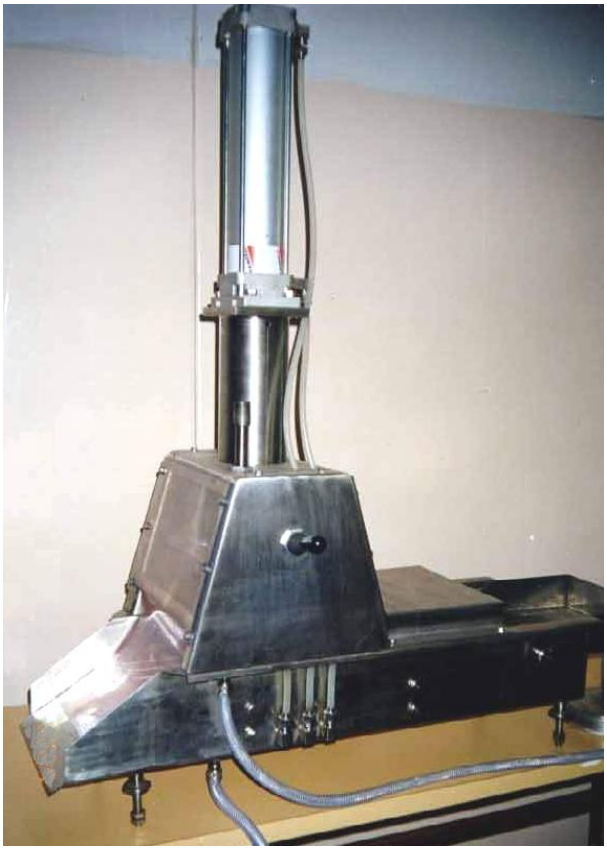

Figure 1 Pneumatic automatic injector Ya5-FSh1L

The studies made it possible to determine the effect of pre-saturation of the meat raw materials with brine on the rate of diffusion processes during pickling of meat, the water-holding capacity of muscle tissue and ways to increase it. Data were obtained on the rational grid placement of needles on the plate of the needle block, the amount of brine fed through the needle into the meat, the stroke of feeding raw materials for processing, the performance of the main components and working bodies of the injector.

In the course of this work, a series of experims was carried out for injecting with multicomponent brines on a pneumatic injector Ya5-FSH1L, the design of which allows you to change the speed of the transporting rake. Pork loin, beef ham and pork neck were injected. The yield of the product was determined depending on the average speed of its transportation during the injecting. The highest yield of the loin was obtained at its transportation speed of 0.012 - 0.0125 m/s (Table 1).

Table 1 Effect of the transporting rake speed upon the yield of pork loin

Injecting		Transporting rake speed, m/s				
		0.0080	0.0100	0.0120	0.0135	0.0145
Test 1	Yield, %	139.0	141.5	142.0	141.0	138.0
Test 2		137.5	139.0	140.5	137.5	134.0
Test 3		135.3	136.5	138.0	135.0	132.0

A similar relationship was obtained when processing beef ham. The yield value has a maximum value in the rake speed range of 0.01 - 0.0115 m/s (Table 2). At higher speeds, the yield of the finished product is reduced due to a decrease in the volume of muscle tissue with channels for the penetration of brine. The decrease in yield at low speeds can be explained by the greater leakage of brine during the heat treatment stage.

Table 2 Effect of the transporting rake speed upon the yield of beef ham

Injecting		Transporting rake speed, m/s				
		0.0080	0.0095	0.0115	0.0140	0.0145
Test 1	Yield, %	135.0	137.0	138.5	131.0	127.0
Test 2		132.0	133.0	134.5	128.4	122.9
Test 3		126.0	128.0	129.0	126.0	121.0

The pork neck is known to have large inclusions of adipose tissue. This influences the nature of the dependence of the product yield on the change in the speed of its transportation (Table 3). The yield of the neck decreases with increasing speed of its movement. Thus, when injecting this product, it is advisable to transport it at a minimum speed, while having an average yield increase of 2–4% compared to twice the transport speed.

Table 3 Effect of the transporting rake speed upon the yield of pork neck

Injecting		Transporting rake speed, m/s				
		0.0080	0.0100	0.0115	0.0130	0.0140
Test 1	Yield, %	131.0	132.5	128.0	129.0	124.0
Test 2		129.0	129.5	126.0	122.0	121.0
Test		125.5	123.0	118.0	121.0	119.0

Thus, it has been established that when injecting meat tissues with a strictly oriented fiber structure, the choice of the optimal number of injection sites and, consequently, the speed of transporting the product through the injector is essential. It has been also established that when injecting products with a low transport speed, there is increased equipment wear due to the greater number of needle head movements, the number of piston pump operations and other mechanical components per unit of processed product. Processing cuts of meat with a thickness of 100 mm or more entails the need for their re-injection with overturning for a more complete and uniform saturation throughout the volume. To prevent re-injection and overturning cuts of meat, it seems appropriate to increase the number of orifices along the length of the needles, which will lead to a more uniform distribution of brine throughout the volume of the processed piece of meat in one processing cycle. It has also been established

that the use of a brine dosing cylinder makes it possible to increase the injection pressure and more uniform distribution of the brine in the deep of the muscles of the raw meat, preventing its leakage from the channels formed by the needles, does not overheat the brine and reduces its losses compared to injectors where the brine is supplied continuously.

References:

1. Tumenova G., Sadupova T., Dauletkhankyzy A., Abilda A., Kudrenova L. Biokhimicheskie aspekty protsessa posola tsel`nomyshechnykh miasnykh produktov (Biochemical aspects of salting process of whole muscle meat products) Prodovolstvennye resursy (Food resources). – 2020. – № 14. – P. 175-188 [in Russian].
2. Jůzl M., Nedomová Š. Quality of animal products. Mendel University in Brno, 2015.
3. Planas i Solivera, S. Caracterització de salmorres i avaluació en un model de producte carni cuit. Universitat de Girona, Escola Politécnica Superior, 2018.
4. Xargayó Teixidor M. Proceso de fabricación de productos cárnicos cocidos de músculo entero II: Inyección y tenderización. Documentos Tecnológicos de Metalquimia. Girona: Metalquimia, 2008, P. 20-28.
5. Verbytskyi S.B., Shevchenko V.V. Nuzhno by pointensivnee (Igol'nye in`ektory i massazhery myasa – You should do it in more intensive way (Needle injectors and meat tumblers). Myasnoy biznes (Meat Business). – 2011. – № 4(99). – P. 49-52 [in Russian].
6. Verbytskyi S.B., Starchevoi S.O., Usatenko N.F., Kryzhska T.A. Tekhniko-tekhnolohichni osoblyvosti vykorystannia kolahenvmishykh komponentiv rozsoliv dlia iniektuvannia miasnoii syrovyny (Technical and technological peculiarities of preparation and use of collagen containing components of brines intended to inject raw meats). Prodovolchi resursy (Food resources). – 2019. – № 12. – P. 35-49 [in Ukrainian].
7. Kudrjashov L. Teorija i praktika intensifikacii posola mjasa (Theory and practice of the intensifying of meat pickling). Vestnik Marijskogo gosudarstvennogo universiteta (Gerald of Marijski State University). – 2009. – № 4. – P. 129-133 [in Russian].