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THE LOSSES OF LIVE WEIGHT, TISSUE SHRINKAGE, CARCASS YIELD AND CHANGES OF SOME PROPERTIES OF MEAT OF SLAUGHTER PIGS OWING TO THE TRANSPORTATION

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The Losses of Live Weight, Tissue Shrinkage, Carcass Yield and Changes of Some Properties of Meat of Slaughter Pigs owing to the Transportation

The task of the work is to find out what losses of live weight, tissue shrinkage, carcass yield and what changes of some properties of meat arrise with slaughter pigs owing to the transportation by truck.

Material and Methods

Experiments with clinically healthy pigs - from large-scale fattening station - of Czech white Breed, 50% of barrows and 50% of gilts, being of weight about 100 kg, fed in the way of automatic feeding of dry complete mixtures with the content of 11% of proteins were carried out in May 1966; the average temperature was 20°. There were three experimental groups, each of them ten by ten pigs.

1) The check group (further only the group 1) was transported to slaughterhouse in cages with iron-plate inside and the pigs were - without resting - slaughtered. Each pig was placed in one cage which was equipped - in a declivate corner - with an outlet pipe by means of which the excreted urine was drained off through a small hose into a plastic bottle. In this manner it was possible to catch and to weigh the urine and faeces regularly. The transportation of a group lasted 1,30 hour and the weight of excreted faeces and urine, during the transportation, was added to the live weight.

2) The second group including 10 pigs (further only the group 2) was continuously transported by means of a motor truck within 24 hours. During the transportation the pigs and the excreted faeces and urine were weighed out after 6 and 12 hours. After the transportation the pigs were slaughtered without resting. The total figure was 642 km at the average speed of about 27 km/hr.

3) After a short transportation to slaughterhouse the last group of pigs (further only the group 3) was kept in cages without watering and feeding. Weighing of pigs, faeces and urine was carried out after 6, 12, 24, 48, 72, 96 and 112 hours. After 96 hours 5 pigs - without feeding and watering - (further only the group 3 a) were slaughtered, the remaining 5 pigs (further the group 3 b) were watered ad libitum and the pigs were slaughtered the second day, i.e. after 112 hours without feeding and after 96 hours without watering. Immediately after slaughter the samples were aseptically cut off from the depth of ham in order to determine the number of microorganisms according to the standard CSN 570155; then pH_{45} was measured in musculus gracilis 45 minutes after slaughter; 24 hours after slaughter the sample was cut off from m. longissimus dorsi between the 10th and the 14th rib and organoleptic evaluation of colour, flavour and tenderness was carried out. Then we continued in quantitative estimating of the total percent moisture, $pH_{ult.}$, the water holding capacity of meat according to Grau-Hamm's method with a sample weighing 0,5 g and under the pressure of 2 kg, the soluble proteins using colorimetric method and biuret reaction in the normal and alkaline solution of NaCl and the amount of ammonia and nitrogen bases. The amount of ammonia was then estimated the 5th, 8th and 12th day during the storing of samples at refrigerating temperatures. Immediately after slaughter individual organs, blood and carcasses were carried away.

The Loss of the live weight is the difference of the live weight before the experiment and after a certain period, the loss of the tissue shrinkage is the loss of the live weight after the subtraction the weight of faeces and urine.

Evaluating the results the mathematical-statistic methods were used.

Results

a) Losses of live weight

The losses of live weight converted into 100 kg of live weight in arithmetic averages are reported in Table I.

Losses of Live weight converted into 100 kg of live weight
Table I.

Hours	6	12	24	48	72	96	112
Group 2	0,55	1,00	2,01	-	-	-	-
Group 3	0,56	0,83	2,55	3,72	5,05	6,49	6,66

Comparing differences of two averages it was determined that the losses of live weight of the group 2 are in both time intervals statistically significant at the 1 % significance level and the same conditions are also in the group 3. The time interval between 96 and 112 hours of the group 3 is statistically insignificant. The differences of losses of the groups 2 and 3 in the same time interval are statistically insignificant. Hence it follows that the transportation and resting without watering and feeding significantly influence losses of live weight. The loss did not practically occur already in the further interval after watering 5 pigs of the group 3 b. This fact refers to a great importance of watering during longer transportation and resting. Finally it is possible to note thatthe losses of the live weight during the transportation and resting are the same, the differences are not statistically significant.

The losses of live weight during the first 12 hours under the condition of the transportation and resting indicate a considerable variability, i.e. 33,00 - 49,10% which decreases only after 24 hours up to the level of 18,00 - 25.00 %. The high variability in the first 12 hours is influenced by various degree of excretion of faeces and unrine. Therefore we can claim that all these facts are influenced by individual properties of each pig reacting variably on the change of environment, body effort and other stress conditions, especially in the first 24 hours.

For this reason it is also possible to notice considerable differences in the amount of excreted urine and faeces and in the loss of tissue shrinkage. The amount of faeces and urine of the group 2 was 1,01 kg and 1,60 kg of the group 3 after 24 hours.

In general it is possible to conclude that the loss of live weight of pigs fed with complete dry mixtures makes 2,0 - 2,5 kg, after the first 24 hours during transportation and resting without feeding and watering and approximately 1,2 kg after further 24 hours; then about 1,3 kg and finally about 1,4 kg in a period from 72 to 96 hours.

b) Losses of tissue shrinkage

Losses of tissue shrinkage converted into 100 kg of live weight in arithmetic averages are reported in Table II.

Losses of tissue shrinkage converted into 100 kg of live weight

Table II.

Hours	6	12	24	48	72	96	112
Group 2	0,16	0,35	1,00	-	-	-	-
Group 3	0,25	0,32	0,78	1,52	2,37	3,16	2,66

Comparing differences of two averages it was determined that the differences of losses of tissue shrinkage of the group 2, at the interval of 6-12 hours, are statistically significant at the 10% level, at the interval 12 - 24 hours at the 1% level, in the group 3 the differences at the interval of 6-12 hours and 96 - 112 hours are statistically insignificant; at all other intervals are significant at the 1% level. The differences of losses of the groups 2 and 3 at time intervals of 6 and 12 hours are statistically insignificant, but at the interval of 24 hours is the difference statistically significant at the 1% level. This indicates that the transportation and resting without feeding and watering significantly influence the losses of tissue shrinkage. In the group 3 the interval within 96 and 112 hours indicates that the loss of weight did not occur after watering 5 pigs of the group 3 b.

The statistic significance of differences of losses of the groups 2 and 3, after 24 hours, indicates that during the transportation higher decreases of tissue shrinkage considerably occur in comparison with only resting pigs; the decrease makes 0,216 kg, i.e. 27,6% which can be presupposed because during the transportation body metabolism, respiration and perhaps also transpiration of body surface probably increases owing to the increased physical effort and nervous irritation . In further time intervals of transportation the increased losses can be presupposed in comparison with only resting pigs, too. The increase makes about 20%.

The losses of tissue shrinkage in the course of 12 hours of the groups 2 and 3 indicate high variability which decreases only after 24 hours. The values are then about 20%. The variability refers again to the various ability of the animal to react on various influences.

In general, it is possible to notice that the pigs weighing 100 kg, fed in the manner of automatic feeding of dry complete mixtures, have nearly regular decrease of tissue shrinkage, about 0,80 kg, during resting without feeding and watering, in the course of 24 hours intervals. During the transportation the loss makes 1 kg from 100 kg of live weight after the first 24 hours. Presupposing that also in further time intervals the comparison with the group of resting pigs and the increase of the loss by 20% of live weight occurs, the loss of tissue shrinkage will probably make 1,80 kg after 48 hours, 2,80 kg after 72 hours and 3,80 kg after 96 hours.

c) Losses of carcass yield

Comparing yields of half carcasses including heads of individual groups immediately after slaughter it was ascertained that the groups 1 and 2 indicated nearly the same amount of yield, on the average 81,14%. The group 3 a indicated the yield 78,84%, 3b 79,60%. In comparison with the standard CSN 466160 the yield of the groups 1 and 2 corresponds to standardized yield, in the group 3a the difference is 2,36% and in the group 3b 1,60%.

Between the groups 3a and 3 b the difference is 0,76%. It means that yields do not change after the transportation, lasting 24 hours; of course a substantial decrease occurs after 96 hours without feeding and watering. The yield of the group 3b increased - owing to the watering of pigs - in comparison with the group 3a. In means that the substantial component in relation to the decrease of yield and simultaneously to the loss of tissue shrinkage (without feeding and watering), is the removal of water from tissues of body and probably from muscular tissue, too.

Interesting results occurred after the more efficient analysis of the loss of tissue shrinkage and yield of half carcasses. It is evident in Table III.

Weight losses in relation to the entrails in kg (arithmetic averages) Table III.

Group	Pluck	Liver	Blood	Stomach		Small Intest.		Large Intest.	
				full	empty	Full	Empty	full	empty
1	2,16	1,61	3,55	2,06	0,61	2,45	1,54	3,56	1,91
2	2,12	1,47	3,31	1,04	0,58	1,94	1,52	2,88	1,93
3a	1,78	1,97	2,54	0,48	0,48	1,50	1,07	1,79	1,37
3b	2,01	1,01	3,14	0,56	0,49	1,27	1,05	1,58	1,28

Comparing the groups 1 and 2 a significant loss of the weight of liver and especially of blood was evident. Comparing the groups 1 and 3a a significant loss of the weight of liver and blood, partly of pluck was evident. The comparison of the groups 3a and 3b indicated a significant change of pluck and blood weight after watering of pigs; on the other hand the differences of liver weight were quite insignificant; for this reason it wan ben concluded that the weight loss of pluck was quite balanced after watering pigs of the group 3b; the weight loss of blood was balanced partially but very expressively. On the other hand the weight loss of liver was lasting even after watering; thus it means that the loss of tissue shrinkage arises from the decrease of liver weight, probably by reduction of glycogen and reserve proteins, by removing water from blood, connective tissue and probably muscular tissue and finally by gradual reduction of reserve substances in body, especially of fat tissue.

The reduction of glycogen and mainly of reserve proteins from liver begins already during the first 24 hours and an evident thickening of blood occurs, too. After watering the weight increases of all organs of pigs of the group 3b practically occurred; on the contrary the weight of small and large intestines including the content considerably decreased. At the same time the pigs did not excrete faeces and urine. This weight decrease is unexpected and it is not possible to give reasons for it. The weight difference of empty small and large intestines and also stomachs among the groups 1, eventually 2 and 3a, eventually 3b is conspicuous.

d) Changes of some meat properties

No marked differences of individual groups were evident after organoleptic evaluation of colour, flavour and tenderness of meat samples, cut off from musculus long dorsi. The values of objective coefficients are evident in arithmetic averages with the deviation in Table IV.

The results of pH_{45}, pH_{ult} and the total percent moisture are the least variable objective coefficients. The group 1 indicates the most balanced course of glycolysis, the group 3a and 3b indicate an accelerated course and the group 2 indicates a gradualer course of glycolysis; pH_{ult} exceeded in no case the critical value 6,2. The group 2 has relatively the superlative value, the other groups become established on the values within 5,30 - 5,38. In general, it can be noted that owing to the transportation the course of glycolysis slows down, but on the contrary it accelerates after a longer interval without feeding and watering; pH_{ult} increases owing to the transportation. The total percent moisture in the samples of muscular tissue indicates only small differences between groups, except the group 1 where the percent moisture is considerably decreased. A considerable difference is also between the groups 3a and 3b, which confirms the premise of ascertainment already during the estimation of carcass yield; hence it follows that the muscular tissue without a long-lasting watering loses water, too; the decrease is balanced after watering.

Table IV: Analytical values of criterions of meat of experimental and check pigs

Group of animals	pH		H_2O total	WHC cm^2/500 kg	Solubility of proteins		mg% NH_3				Microorganisms amount in 1 g
	45	ult			normal NaCl	alkal. NaCl	24hr.	5 day	8day	12. day	
1	6,33 (±0,26)	5,38 (±0,06)	69,89 (±1,22)	7,49 (±0,83)	0,170 (±0,02)	0,177 (±0,04)	11,66 (±4,26)	28,34 (±5,41)	32,84 (±3,89)	43,17 (±13,39)	150,00 (±138,80)
2	6,45 (±0,18)	5,52 (±0,20)	71,93 (±1,90)	7,27 (±1,66)	0,191 (±0,03)	0,187 (±0,02)	8,50 (±1,53)	23,69 (±3,65)	24,84 (±4,71)	36,17 (±6,87)	137,00 (±184,90)
3a	6,05 (±0,10)	5,30 (±0,06)	71,34 (±1,28)	7,94 (±0,77)	0,182 (±0,02)	0,228 (±0,02)	22,96 (±3,90)	18,03 (±1,33)	29,91 (±3,19)	35,22 (±4,11)	26,00 (± 17,44)
3b	5,99 (±0,10)	5,37 (±0,07)	72,28 (±0,68)	7,06 (±0,67)	0,205 (±0,04)	0,301 (±0,02)	24,20 (± 4,24)	29,98 (±5,56)	21,31 (±2,43)	34,25 (±4,60)	128,50 (±177,20)

If we estimate the group 1 as a check one, the group 3b has relatively the best water holding capacity, the group 2 has a slightly increased WHC and the group 3a has a little worse WHC. Even when the differences are not great it is possible to conclude that the transportation within 24 hours does not negatively influence water holding capacity and not even resting including watering. On the other hand the group during long resting and without watering has a little worse WHC.

At the evaluation of the soluble proteins amount the results of the group 3b bear resemblance to the results reported in the literature as the normal ones. The group 3a indicates relatively good results. The other groups have less valuable results which proves an irregular course of rigor mortis. In the group 2 the influence of rigor mortis did not practically become evident because the relation of extinctions in a normal and an alkaline solution of NaCl nearly equals 1. The solubility is also higher in a normal solution. Relatively the least valuable results were established in the group 1. The decrease of solubility of proteins probably occurred owing to their denaturing. In general, it can be noted that the resting without feeding and watering did not influence the solubility of proteins, of course the transportation as well as a short-termed one relatively influenced these results. Probably the breaking of proteins structure - their denaturation - occurred. The content of ammonia and nitrogen bases was practically in all groups on or above the critical limit, i.e. 35 mg%, after the 12 days storage. All samples organolepticly showed features of initial decay after the 12 days storage. The samples of the group 3a and 3b showed the relatively best results, the samples of the group 1 showed the relatively worse results. In general, it can be noted that the shelf-life of meat at refrigerating temperatures was not relatively decreased owing to the transportation within 24 hours and owing to longer resting without feeding and watering. Contrary to all logical premises the group 3 a showed the lowest amount of germs in one gram, the group 1 showed the highest amount. Of course the results do not differ in their numeral order and therefore it is necessary to estimate carefully the differences. In general, it can be noted, that by this method we were not able to prove the influence of transportation and resting on the quality of meat.

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SUMMARY

The losses of live weight, tissue shrinkage, carcass yield and chrnges of some properties of meat of slaughter pigs after the transportation and resting were ascertained. Experiments were carried out in May 1966; the average temperature was 20°C. The results of experiments can be briefly summarized in this way:

1) The loss of live weight of pigs, fed in the way of automatic feeding of dry complete mixtures in influenced in the first 24 hours - both after resting (without feeding and watering) and after the transportation - above all by various degree of excretion of faeces and urine; the loss makes 2,0 - 2,5% after 24 hours, 3,7% after 48 hours, 5,0% after 72 hours and 6,5% after 96 hours.

2) The loss of tissue shrinkage, i.e. live weight minus faeces and urine - after resting without feeding and watering - makes 0,8% after 24 hours, 1,5% after 48 hours, 2,4% after 72 hours and 3,2% after 96 hours. After the transportation the loss makes 1% after 24 hours, 1,9% after 48 hours - probably on the basis of consideration. - 3% after 72 hours and 4% after 96 hours. Thus after 24 hours the increase of tissue shrinkage caused by transportation makes 27,6% in comparison with the group of resting pigs without feeding and watering.

3) The yield of half carcases immediately after slaughter after 24 hours transportation, was within the Czechoslovak norm CSN 466160 and was identical with the norm in relation to the halves of the check group of pigs. In comparison with the norm the difference of the resting group without feeding and watering makes approximately 2,4% after 96 hours and only 1,6% after watering, 12 hours before slaughter. This fact indicates the importance of regular watering of pigs during a long-termed transportation and resting before slaughter.

4) The transportation and resting did not influence the shelf-life of meat at refrigerating temperatures and the change of colour, flavour and tenderness of meat was not evident.

After a longer resting, especially without watering, the course of glycolysis accelerates, after a longer transportation, on the contrary it retards. The final pH_{ult} increases owing to a long-termed transportation and reaches the value about 6,0. The water holding capacity was increased after 24 hours transportation and as well as after a longer resting on the condition that the pigs were watered one day before slaughter. On the contrary, the water holding capacity got worse after a longer resting without feeding and watering. Resting did not nearly influence the solubility of proteins, but the transportation, as well as the short-termed one did not substantially influence these values. Probably the breaking of protein structure- their denaturation - occurred. By the method of determination of microorganisms amounts in 1g of muscular tissue we were not successful in proving the influence of transportation and resting on the quality of meat.

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