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BEEF STABILITY AS AFFECTED
BY ANTIBIOTICS

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S U M M A R Y

The problem of storage of chilled meat is not practically solved as yet. The experiments showed that the use of antibiotics for preventing meat from bacterial spoil and moulding creates the possibility of increasing storage life of chilled meat.

Studies of meat, carried out in the USSR and abroad, showed that from existing antibiotics the most effective are antibiotics of tetracyclin group, namely chlortetracyclin and oxitetracyclin.

The All-Union Meat Research Institute found that the best results are obtained with the following methods of processing meat with antibiotics:

1. Intravital intravenous infusion of chlortetra-cyclin 2 hours before slaughter.
2. Surface spraying of halves I,5 or 2 hours after washing.

The second method is more economical and easier for practical industrial application. It should also be taken into account that with this method an antibiotic settles on the surface of halves only, and the antibiotic content of meat is considerably less than with the intravenous infusion. The last circumstance is of great importance for hygienists.

When spraying halves with I,5 l of chlortetra-cyclin solution, some 700 ml settle on meat.

The quantity of an antibiotic on the surface of

a processed half was determined in the region of blade bone, back, round and along the cut of round.

The distribution of chlortetracycline solution on a half was not uniform.

The depth of penetration of chlortetracycline into meat was no more than 0,5 cm.

Inactivation of chlortetracycline in inner layers of meat goes on quicker than on its surface.

For determining storage life cooled and chilled meat processed with chlortetracycline was placed in refrigerated cars at - I,2 and +I,3°C and relative humidity of air 85-94%. It was found that the storage life of meat processed with chlortetracycline is 7 days longer than that of control samples. The spoil of meat processed with chlortetracycline was not of a bacterial nature. In all the experiments moulding of meat was noticed. Slime forming was observed on control meat. Nystatin was used to neutralize the development of yeasts and mould on meat.

The use of chlortetracycline and nystatin makes it possible to increase the storage life of chilled meat by 9-10 days as compared with not processed meat.

The work on transportation (during 9-12 days) of cooled and chilled meat processed by chlortetracycline (50 halves engaged) showed that chlortetracycline increases the stability of beef. The use of chlortetracycline and nystatin permits shipping of chilled meat (86 halves engaged) to long distances without affecting quality of fresh meat.

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DAS ALLUNIONSFORSCHUNGSI
TUT FÜR
FLEISCHWIRTSCHAFT
U d S S R

EINFLUSS DER ANTIBIOTIKA AUF DIE HALTBARKEIT
DES RINDFLEISCHES

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Z U S A M M E N F A S S U N G

Das Problem der Aufbewahrung des abgekühlten Fleisches ist bis jetzt noch nicht gelöst. Bei der Verwendung der Antibiotika zur Vermeidung des bakteriellen Verderbens des Fleisches und der Schimmelerscheinung wird eine längere Aufbewahrung möglich wie es auch die durchgeföhrten Experimente gezeigt haben.

Die in der Sowjetunion und im Ausland durchgeföhrten Versuche haben gezeigt, dass von den jetzt zur Verfügung stehenden Antibiotika diese der Tetrazyklinreihe und zwar Chlortetrazyklin und Oxytetrazyklin den höchsten Wirkungsgrad besitzen.

Das Forschungsinstitut für Fleischwirtschaft der UdSSR hat festgestellt, dass die besten Resultate bei der Antibiotikafleischbearbeitung mit Hilfe folgender zwei Methoden erzielt werden können.

- I. Durch eine intravenöse Injektion des Chlortetrazyklins, die 2 Stunden vor der Schlachtung erfolgt.
2. Durch die Berieslung der Rinderhälftenoberfläche mit einer Chlortetrazyklinlösung, die 1,5-2 Stunden nach dem Waschen unternommen wird.

Das zweite Verfahren ist wegen der ökonomischen und betrieblichen Vorteile überlegen. Man muss dabei auch damit rechnen, dass bei der Anwendung des letzten Verfahrens nur die Oberflächenschicht an Antibiotika reich wird, während in Kernschichten des Fleisches nur eine geringe Menge durchdringt, was bei der Verwendung des ersten Verfahrens nicht der Fall ist. Das ist vom

hygienischen Standpunkt aus von Bedeutung.

Bei der Berieselung einer Rinderhälfte mit der Chlortetrazyklinlösung werden von 1,5 l der gesamten Menge der Lösung 700 ml an der Oberfläche festgehalten.

Die Menge von festgehaltenem Antibiotik wurde im Bereich der Schulter, des Rückens, der Keule festgestellt.

Die Chlortetrazyklinlösung war unregelmässig an der Oberfläche aufgeteilt.

Sie drang in die Tiefe von etwa 0,5 cm ein.

Die Inaktivierung des Chlortetrazyklins in Kernschichten geht schneller vor sich als an der Oberfläche.

Zur Bestimmung der Lagerungszeit wurde das mit der Chlortetrazyklin behandelte abgekühlte Frischfleisch in einem mit Eis gekühlten isothermischen Wagen gelagert, wo die Temperatur von ca - 1,2 I,3°C und die relative Feuchtigkeit von ca 85-94% erhalten wurden. Es wurde dabei festgestellt, dass das mit dem Chlortetrazyklin behandelte Fleisch 7 Tage länger aufbewahrt werden konnte als die Kontrolle. Das Verderben des mit dem Chlortetrazyklin behandelten Fleisches wurde durch nicht-bakterielle Ursachen hervorgerufen. Bei allen Versuchen wurden Schimmelflecken festgestellt, beim Kontrollfleisch kam es zu Schleimerscheinungen. Um die Entwicklung von Hefen zu verhindern, wurde Nistatin angewandt.

Die Verwendung von Chlortetrazyklin und Nistatin hat es möglich gemacht, die Aufbewahrung von abgekühltem Fleisch um 9-10 Tage im Vergleich zu unbehandeltem Fleisch zu verlängern.

Der Transport (innerhalb von 9-10 Tagen) von dem mit dem Tetrazyklin behandelten abgekühlten Frischfleisch (50 Rinderhälfte wurden dabei geprüft) hat es ermöglicht festzustellen, dass der Chlortetrazyklin die Haltbarkeit des Fleisches wesentlich erhöht.

Durch die kombinierte Anwendung von Chlortetrazyklin und Nistatin wird eine längere Transportweite des abgekühlten Fleisches (86 Rinderhälften wurden geprüft) ermöglicht, wobei die Qualität des Frischfleisches nicht beeinträchtigt wird.

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INSTITUT DE RECHERCHES SCIENTIFIQUES DE L'INDUSTRIE
DE VIANDE
DE L'URSS

L'INFLUENCE DES ANTIBIOTIQUES SUR LA CONSERVATION
DE LA VIANDE DE BOEUF

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S O M M A I R E

Le problème de la conservation de la viande refroidie n'a pas encore trouvé une solution pratique satisfaisante. Grâce à l'emploi des antibiotiques visant à empêcher l'altération bactériologique et le moississement de la viande on parvient - et les expérimentations prouvent - à une conservation plus longue du produit en question.

Les recherches de la viande entreprises en Union Soviétique et à l'étranger ont montré que parmi les antibiotiques dont on dispose actuellement ce sont ceux qui appartiennent à la série tétracycline et notamment la chlortétracycline et l'oxytétraoencycline qui sont capables de réaliser les performances les plus remarquables.

A la suite des recherches entreprises par l'Institut de la viande de l'URSS on a pu établir que les meilleurs résultats de la conservation de viande à l'aide des antibiotiques sont obtenus par des méthodes suivantes:

I. L'injection intravénale de chlortétracycline 2 heures avant l'abattage.

2. L'arrosage de la surface des moitiés de boeuf par de la solution de chlortétracycline 1,5-2 heures après le lavage.

La seconde méthode est la plus économique et la plus facile du point de vue de son emploi. Il faut tenir compte aussi du fait que l'emploi de la seconde

méthode n'intéresse que la surface qui s'enrichit en antibiotiques tandis qu'à l'intérieur de la viande sa présence ne se manifeste que par des quantités considérablement plus faibles. Cette dernière circonstance est importante du point de vue hygiénique. Sur 1,5 l de solution de chlortétracycline la viande ne retient que 700 ml.

Les tests de la présence d'antibiotique à la surface de la moitié de boeuf ont été faits dans la région du dos, de l'épaule, de la cuisse et à l'endroit de la tranche de la cuisse.

La solution de chlortétracycline pénétrait à l'intérieur de la viande irrégulièrement selon les endroits de la moitié.

Cette solution pénétrait jusqu'à la profondeur de 0,5 cm.

La perte d'activité de chlortétracycline s'opérait plus rapidement à l'intérieur de la viande qu'à sa surface.

Pour établir les durées maxima de la conservation de la viande refroidie et réfrigérée un lot témoin a été placé à l'intérieur d'un wagon réfrigéré à glace à la température de $-1,2 + 1,3^{\circ}\text{C}$ et où l'humidité relative était de l'ordre de 85-94%. L'expériment a fait ressortir que la viande traitée avec de la chlortétracycline se conservait 7 jours plus longtemps qu'un lot témoin ordinaire. L'altération de la viande traitée avec de la chlortétracycline n'avait pas pour origine une influence bactériologique; dans tous les essais on signale l'apparition de moisissure et le lot témoin présentait des traces de mucilage. Pour empêcher le développement de fermentations et de moisissure on a eu recours à la nistatine.

L'emploi de la chlortétracycline et de la nistatine permet de prolonger la durée de conservation de la viande refroidie de 9 à 10 jours par rapport à la

viande non-traitée.

Le transport (au cours de 9-10 jours) de la viande refroidie et réfrigérée traitée avec de la chlortétracycline (l'expérience a été faite sur 50 moitiés de boeuf) a permis d'établir que le traitement avec de la chlortétracycline relève la stabilité de la viande de boeuf. L'emploi combiné de chlortétracycline et de nistine permet de transporter plus loin (l'essai a été fait sur 86 moitiés de boeuf) sans pour autant diminuer les qualités de la viande fraîche.

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The problem of storing chilled meat is not solved practically as yet. The experiments showed that the use of antibiotics for preventing bacterial spoil and moulding creates the possibility of increasing storage life of chilled meat.

Studies of meat carried out in the Soviet Union and abroad showed that from existing antibiotics the most effective are those of tetracycline group, namely chlortetracycline and oxytetracycline.

Actually the use of aureomycin is permitted in the USA for processing hot and chilled poultry by submersion. In Canada the storage of fresh fish in aureomycin ice is allowed. Chlortetracycline is used in the USSR for shipping cod in the Murmansk basin.

The laboratory of antibiotics of the All-Union Research Institute of the Meat Industry carried out a study of the effect of chlortetracycline on storage life of chilled beef.

The data obtained show that the best results are achieved with the following methods of processing meat with antibiotics:

1. Intravital intravenous infusion of chlortetracycline 2 hours before slaughter.

2. Surface spraying of halves by chlortetracycline solution 1,5 or 2 hours after washing.

For our studies we used the second method as the most economical and convenient for the practical use. Furthermore, with this method an antibiotic settles on

meat surface only and the quantity of antibiotic settled is far less than with the intravenous infusion. This circumstance is of great importance for hygienists.

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Our aim was to study:

I. the quantity of chlortetracycline solution settled on the surface of halves treated with the antibiotic;

2. distribution of chlortetracycline on processed meat surface;

3. depth of penetration of the antibiotic into processed meat;

4. storage life of meat treated with chlortetracycline and chlortetracycline with nystatin;

5. effect of antibiotics (chlortetracycline and chlortetracycline with nystatin) on cooled and chilled meat shipped in refrigerated cars.

To solve the first three problems experiments were carried out on cooled beef of young animals of the 2nd grade. Chlortetracycline solution (100 mg/l) was used for spraying. The consumption of the solution was 1,5-2 l per half. The halves were stored hanged at +2, +6°C and relative humidity of air 80-94%.

As a result of the experiments it was found that 700 out of 1500 ml of antibiotic solution settle on the surface of a half.

To determine the quantity of the antibiotic on the surface of the treated halves samples in the form of thin layers of meat were taken from the region of blade bone, back, round and cut of round 2 hours, 1, 2, 3, and 4 days after processing. The upper layer, 1-2 mm thick, was subcutaneous cellular tissue, sometimes with a small streak of fat or muscular tissue. Samples were taken from control meat too since we found (1958) in meat antibacterial substances, which actively affect the test culture L_2 . The content of chlortetracycline was determined by a microbiological method - diffusion into agar.

As a result of the experiments it was found that 2 hours after processing the largest quantity of the antibiotic on the surface of halves was in the places of presence of subcutaneous cellular tissue, for example on loins (from 0,6 to 2,2 γ/g). In the places where this tissue was present in the form of a thin membrane there were less chlortetracycline (0,1 - 0,5 γ/g).

In the process of storage of meat the content of chlortetracycline in the upper layer of the tissue gradually decreased in all the points of sample taking. On the third day of storage of the processed halves no antibiotic was found in the upper layer of meat.

Table I.

Time of sample taking after treatment with chlortetracycline	Quantity of antibiotics (γ/g)		
	back- loin	shoulder	round
2 hours	: 1,04	: 0,6	: 0,28
1 day	: 0,84	: 0,45	: 0,14
2 days	: 0,21	: 0,23	: 0,07
3 --"	: 0	: 0	: 0
4 --"	: 0	: 0	: 0

It was found earlier that the inactivation of an antibiotic sets in somewhat later, for example on the fifth day. But there were cases when chlortetracycline was inactivated on the first day after processing. The reasons of this phenomenon are not clear as yet.

To determine the depth of penetration of chlortetracycline into processed meat after antibiotic solution is put on it samples were taken from the first upper layer, 1-2 mm thick (subcutaneous cellular tissue, sometimes with a slight streak of fat or muscular tissue), the second, third and fourth layers

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(muscular tissue), 3 mm thick. The results of the studies are shown in Table 2.

Table 2.

Place of sample taking	Quantity of chlortetraciclin after processing (γ/g)	2 hours				days			
		I	2	3	4	I	2	3	4
Shoulder 1st (upper) layer	0,6	0,45	0,23	0	0				
2 nd layer	0,II	0,15	0	0	0				
3 rd layer	0	0	0	0	0				
4 th layer	0	0	0	0	0				
<hr/>									
Loin									
1 st (upper)layer	I,04	0,84	0,2I	0	0				
2 nd layer	0,07	0	0	0	0				
3 rd layer	0	0	0	0	0				
4 th layer	0	0	0	0	0				
<hr/>									
Round									
1 st (upper)layer	0,28	0,I4	0,07	0	0				
2 nd layer	0,I4	0	0	0	0				
3 rd layer	0	0	0	0	0				
4 th layer	0	0	0	0	0				

2 hours after processing the antibiotic was found in the majority of the samples no deeper than 0,5 cm from the processed surface (Table 2). In some halves chlortetraciclin was found only in the first upper layer. Hence, the preparation settled in subcutaneous cellular tissue.

Not more than 0,I4 γ/g of antibiotic was found in the layer 0,5 cm deep. In deeper layers no chlortetraciclin was found at all (8 experiments).

In two days of storage of processed meat chlortetraciclin was not found in the layer 0,5 cm deep.

It can be assumed that chlortetracyclin penetrates into meat in the moment when it is put on the surface because the antibiotic was found in the layer 0,5 cm deep 2 hours after processing and it did not penetrate more during subsequent storage of meat.

Hence, with spraying of meat with chlortetracyclin the largest quantity of it settles on meat surface, in subcutaneous cellular tissue. Its depth of penetration is not more than 0,5 cm from the processed surface.

When storing meat the antibiotic is inactivated in inner layers of tissue in 2 days and in the upper layer - in 3-5 days.

Storage life of meat processed with either chlortetracyclin or chlortetracyclin and nistatin

To determine storage life of meat processed with chlortetracyclin it was put into refrigerated cars. The temperature regime in the cars was as is required for shipping chilled meat. The experiments on storage of meat processed with either chlortetracyclin or chlortetracyclin and nistatin were carried out also in refrigerators of the experimental sausage plant of the Institute.

20 young animals (cattle) were chosen for the experiments. Most of them were of the "Krasnaya Stepnaya" breed. Meat obtained from these animals was 2nd graded.

Slaughter and primal processing of the animals were carried out along the lines of the standard technological scheme with electric stunning, bleeding on the rail, mechanical hide pulling, carcass sawing, and washing.

1,5 - 2 hours after washing 20 halves were processed with chlortetracyclin solution (100 mg/l). One half of every carcass was sprayed, while another ser-

ved as control sample. 1,5 l of solution was sprayed on each half on the rail and in the cooler by means of the hydrostand Gsh-2.

Cooled meat was loaded at 12°C in a refrigerated car with the temperature of air -5°C. Halves were hanged in the car in staggered rows so that in all the points of a completely loaded half of the car there were halves both processed and not processed with the antibiotic. Besides the experimental halves meat (of the same animals) not processed with chlor-tetraciclin was loaded in the car (before loading was completed). Resistance thermometers were installed for measuring air and meat temperature in the refrigerated car. Workers of the All-Union Railway Transport Research Institute recorded temperature and relative humidity of the air in a special laboratory car every 2 or 4 hours.

The refrigerated car was subjected to a corresponding sanitary processing before loading. During the experiment ice and salt were furnished according to the existing norms.

In the beginning of the storage the experimental meat (both processed and not processed with the antibiotic) was examined every 2-3 days. After spoil (sliming) appeared on the control halves the meat was examined every day.

During the experiment the meat was stored at an average temperature from -1,2 to +1,3°C and relative humidity 85-94%. The temperature in the inner layers of muscles varied from -0,3 to +1,6°C.

On the 12th day of the storage the control meat (80% of the halves) had signs of spoil in the form of sliming on bellies, rounds, under shoulders, and hind legs; musty smell on the cuts of Achilles tendons; discolouration (greyish tint) on the cuts. The control meat was removed from the experiment due to sliming.

No sliming was found on the meat processed with chlortetracycline during a careful examination, but since mould forming was noticed the experiment was discontinued.

The work carried out showed that the use of chlortetracycline makes it possible to increase the duration of storage of chilled meat (at the temperatures of the experiment) by 7 days as compared with the control meat kept under the same conditions.

The spoil of the meat processed with the antibiotic had a nonbacterial nature. Therefore we can assume that with the action of antimycotic preparations the storage life of the meat will increase.

To obtain a major effect of the use of chlortetracycline the laboratory of antibiotics carries out works on selection of antimycotic preparations. In the experiments with pure cultures of moulds the most notable preparation for its fungicide activity was K-25. However, when put on meat, it was not active against yeasts and moulds and added a specific smell to meat.

The action of preparations was studied on pure cultures and meat simultaneously.

The antibiotic nystatin was active only in large concentration with respect to pure cultures. The development of Aspergillus was suppressed at the concentration of 500 mg/ml. With experiments on meat positive results were obtained at lower concentrations of nystatin.

In experiments with meat nystatin was used together with chlortetracycline since this preparation does not prevent meat from bacterial spoil. Meat was processed with aqueous suspension of nystatin.

When putting solution of the antibiotics (chlortetracycline 100 mg/l and nystatin 250 mg/l) on quarters of meat, it was found that mould forming was

delayed by 5-7 days as compared with meat not processed with antibiotics. During the experiments meat was kept at +3, +5°C and relative humidity 80-94%.

Bacterial spoil of meat processed with the two antibiotics set in 4-5 days later than that of meat processed with chlortetracycline only. The use of chlortetracycline in combination with nystatin made it possible to increase storage life of meat by 9-10 days.

It should be mentioned that the rate of yeast and mould development on meat processed with chlortetracycline and nystatin is significantly lower than on meat which was not processed.

Effect of chlortetracycline and chlortetracycline with nystatin when shipping cooled and chilled meat in refrigerated cars

Effect of chlortetracycline on storage life of cooled meat during shipping was studied together with workers of the All-Union Railway Transport Research Institute. Cooled meat was shipped from Krasnodar to Moscow in refrigerated cars with wall ice containers. Time of shipping - end of April - beginning of May.

The refrigerated cars were subjected to a corresponding sanitary processing before loading.

10 resistance thermometers were installed in every car to measure temperature of air and meat. Temperature was measured at the top and at the bottom between doors, in the centre of both halves of the car, at the top and at the bottom near one ice container.

During loading meat thermometers were placed in several halves into necks and rounds at the depth of 5-6 cm.

Temperature of meat was measured in halves located in the centre of both halves of the car, at the top between doors, and near instruments of refrigeration.

During all the experiment observations of temperature and humidity were made every 2-4 hours. The

refrigerated car was accompanied by a laboratory car for recording temperature of meat and temperature and humidity of air in the car in which meat was transported.

When shipping cooled and chilled meat the methods of processing it with the antibiotic were the same as in the above described experiments. Halves both processed with the antibiotic and not processed (control) were loaded into the refrigerated car. The temperature of meat during loading was +6, +12°C.

During transportation the temperature of the load varied from +1,5 to -0,3°C. The temperature of air in the car was +0,8 +0,7°C. Shipment lasted 9 days. Having arrived to the place of destination each half was examined. It was found that the halves processed with chlortetracyclin had a normal smell characteristic for ageing of meat. All the halves not processed with the antibiotic had a darker colour with a greyish tint, especially in the places of sliming.

Besides discolouration 66,6% of control halves developed sliming (rounds, necks, bellies, and in the cuts).

Subsequent shipments of cooled beef were made under conventional conditions of meat transportation in refrigerated cars.

107 cooled halves (50 of them were processed with chlortetracyclin) were loaded into a refrigerated car with the temperature of inner layers of muscles +10°C. The temperature of air in the car before leading was -2°C. The temperature of outside air was +12°C.

The meat was en route 9 days. When the car was opened, the temperature of air was +3°C between doors, +2,5°C near the instruments of refrigeration; the temperature in the inner layers of muscles was from +2 to +4°C. The temperature of outside air at the time of unloading was +16°C.

As a result of a careful examination it was found that the meat processed with chlortetracycline was in good condition (its colour was bright red). 95% of halves not processed with the antibiotic developed surface sliming on the cuts of breast, neck, aitch bone, backbone, pelvis and round, and belly. In the places of sliming the colour of meat was dark with greyish and on some halves greenish tint. The smell in the places of major sliming was sourish, slightly musty and musty.

Antibiotics were also used for shipping chilled meat from the regions where meat, according to the transportation rules, may be shipped in frozen condition only (from Alma-Ata to Moscow). In this case 86 beef halves were sprayed with solution of chlortetracycline (100 mg/l) and nistatin (250 mg/l). 10 halves not processed with antibiotics were used as control samples.

After processing the meat was chilled until the temperature of the inner layers of muscles reached +3°C. Then the meat was loaded into a refrigerated car where the temperature was -5°C before loading. At the time of loading the temperature of outside air was +12°C. The meat was en route 14 days, and 17 days passed from the moment of slaughter.

The temperature of meat at the moment of unloading was +0,4, +1,0°C.

The expert commission which examined meat found that the beef processed with the antibiotics (chlortetracycline and nistatin) meets the requirements of the All-Union Standard 779-55 and may be marketed on general grounds.

The control meat had to be sent to industrial processing due to surface sliming, some mould, discolouration, and smell of unfresh meat.

The work carried out allows us to draw the following conclusions:

1. If processing of cooled beef with chlortetracyclin is made by means of spraying, the antibiotic on the surface of halves is distributed unevenly.

2. The major part of the antibiotic is settled in the subcutaneous cellular tissue.

3. A slight quantity of chlortetracyclin penetrates to the depth of 0,5 cm from the processed surface of meat.

4. The use of chlortetracyclin makes it possible to increase storage life of chilled beef by 7 days (at +1,3, -1,2°C).

The use of chlortetracyclin and nistatin makes it possible to store chilled meat 9-10 days longer than control samples.

5. After 9 days shipment chilled meat processed with chlortetracyclin is in good condition, while meat not processed and shipped under the same conditions develops signs of spoil - sliming, musty smell, discolouration.

6. Chilled beef processed with chlortetracyclin and nistatin may be shipped to long distances without impairing its freshness.
