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THE DIFFUSION OF BRINE INGREDIENTS SINGLES (CERTAINS) IONS
IN THE SWINE THIGH MUSCLES

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Nuclear energy is being applied more and more in food irradiation technology as well as in food radiation hygiene of animal origin. In last decade the methods of radiopasteurization and radiosterilization of food, especially ones of the animal origin are developed. The technique of optimal doses of irradiation was improved, keeping the nutritive values of food and destroying bacteria, viruses, parasites and eventually the eggs of insects. However, there are some domains of meat hygiene and technology where the application of nuclear irradiation and radioisotopes as the tracers of certain chemical reactions is still limited.

Since 1965 we have been particularly interested in the application of technique of marking in the meat curing process, where we tried to mark certain ingredients of the

brine solution by radioactive isotopes in order to complete the data on dynamics and kinetic analysis of the penetration of brine regarding different aspects (kind of meat, structures, way of application etc.). In this paper we have shown, using a model, the differences in diffusion and osmosis of some ions that are constant ingredients of the brine, such as sodium and the phosphate group.

Material and methods

Pork, different sort of the muscles: m. quadriceps femoris, (m. rectus femoris), m. biceps femoris and m. semimembranosus was put between the two compartments of the diffusional cell containing at one side the conductometric cell with brine solution. There was water at the other compartment. Using the conductometric cell we could follow the specific conductivities changes dependents on time, resulting from the transport process of brine solution. From the calibration graph it was possible to get the concentration variations and calculate the flux of Na-ion, as the parameter of the brine transport through the meat. Ion flux denotes the change of the solution concentration per unit area and unit time.

The brine solution, we used in our experiments, has the following composition:

NaCl - 190,0 g/l

NaNO₂ - 0,8 g/l

Polytal - 40 g/l

Na₃PO₄ 10-15%

Na₄P₂O₇ 5 - 7%

Na₅P₃O₁₃ 70-80%

Na₈P₆O₁₉ 1-2%

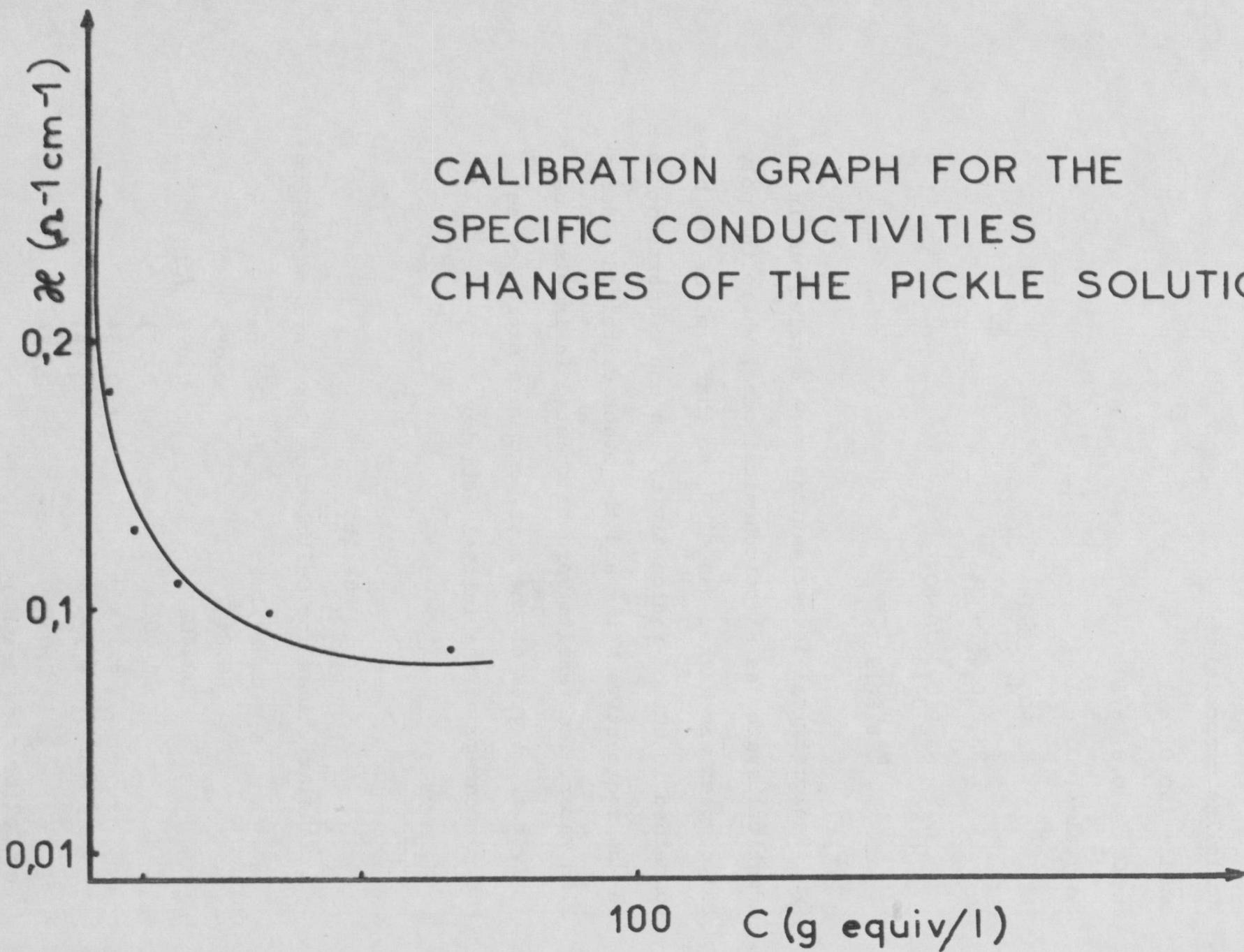
Radiometrical investigations were carried out in the identical system as electrochemical ones, where the polytal complex was marked NaH₂³²PO₄ so that 1 ml of the brine contained 10,_uCi of radioactivity. In one compartment there was radioactive brine and the other contained a distilled water. The results were calculated in impulses per 1 ml, i.e., 1 gram of the mass, and were expressed as the percentage of the initial activity.

Results

Tabelar values for Calibration Graph are as follows:

c (g equiv/l)	H ($\Omega^{-1} \text{ cm}^{-1}$)
66,84	0,085
33,402	0,099
16,701	0,111
8,351	0,134
4,175	0,183
2,088	0,254

(See Calibration Graph)



Numerical values of Na-ion flux from the brine solution in muscles (m. quadriceps femoris, m. biceps femoris and m. semimembranosus) are:

Sample of muscle	ΔR Ω	Δc g equ/l	I_s mol $\text{cm}^{-2} \text{sec}^{-1}$	t sec
m. quadriceps				
femoris				
longit.section	90	60,12	0,0027	$2,7 \times 10^3$
cross section	120	39,41	0,0013	$3,6 \times 10^3$
m. semimebranosus				
longit.section	130	40,08	0,0015	$3,3 \times 10^3$
cross section	130	40,08	0,0012	$3,9 \times 10^3$
m. biceps				
femoris				
longit.section	90	39,05	0,0032	$1,5 \times 10^3$
cross section	120	39,41	0,0018	$2,7 \times 10^3$

The results of radiometrical investigations on the models of swine thigh muscle: m. quadriceps, m. semimembranosus and m. biceps femoris (thickness of 1 cm) with R^{32}PO_4 of the marked brine solution from one side and the distilled water from the other side showed that during 10 hour observation there was no passage of the marked phosphate through the examined sample. Table of these results is expressed in the percentage of isotopic dilution of the marked brine:

muscle	activity in the brine solution after 9 hours of exposition	Initial acti- vity imp/100 sec/g
marked brine	100%	$6283 \pm 1,230$
m.quadriceps	37,05	
m.semimembranosus	41,71	
m.biceps	44,94	

During the 24 hour exposition, the diffused radioactive solution in the halves of models on the side of radioactive solution were found (layer 0,5 cm thick):

muscle	activity in the muscle after 24 h expressed in percentages of the brine activity
m.quadriceps	87,01
m.semimembranosus	58,04
m.biceps	54,76

Conclusion

On the basis of electrochemical and radiometrical investigations of the models of swine thigh muscle (m.quadriceps femoris, m.semimembranosus and m. biceps femoris) some conclusions can be drawn out:

Under the conditions of simple diffusion and osmosis of the brine (injected into the meat without pressure)

through 1 cm thick muscle layer flux of Na - ion has the following range of values: m. quadriceps, m. semimembranosus and then m. biceps femoris.

Under the identical conditions, the diffusion of the group $^{32}\text{PO}_4^-$ anion is very slow but selective one. Thus, the presence of radioactive phosphate group is the highest in m. quadriceps, and approximative one in m. semimembranosus and m. biceps femoris.

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THE DIFFUSION OF BRINE INGREDIENTS SINGLES IONS IN THE SWINE THIGH
MUSCLES

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The diffusion of singles ions from brine through the swine muscles has been researched in the electrochemical and radiometrical way.

The electrochemical researches were done using diffusion cells with calomel electrodes. By this technics the diffusions of Na-ions in different experimental conditions was undertaken, determining the Na-ions flux ($\text{mol cm}^{-2} \text{sec}^{-1}$). Based on the obtained data the conclusions on the influence of some factors as muscles species, position and thickness of muscles fibers, on the Na-ions diffusion speed from brine ingredients in partial muscles of down extremities (m.quinticeps, m.semimembranosus and m.biceps femoris) were done.

The other part of the matter deals with the application of radiotracer: marking cations ($^{24}\text{NaCl}$) and anions ($R^{32}\text{PO}_4$) in the function of contentracion shift and penetration speed, the conditions being indentical as at electrochemical researches.

DIFFUSION DES CERTAINS IONS DE LA SALINE AUX MUSCLES DU
JAMBON DE PORC

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On étudie la diffusion des certains ions de la saline aux muscles de porc par les méthodes électrochimiques et radiométriques.

Nous avons utilisé une cellule de diffusion avec des électrodes de carbone pour effectuer les expériences électrochimiques. Par cette technique on étudiait la diffusion des Na-ions dans des différentes conditions expérimentales et déterminait le flux des ions ($\text{mol} \cdot \text{cm}^{-2} \cdot \text{sec.}^{-1}$). Les résultats obtenus nous montrent que les facteurs: qualité de muscle, direction et épaisseur des miofibrilles etc, ont l'influence sur la vitesse de la diffusion des Na-ions de la saline aux muscles de jambon.

Nous avons utilisé la technique de radiotraceurs: cation ($^{24}\text{NaCl}$) et anion (R^{32}PO_4) en fonction de changement de la concentration et la vitesse de pénétration aux mêmes conditions expérimentales que dans les recherches électrochimiques.

DIFFUSION EINZELNER SALZINGREDIENZIONEN IN DIE SCHWEINOBER-
SCHENKELMUSKEL

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Zusammenfassung

Die Diffusion einzelner Salzionen durch das Muskelgewebe des Schweines wurde elektrochemisch und radiometrisch erforscht.

Für die elektrochemischen Forschungen wurden die Diffusionszellen mit Kalomelelektroden benutzt. Durch dieses Verfahren wurde die Na-Ionen-Diffusion unter diversen experimentalen Voraussetzungen verfolgt und zwar durch Na-Ionen-Flux-Bestimmung ($\text{mol cm}^{-2} \text{sek}^{-1}$). Auf Grund der so erforschten Resultate werden Schlussfolgerungen im Hinblick auf die folgenden Faktoren gezogen und zwar: die Art der Muskel, die Lage und Durchmesser der Muskelfasern beeinflussen die Geschwindigkeit der Na-Ionen-Diffusion von der Salzingredienz in die einzelnen Muskeln der Extremitäten posterior (m. quiticeps, m. semimembranosus und m.biceps femoris).

Der zweite Teil dieser Forschungsarbeit bezieht sich auf die Anwendung von Radioaktiven Isotopen: durch Markierung von Kationen ($^{24}\text{NaCl}$) und Anionen ($R^{32}\text{PO}_4$) verfolgt man die funktionalen Änderungen in der Konzentration und Geschwindigkeit des Vordrangs dieser Ionen unter identischen Voraussetzungen wie bei den elektrochemischen Untersuchungen.

ДИФФУЗИЯ ОТДЕЛЬНЫХ ИОНОВ ИНГРЕДИЕНТА РАССОЛА В МЯСО СВИНОГО ОКОРОКА

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Диффузия отдельных ионов из рассола в мышечную ткань свинины исследована электрохимическим и радиометрическим методом.

Радиометрические исследования проводились путем использования диффузных клеток с каломельными электродами. При помощи этой техники велись наблюдения над диффузией Нa-ионов в различных экспериментальных условиях определением потока Нa-ионов /мол см⁻² сек⁻¹/ . На базе полученных данных делается вывод насколько факторы – вид мышечной ткани, положение и толщина мышечного волокна влияют на скорость диффузии Нa-ионов из ингредиента рассола в мышцы заднего окорока. /m quinticeps m semimembranosus i m. biceps femoris/.

Другая часть настоящего труда относится на применение радиотрассера: обозначением катиона /²⁴NaCl/ и аниона /³²PQ₄/ в функции изменения концентрации и скорости проникновения в таких же условиях как при электрохимических исследованиях.