HYGIENE AND ECONOMY OF SCALDING WITH CONDENSED WATER VAPOR AND IN TANK

CHRISTIAN NICKELS, INGEMAR SVENSSON, ANDERS TERNSTRÖM and LARS WICKBERG

Swedish Meat Research Centre, Kävlinge, Sweden

Scalding of slaughterpigs with condensed water vapor and in tank are compared with special reference to economy and hygiene.

Samples of the skin were taken both after dehairing and before chilling of the carcasses. Results from samples taken before chilling showed significantly lower bacterial counts for the pigs scalded with condensed water vapor. However, no significant difference between the two scalding methods was found on samples taken after scalding and dehairing.

Microbiological analysis of samples from skin and muscle of the front legs were performed after chilled storage for 7 to 13 days. The total bacterial counts on skin and in the muscle were lower when scalding with condensed water vapor was used. The difference in bacterial counts in the muscle was of such a dignity that it should be of practical interest. However, total bacterial counts on skin were always higher than in the muscle. The difference of the bacterial load on the skin between the two methods was small.

The cost of scalding with condensed water vapor were found to be higher than the costs of scalding in tank. The difference was almost entirely due to differences in investment costs.

HYGIENE ET ECONOMIE DE L'ECHAUDAGE A LA VAPEUR D'EAU CONDENSEE ET EN CUVE

CHRISTIAN NICKELS, INGEMAR SVENSSON, ANDERS TERNSTRÖM et LARS WICKBERG

L'Institut Suédois de Recherche sur les Viandes de Boucherie, Kävlinge, Suède

Il est procédé à une comparaison, en matière d'hygiène et d'économie, entre les deux procédés d'échaudage des porcs d'abattage à la vapeur d'eau condensée et en cuve.

Il a été opéré des prélèvements après épilation et avant réfrigération des carcasses. Les résultats concernant les prélèvements opérés avant réfrigération ont fait ressortir des nombres de bactéries notablement plus bas pour les porcs échaudés à la vapeur d'eau condensée. Cependant, sur des prélèvements opérés après échaudage et épilation, il n'a été constaté aucune différence significative entre les deux procédés d'échaudage.

A la suite d'un entreposage de 7 à 13 jours, il a été effectué une analyse microbiologique de prélèvements opérés sur la peau et sur les muscles des pattes antérieures. Les nombres totaux de bactéries constatés sur ces prélèvements étaient plus bas lorsqu'il y avait eu échaudage à la vapeur d'eau condensée. Dans les muscles, cette différence était assez importante pour présenter un intérêt pratique. Mais les nombres totaux de bactéries constatés sur la peau étaient toujours plus élevés que dans les muscles. Les deux procédés donnaient une faible différence de contamination bactérienne pour la peau..

Il a été constaté que le coût de l'échaudage à la vapeur d'eau condensée était plus élevé que celui de l'échaudage effectué en cuve, cette différence portant presque exclusivement sur les frais d'investissement.

C1:2

HYGIENE UND ÖKONOMIE BEIM BRÜHEN MIT KONDENSIERTEM WASSERDAMPF UND IM KESSEL

CHRISTIAN NICKELS, INGEMAR SVENSSON, ANDERS TERNSTRÖM und LARS WICKBERG

Schwedisches Fleischforschungsinstitut, Kävlinge, Schweden

Das Brühen von Schlachtschweinen mit kondensiertem Wasserdampf und im Kessel wurden mit spezieller Hinsicht auf die Hygiene und die Ökonomie untersucht.

Hautproben der Schlachtkörper wurden nach dem Enthaaren und bevor dem Kühlen genommen. In den Proben die bevor dem Kühlen genommen wurden war die Gesamtkeimzahl signifikant niedriger wenn die Schweine mit kondensiertem Wasserdampf bebrüht wurden. Dagegen wurde kein signifikanter Unterschied zwischen den Brühverfahren an den Proben die nach dem Brühen und Enthaaren genommen wurden festgestellt.

Mirobiologische Analysen von Haut- und Muskelproben der Vorderbeine die gekühlt gelagert wurden während 7 bis 13 Tagen, wurden durchgeführt. Die Gesamtkeimzahl auf der Haut und in der Muskulatur war niedriger wenn die Schweine mit kondensiertem Wasserdampf bebrüht wurden. Der Unterschied war von solcher Grössenordnung, dass es für die Praxis interessant sein dürfte. Jedoch war die Gesamtkeimzahl immer höher auf der Haut als in der Muskulatur. Der Unterschied in der Gesamtkeimzahl der Haut zwischen den beiden Verfahren war klein.

Die Kosten für das Brühen mit kondensiertem Wasserdampf waren höher als die Kosten für das Bebrühen im Kessel. Der Unterschied war zum grössten Teil auf die Investierungskosten zurückzuführen.

ВОПРОСЫ ГИГИЕНЫ И ЭКОНОМИИ ПРИ СКОЛЬДИРОВАНИИ КОНДЕНСИРОВАННЫМ ВОДЯНЫМ ПАРОМ И В ЧАНЕ

КРИСТИАН НИКЕЛЬС, ИНГЕМАР СВЕНССОН, АНДЕРС ТЕРНСТРЕМ и ЛАРС ВИКБЕРГ

Шведский мясной научно-исследовательский центр, Чевлинге

Сравнение операций скольдирования убойных свиней конденсированным водяным паром и в чане производится с особым упором на вопросы гигиены и экономии.

Образцы шкуры брались после обезволашивания и перед охлаждением туши. Результаты, полученные при исследовании образцов,взятых до охлаждения показали, что общее количество бактерий в них значительно меньше такового для свиных шкур, скольдирование которых производилось конденсированным водяным паром. Однако, какой-либо существенной разницы между двумя методами скольдирования на образцах, взятых после скольдирования и обезволашивания обнаружено не было.

Микробиологический анализ образцов шкур и мускулов, взятых с передних ног был выполнен после холодильного хранения в течение от 7 до 13 дней. Общее количество бактерий на шкуре и в мускулах было ниже при скольдировании конденсированным водяным паром. Разница в количестве бактерий в мускулах выражалась такой величиной, которая представляет практический интерес. Тем не менее общее количество бактерий на шкуре было настолько велико, что разница в обсеменности бактериями более не представляла практического интереса.

Стоимость скольдирования конденсированным водяным паром оказалась выше стоимости скольдирования в чане, в основном за счет разницы в капиталовложениях.

HYGIENE AND ECONOMY OF SCALDING WITH CONDENSED WATER VAPOR AND IN TANK

CHRISTIAN NICKELS, INGEMAR SVENSSON[1], ANDERS TERNSTRÖM AND LARS WICKBERG[2]

Swedish Meat Research Centre, Kävlinge, Sweden

INTRODUCTION

Several authors (i.e. 1,2,3,4,5,6,7,) have questioned the hygienic conditions of scalding slaughter pigs in tank. Enrichment of spore forming bacteria has been demonstrated by Prost and Libelt (8). Ekstam (4) even found eggs of Ascaris lumbricoides and Thriciuris thriciura in scalding water. Ekstam also concluded that scalding water during the scalding process is forced not only into the lungs but also into the vascular system of the animal.

In order to improve hygiene in the scalding of slaughter pigs different systems based on scalding in a hanging position have been developed (3, 5, 9, 10).

The aim of this work has been to compare the hygiene and economy of scalding in a tunnel using condensed water vapor with conventional scalding in a tank.

MATERIAL AND METHODS

The principle for scalding with water vapor is demonstrated in fig. 1, and has been described elsewhere (5, 6). The system is also known as the Ekstam system.

In order to make reading of the present work easier the two scalding systems are henceforth referred to as system A and system B.
System A represents the scalding with water vapor in a hanging position followed by dehairing in a vertical position.
System B represents conventional scalding in a tank and dehairing in a horizontal position.

Details about the construction of system A may be obtained from the manufacturer (Meat Industry Technique AB, (MITAB), MALMÖ, Sweden).

The testing of system A was performed at the slaughterhouse of KBS, Kristianstad, where scalding and dehairing in a vertical position has been in use for four years.

As for system B a conventional scalding tank (8,0 x 1,9 x 1,5 meters, capacity 180 pigs/h) followed by a single roller dehairing machine has been used. The equipment was installed at the slaughterhouse of Skanek, Kävlinge.

Data on scalding times and temperatures are shown in table 1.

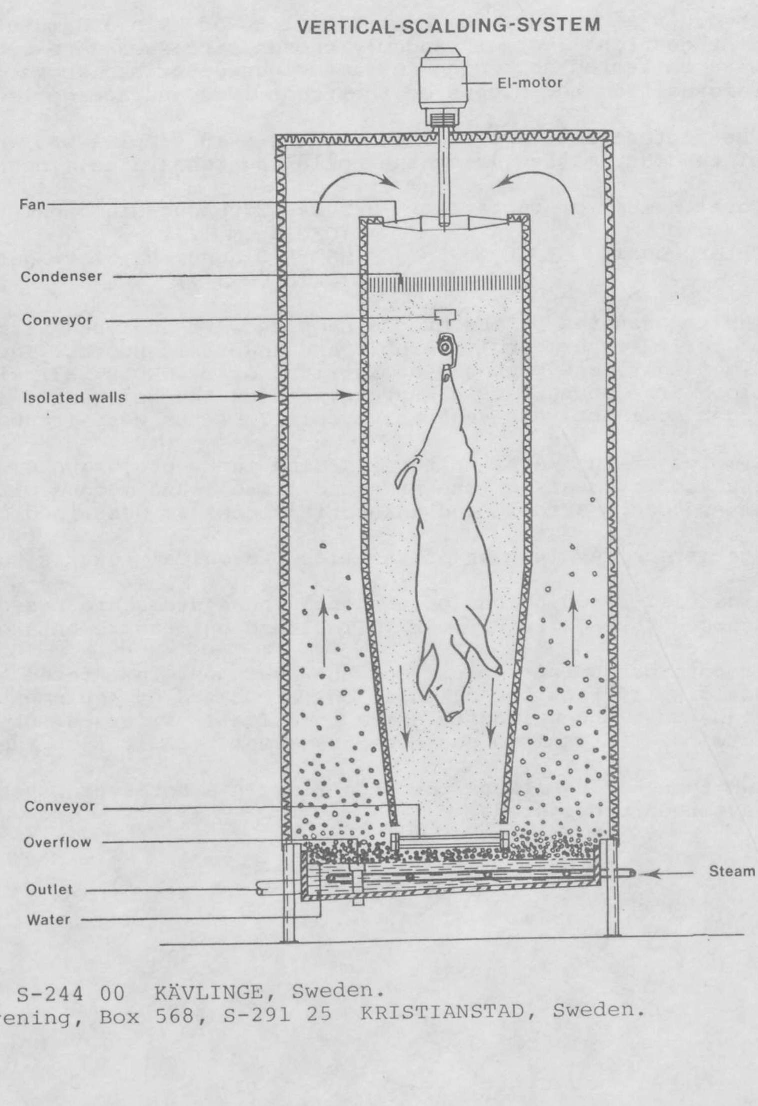

Fig. 1. Principle for scalding with condensed water vapor. (Meat Industry Technique AB, (MITAB), Malmö, Sweden).

Present address:
1. Skånska Andelsslakterier, Box 34, S-244 00 KÄVLINGE, Sweden.
2. Kristianstad-Blekinge Slakteriförening, Box 568, S-291 25 KRISTIANSTAD, Sweden.

Table 1. Scalding times and temperatures for system A and system B.

Scalding system		Time for passage s	Temp. °C
A	Scalding tunnel	420	60
	Dehairing tunnel	80	45
B	Scalding tank	330	60
	Dehairing	32	25

The steam and water consumption during scalding was measured. The use of electrical power was calculated by noting the stated effect of each engine. Measurements were taken over a one month period.

Pigs for microbiological tests were randomly selected during a slaughter period of 4 hours. Sampling days were always Tuesdays or Wednesdays. On each experimental day samples were taken from 20 animals. From these animals 10 were chosen randomly for measurements of the bacterial load in a muscle and on the skin after storage. The microbiological investigations were performed during summer in order to avoid seasonal variations.

Samples for microbiological analyses of the skin were taken by means of a cork borrer with a diameter of 2 cm (area 3,1 cm^2). From each carcass a pair of samples of the skin on the belly side at the height of the last rib were taken immediately after dehairing and a second pair were taken at the end of the slaughterline. The samples were transferred to bottles containing an adequate amount of physiological saline containing 0.1% peptone. The samples were then kept at 0 - +4°C. Before analysing the peptone salt solution for bacterial content the bottles were shaken for 30 min. at a temperature of +2°C.

In order to measure the bacterial load of skin and muscle parts of the carcasses after storage front legs of randomly chosen carcasses were cut off. After storage skin samples were collected according to the method described above. Muscle samples of 30 g were removed from the biceps of the front legs and homogenized in a stomacher.

The peptone salt solution containing skin samples was analysed by means of the standard plate count method using the following substrates, incubation temperatures and times.

Total number of bacteria	TGEA (Tryptone-Glucose-Extract-agar) (OXOID CM 127)	30°C	3 days
Enterococci	SB (Slanetz-Bartley-Agar) (OXID CM 377)	37°C	2 days

The homogenates of the muscle samples were analysed with respect to the total number of bacteria, enterococci, aerobic and anaerobic spores. The substrate used for spore counts, Blood-Agar, was composed of Nutrient Agar (OXOID CM3) with the addition of 7 per cent blood from young cattle. Before seeding the homogenate was heated to 80°C for 10 min. in order to inactivate vegetative cells. Plates were incubated at 37°C for 2 days.

Samples of the water in the scalding tank were drawn every 30 min. Scalding water was analysed by means of the standard plate count method with respect to the total count, enterococci, aerobic and anaerobic spores as described earlier.

Statistical evaluation of the microbiological results was performed by means of t-test.

Financial calculations on the scalding systems are based on a tender from the manufacturer of both types of equipment (MITAB) and on measurements of water, steam and power consumption.

In both cases the capacity of the equipment was stated to be 180 pigs/h. As for the scalding in tank the calculations are based on equipment of the automatic type, which means that the carcasses are automatically immersed into the scalding water, transported forward, lifted into and rejected automatically from the dehairing equipment.

Two types of equipment for dehairing in a horizontal position with one and two rollers, have been considered.

RESULTS AND DISCUSSION

Microbiological data

The results from the microbiological analyses are presented in tables 2-6.

In the tables and in the text all bacterial counts are expressed as ^{10}log. units/cm^2 if not otherwise stated.

The comparison of total bacterial counts found on the skin immediately after scalding and dehairing in systems A and B are shown in table 2.

Table 2. Total number of bacteria on skin immediately after scalding and dehairing. All values represent the mean of 20 samples.

Sampling day	System A	System B
1	4.47	3.72
2	3.62	3.71
3	4.12	4.04
4	3.70	3.67
5	4.16	3.67
Total mean value	4.01	3.67
Standard deviation	0.44	0.37
Total number of samples	100	100

Counts of enterococci found on the skin at this stage of the slaughter line are not presented in detail as the number of enterococci was less than, or equal to, 2.00 in 99 samples out of 100 irrespective of the scalding and dehairing method.

As may be seen from these data the difference in total counts on the skin between the two methods is small. In spite of being statistically significant ($p < 0,001$) it is probably of minor practical importance.

Data on the hygienic standard of the scalding water from the tank are presented in table 3. As water used in system A is condensed water vapor it was considered sterile.

Table 3. Microbiological standard of tank scalding water. Counts in ^{10}log. units/ml.

Sampling day	Total number	Enterococci	Aerobic sporeformers	Anaerobic sporeformers	Number of samples
1	2.66	<1.00	1.05	1.10	6
2	3.28	<1.00	1.10	<1.00	3
3	4.40	1.32	1.27	1.00	4
4	2.91	<1.00	<1.00	1.00	4
5	3.14	1.00	1.11	<1.00	4
Total mean value	3.22	1.06	1.10	1.03	21
Standard deviation	0.72				

The hygienic standard of the scalding water in the tank may vary considerably as indicated by the results presented in table 3. Total counts found in this investigation are of the same magnitude as those published by Snijders (7). Spore counts, however, seem to be lower than those quoted by other authors (4, 8). The highest values found in this work are 1.48 for aerobic spores and 1.30 for anaerobic spores.

Data on the microbiological standard of skin at the end of the slaughterlines, i.e. immediately before chilling of the carcasses, are presented in table 4.

Table 4. Total number of bacteria on skin at the end of the slaughter line. All values represent the mean of 20 samples.

Sampling day	System A	System B
1	3.42	3.52
2	3.52	3.58
3	3.06	3.90
4	3.56	3.59
5	3.30	3.71
Total mean value	3.37	3.66
Standard deviation	0.42	0.34
Total number of samples	100	99

Results in table 4 indicate a small, but statistically significant difference ($p < 0,001$) between the two slaughterlines with regard to total counts.

A comparison between the results in table 2 (sampling immediately after scalding and dehairing) and those in table 4 (sampling at the end of the slaughterlines) reveals a reduction in total counts on the skin. In both cases the reduction is statistically significant ($p < 0,001$). Furthermore, the total counts on the skin at this stage of the line are lower for pigs treated by system A than for pigs treated by system B.

The number of enterococci, however, has increased compared to the samples taken after scalding and dehairing. Only in 78 samples out of 100 were the number of enterococci on the skin less than, or equal to, 2.00 when system A was used. As for system B the corresponding results were 93 samples with less than, or equal to, 2.00.

These observations show that the slaughter equipment after scalding and dehairing and the hygienic standard in dressing of the carcasses is of great importance for the bacterial load on the skin.

As described in material and methods the front legs of randomly chosen pigs from each scalding alternative were stored at different temperatures and relative humidities for 7 or 13 days in order to record any differences in the microbiological standard of the skin after storage. The results from these experiments are presented in table 5.

Table 5. Total number of bacteria on skin from front legs after storage at different conditions. All values represent the mean of 10 samples.

Storage conditions	Sampling day	System A	System B
3.5°C 85% RH 13 days	1	7.51	6.81
	2	6.72	7.20
Total mean value		7.11	7.01
Standard deviation		0.93	1.00
Total number of samples		20	20
7.5°C 90-95% RH 7 days	3	8.24	8.53
	4	7.86	8.59
	5	8.28	8.81
Total mean value		8.13	8.64
Standard deviation		0.45	0.32
Total number of samples		30	30

As may be seen from the figures in table 5, total counts on the skin are of the same magnitude independent of the scalding system. The differences are not statistically significant.

Data on total bacterial counts in muscle samples after storage are presented in table 6.

Table 6. Total number of bacteria in muscle of front legs after storage at different conditions. All values represent the mean of 10 samples.

Storage conditions	Sampling day	System A	System B
3.5°C 13 days	1	2.98	5.21
	2	3.28	4.71
Total mean value		3.13	4.96
Standard deviation		1.56	1.43
Total number of samples		20	20
7.5°C 7 days	3	4.29	5.28
	4	2.53	3.91
	5	4.04	3.86
Total mean value		3.62	4.35
Standard deviation		1.21	1.02
Total number of samples		30	30

The results in table 6 indicate that the microbiological quality of meat may be improved by scalding with water vapor in a vertical position. The difference in total counts in biceps brachii after storage for 13 days at 3.5^{o}C is highly significant ($p < 0,001$). The level of significance is, however, lower ($p < 0,02$) when the legs were stored for 7 days at 7,5^{o}C.

In all muscle samples the number of enterococci, aerobic and anaerobic spores were less than 1.00.

FINANCIAL CONSIDERATIONS

A calculation model is presented in tables 7 and 8. The life time of both types of scalding equipment is in this calculation considered as being 10 years. The depression of interest in the calculation is based on an interest of 10% calculated on 50% of the total investment. For both types of equipment the capacity is stated to be 180 pigs/h which means a total slaughter capacity of about 300.000 pigs a year.

As may be seen from tables 7 and 8 the main part of the difference in total costs between the scalding systems is due to investment costs.

When scalding in a hanging position the lungs may be used for human consumption as there is no reason to believe that they are contaminated with scalding water. As there is no realistic price for pig lungs, this source of income has not been taken into account in the calculations.

Dehairing in a vertical position caused certain damage around the anus. The economical effect of this damage seems to be of minor importance and has therefore not been taken into account.

Table 7. Investment and installation costs.

	System A
Horizontal debleeding table	62.000 Sw. Cr.
Vertical scalding tunnel	525.000
Vertical dehairing equipment	222.500
Belly scraper	23.000
Hind leg scraper	18.300
Hind leg nail remover	4.500
Installation costs	128.296
Total investment	983.595 Sw. Cr.

System B	Alt. I	Alt. II
Automatic scalding tank	104.000 Sw. Cr.	104.000 Sw. Cr.
One roller dehairer	62.000	–
Two roller dehairer	–	134.000
Gamberling table	5.400	5.400
Installation costs	12.855	12.255
Total investment	184.255 Sw. Cr.	261.655 Sw. Cr.

Table 8. Costs of running and maintenance.

System A.
Costs per 1.000 pigs:

	Consumption	Price/unit	Costs
Electricity	304 kWh	0.11 Sw. Cr.	33.44 Sw.Cr.
Steam	5.7 tons	42.70	243.39
Cold water	54.2 m^3	2.50	135.50
Spare parts and maintenance			221.69
Total running costs			634.02 Sw. Cr.

Costs per slaughtered unit:

Running costs	0.63 Sw. Cr.
Capital costs	0.49
Labour costs	0.50
Total costs per slaughtered unit	1.62 Sw.Cr.

System B.
Costs per 1.000 pigs:

	Consumption		Price/unit	Costs	
	Alt. I 1)	Alt. II 2)		Alt. I	Alt. II
Electricity	85 kWh	142 kWh	0.11 Sw. Cr.	9.35 Sw. Cr.	15.62 Sw. Cr.
Steam	1.3 ton	1.3 ton	42.70	56.36	56.36
Hot water	24.7 m^3	34.7 m^3	5.15	127.21	178.71
Cold water	35.2 m^3	60.0 m^3	2.50	88.00	150.00
Spare parts and maintenance				97.24	165.51
Total running costs				378.16	566.20

Costs per slaughtered unit:

	Alt. I	Alt. II
Running costs	0.38 Sw. Cr.	0.57 Sw. Cr.
Capital costs	0.09	0.13
Labour costs	0.50	0.50
Total costs per slaughtered unit	0.97	1.20

1) One roller dehairer
2) Two roller dehairer, figures calculated from data given by the manufacturer (MITAB)

CONCLUSIONS

The results from the microbiological analysis of skin samples show that only small, although statistically significant differences in bacterial load occur between the two scalding systems.

Technical design of the slaughterline after scalding and dehairing together with dressing of the carcasses is obviously of great importance for the microbiological standard of the skin before chilling and thus for the appearance of the carcasses after storage.

However, microbiological analysis of muscle parts from front legs stored at chilling temperatures for different periods of time revealed lower bacterial loads when scalding with water vapor. The differences found should be of practical interest.

These results support the conclusion of Ekstam (4) that microorganisms from the scalding water when scalding in tank may invade the vascular system and thus contaminate the meat. However, the connection between the scalding method and meat quality should be investigated further.

Mainly due to the higher investments, the costs for scalding with water vapor and vertical dehairing (Ekstam system) are higher than the costs for scalding in tank and horizontal dehairing.

References

1. Gisske, W. und Klemm, G.: Beeinflussung des Hautkeimgehaltes bei Schlachtschweinen durch verschiedene Brühverfahren. Fleischwirtschaft 15, 288-291 (1963).
2. Glees, A., Danneil, E., Gattermann, W. und Kamm, E.: Erfahrungen mit der ersten Durchlaufanlage zum Brühen und Enthaaren von Schweinen im Hängen. Fleischwirtschaft 45, 1411-1416 (1965).
3. Becker, G.: Brühen und Entborsten der Schweine im Hängen. Fleischwirtschaft 38, 763-765 (1958).
4. Ekstam, M.: Skållvatten, en infektionskälla. Medlemsblad för Sveriges Veterinärförbund nr 10 (1963) (In Swedish).
5. Tändler, K.: Hygienisch vorbildliche Schweineschlachtung. Fleischwirtschaft 54, 1425-1426 (1974).
6. Nilsson, R. and Persson, K.: Preliminära försök med hängande skållning av svin i skålltunnel konstruerad av överveterinär Mats Ekstam vid KBS i Kristianstad. Report nr 6 from The Swedish Meat Research Centre (1968). (In Swedish).
7. Snijders, J.M.A.: Hygiene bei der Schlachtung von Schweinen. 1. Das Brühen der Schlachtschweine. Fleischwirtschaft 55, 836-840 (1975).
8. Prost, E. und Libelt, K.: Variabilität der bakteriellen Kontamination der Schlachttierkörper und des Brühwassers bei der Schlachtung von Schweinen. Fleischwirtschaft 52, 867-870 (1972).
9. Becher, C.: Verfahren zur Entborstung von Schlachtschweinen mit Infrarot-Strahlen. S.V.Z. 59, 108-112 (1959).
10. Gisske, W. und Bozkurt, M: Brühen der Schweine im Hängen. Fleischwirtschaft 15, 284-287 (1963).