EFFECTS OF FREEZING AND THAWING ON THE SALTING PROCESS OF NORMAL AND PSE PORCINE MUSCLES

Severini, M., Cenci, G. and Vizzani, A., Istituto di Ispezione degli Alimenti di Origine Animale Università di Perugia, Via S. Costanzo 06100 Perugia, Italia

SUMMARY

The study was aimed at evaluating the effects of freezing and thawing on normal and PSE porcine Longissimus dorsi muscles salted by immersion in brine. Slices were frozen either 2 hr after slaughter or after 24 hr of storage at refrigeration temperature. After 7 days at -25°C, slices were either immersed in a 10% NaCl solution while frozen or thawed and then immersed in the brine. Slices were collected 48 hr later and used for evaluating weight change, salt content, moisture and protein content.

A comparison was made with unfrozen slices immersed in the brine 2 hr after slaughter.

The results show that normal late frozen muscles gained less weight and had a higher salt content than early frozen muscles. Moreover, the thawed samples showed a lower weight gain and a higher salt content than the samples immersed in brine while frozen. PSE muscles salted after thawing showed a very low weight gain and high salt content. On the other hand, those samples either early or late frozen which were immersed in brine while frozen showed high weight gain. However, the slices frozen late had a high salt content.

The conclusion arises that a long, cool storage period before freezing and the thawing before brining reduces the total weight gain after the salting process. Moreover, the amount of brine absorbed is increased and leads to a higher salt content. This effect is especially noticeable in PSE muscles.

INTRODUCTION

The freezing-thawing process affects the ability of normal and PSE porcine L. dorsi muscle to exchange salt and water during the immersion in brine (Severini et al. 1986).

Muscles frozen after chilling and thawed before brining in a 10% NaCl solution show a higher salt content than muscles salted after the refrigeration. However, PSE muscles have a slightly higher percentage of salt than the normal ones (Severini et al. 1987). This fact is due to the different amount of brine absorbed by the muscles and partly depends on the amount of water lost during the period of chilling and thawing.

Because the frozen-thawed muscles show a higher weight loss than the refrigerated muscles, they absorb more brine and this leads to a higher salt content. In PSE muscles this fact is stressed slightly more.

The present experiment was carried out to evaluate the relationships which exist between the early and late freezing process of normal and PSE muscles and the brining of these muscles while frozen or after thawing. The choice of the 10% salt concentration of the brine was made according to the highest weight gain previously observed in the muscle (Severini et al. 1986a). This makes it easier to study the water-salt exchanges.

MATERIALS AND METHODS

Normal and PSE Longissimus dorsi muscles were selected according to the appearance, the pH and the WHC at 1 hr post mortem from crossbred pigs weighing 120-140 Kg, conventionally slaughtered at a commercial abattoir.

Slices of about 50 g, 1.5 cm thick and with about the same surface area were taken across the muscle at 2 hr after death and then weighed.

1) Fresh slices were used for evaluating moisture and protein content.

2) Unfrozen slices were immediately immersed in a 10% NaCl solution and stored at 6°C. After 48 hr they were weighed again and analysed.

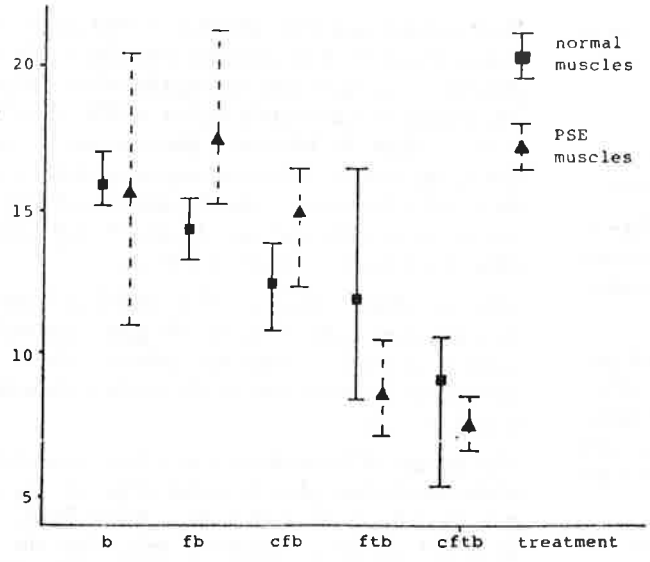

Fig. 1 . Percentage weight change.

b= brining; f= freezing; c= chilling; t= thawing

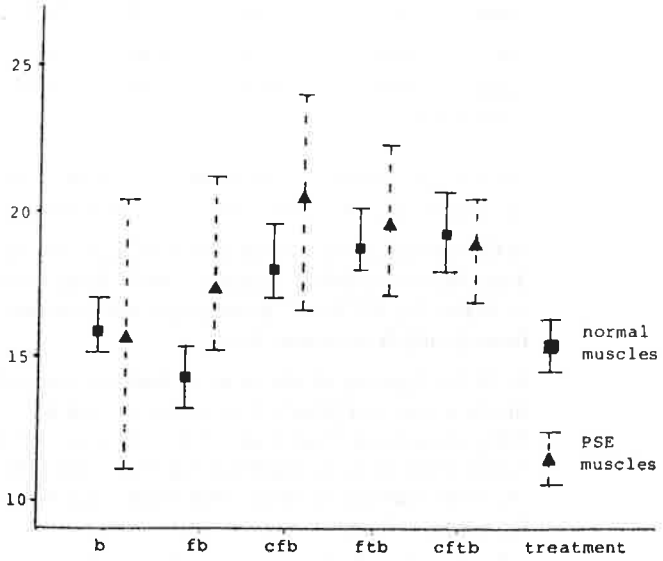

Fig. 2 . Brine absorption expressed as percentage of fresh muscle's weight.

b= brining; f= freezing; c= chilling; t= thawing

Table 1

Average weight changes[1]

muscle	after chilling	freezing process	after thawing	after brining
N		no		+15,87
PSE		no		+15,67
N		yes		+14,39
PSE		yes		+17,51
N	-5,48	yes		+12,62
PSE	-5,70	yes		+15,06
N		yes	- 6,88	+11,97
PSE		yes	-11,12	+ 8,64
N	-5,83	yes	-10,23	+ 9,15
PSE	-6,14	yes	-11,34	+ 7,84

(1) The weight changes are expressed as percentage of the weight of the fresh sample before brining.

Table 2

Average moisture, salt and protein content

muscle	treatment	percentage of moisture	salt	protein	moisture / protein
N	--	72,6	--	21,71	3,34
PSE	--	73,4	--	21,69	3,38
N	b	74,4	5,89	17,25	4,31
PSE	b	75,5	5,85	16,72	4,51
N	fb	75,2	5,73	16,59	4,53
PSE	fb	75,2	5,97	15,51	4,85
N	cfb	74,6	6,01	17,23	4,33
PSE	cfb	75,1	6,18	16,30	4,61
N	ftb	74,2	6,19	16,89	4,39
PSE	ftb	74,9	6,28	15,80	4,74
N	cftb	74,0	6,31	16,93	4,37
PSE	cftb	74,5	6,09	16,34	4,56

N = normal muscle; PSE = pale soft exudative muscle; b = brining; f = freezing; c = chilling; t = thawing

3) Other slices were frozen and stored at -25°C for 7 days. Then they were either immersed in the brine while frozen or thawed at 4°C for 24 hr weighed and then immersed in brine (early frozen muscles).

4) A final group of slices were laid on a metal net put inside a covered plastic box and cooled at 4°C for 24 hr. They were then frozen at -25°C and stored for 7 days. Some of them were immersed in brine while frozen and the rest thawed, weighed and immersed in brine.(late frozen muscles).

After brining all slices were weighed and analysed for salt content, moisture and protein content, according to standard AOAC procedures (AOAC 1984).

RESULTS AND DISCUSSION

Unfrozen muscles

The average values of the weight gain after brining in both normal and PSE muscles immersed unfrozen in salt solution at 2 hr after slaughter are very similar (Fig. 1; Tab. 1).

However, the PSE muscles show a wider range of values.

In this case the ability of the muscle to gain weight seems to depend on the ability of the muscle to absorb enough brine to reach the balance between the salt concentration in the muscle and in the brine. The different WHC values of the normal (WHC $>$ 2.0) and PSE (WHC $<$ 1.5) muscles at the beginning of brining do not greatly affect this ability. As a consequence, the salt content is more or less the same in both normal and PSE muscles (Tab. 2).

After brining the percentage of moisture is increased and the protein content is decreased more in PSE than in normal muscles. Therefore, the moisture/protein content ratio is higher in PSE than in normal muscles (Tab. 2).

Effect of freezing

a) Early freezing

The normal muscles frozen early and stored at -25°C for 7 days before brining show a slightly lower and the PSE muscles a slightly higher final weight gain (Fig. 1).

Due to the fact that the weight gain depends on the amount of brine absorbed, the normal muscles have a slightly lower and the PSE a slightly higher salt content (Fig. 2; Tab. 1 and 2).

The moisture/protein content ratio after brining is higher in these than in the unfrozen slices (Tab. 2).

Therefore, the brining of these muscles whilst frozen does not lead to any very important differences in comparison with the unfrozen muscles, even though the thawing process which takes place during the brining may slightly affect the weight gain and the salt absorption.

b) Late freezing

Both normal and PSE muscles cooled at 4°C for 24 hr before freezing show a weight loss due to the drip loss plus the evaporative loss during the refrigeration period. The weight loss is slightly higher in PSE than in normal muscles (Tab. 1). However, the amount of evaporative loss seems to have played an important role in balancing the total weight loss. Indeed, normal and PSE muscles always show different drip losses during refrigeration (Warriss 1982; Severini et al. 1986a).

After freezing, storing at -25°C and then brining, these muscles show a different weight gain: normal muscles reach lower values than the unfrozen slices and PSE muscles show values very similar to the unfrozen samples (Fig. 1; Tab. 1).

The amount of brine absorbed in these cases is the value of the weight loss plus the value of the final weight gain. It is therefore clear that the chilled-frozen muscles absorbed a greater amount of brine than the unfrozen ones (Fig. 2) and they have a higher salt content (Tab. 2). Nevertheless, the moisture/protein content ratio is

similar to that recorded in the unfrozen normal and PSE muscles (Tab. 2).

The chilling period had very little effect on the ability of PSE muscles to gain weight. This may depend on the fact that the characteristics of these muscles remain almost the same from the 2 nd to the 24 th hour after death at refrigeration temperature. On the contrary, chilling before freezing leads to a decrease in the ability of normal muscles to gain weight.

Effect of thawing

a) Before brining

Slices thawed at 4°C for 24 hr before brining show a different weight loss after the thawing (Tab. 1). Normal early frozen muscles decrease in weight less than those frozen late (after chilling).

PSE muscles show the same weight loss, whether they are frozen early or late. This value is slightly higher than that in normal muscles, frozen after chilling. It is evident that weight loss of muscles is increased more by the thawing process than by the chilling itself. However, the effect of thawing is greater in normal late frozen muscles and in PSE muscles whenever they are frozen. This might depend on a higher fragility of these muscles.

b) After brining

Both normal and PSE muscles thawed before brining show a lower weight gain after salting than those immersed in brine whilst frozen (early and late frozen) (Fig. 1).

The reduction in weight gain is especially marked in PSE muscles.

The amount of brine absorbed is similar in normal thawed and PSE thawed muscles (Fig. 2). However, in comparison with non-thawed muscles, the brine absorption is slightly higher in early and in late frozen normal muscles and in early frozen PSE muscles, but is slightly lower in late frozen PSE muscles.

The salt content appears to be closely related to the amount of brine absorbed (Tab. 2).

The moisture/protein content ratio in early frozen and thawed normal or PSE muscles, is lower than in non-thawed muscles, but is similar in late frozen and thawed or unthawed muscles.

The thawing process before brining seems to cause a decrease in the ability of the muscles to gain weight, even though the amount of brine absorbed is very high. Moreover, the ability of PSE muscles to absorb brine decreases if they are chilled before freezing and thawing.

CONCLUSIONS

Compared with unfrozen muscles salted 2 hr after death, freezing of normal and PSE muscles within few hours of slaughter slightly affects weight change and salt uptake if these are brined whilst frozen in a 10% NaCl solution. Chilling before freezing causes a lower weight gain especially in normal muscles and a higher salt absorption in both normal and PSE muscles.

Thawing before brining exaggerates the decrease of weight and the increase of salt content. Moreover, late freezing and thawing before brining seems to lead PSE muscles to a critical point where the weight gain reaches very low values and the salt uptake does not increase further. All these facts should be taken into account in order to plan the curing process of normal (Kemp et al. 1978) and, above all, of PSE muscles.

Moreover, it is important to consider that joints such as ham often present the PSE condition in a few muscles only, whereas the other muscles are normal. Curing these hams might therefore lead to a different hydration and salt concentration in the muscles.

REFERENCES

Kemp, J.D., Langlois, B.E. and Fox, J.D. (1978). *J. Food Science* **43**:860.

Severini, M., Cenci, G. and Vizzani, A. (1986). Recent Advances and Developments in the Refrigeration of Meat by Chilling. I.I.R. Paris, p363.

Severini, M., Cenci, G. and Vizzani, A. (1986a). Proceed. 32 nd European Meeting of Meat Research Workers p323.

Severini, M., Vizzani, A. and Cenci, G. (1987). Proceed. 33 rd Internat. Congress of Meat Sci. and Technol. p198.

Warriss, P.D. (1982). *J. Fd Technol.* **17**:573.