COMPARISON OF WATER RETENTION AND COLOUR OF MEAT TREATED WITH VARIOUS SALTS AT DIFFERENT pH VALUE

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Keywords: meat curing, water retention and colour of meat, pH value

INTRODUCTION

Sodium chloride and phosphates are among the most popular mixtures in use at present. Phosphates comprise several compounds differing in their functionality and in their influence on meat properties (Hamm 1972, Trout & Schmidt 1983). Recently, a groving interest has been observed in Europe in the possibility of carbonates application in meat processing and one of the main reason for this interest have been restrictions in the use of phosphates (Hammer 1993, Vösgen 1993). Several studies were performed showing possible mechanisms by which sodium chloride or phosphates may improve the water holding capacity (WHC) of meat (Offer & Trinick 1983). Carbonates and bicarbonates influence the WHC of meat through the moderate increasing of pH value. The possibility of a substitution of phosphates through carbonates and the influence of these compounds on some meat properties, namely on water retention and colour of meat the end pH value of which, after salt addition, was corrected to three defined levels i.e. 5.6, 6.0 and 6.4.was the main purpose of this paper.

MATERIAL AND METHODS

The experiments were conducted on lumbar part of m. longissimus dorsi. The muscle was cut out from six carcasses of two years old bulls 72 hours after slaughter. The pH value of meat varied from 5.3 to 5.7. Meat was minced twice and divided into five portions. Either water or solutions containing curing salts were mixed with each portion (60% by weight). To the first portion (C) water was added. The second portion (S) was treated the mixture containing sodium chloride, sodium nitrite and sodium ascorbate. To the third portion sodium pyrophosphate (P) plus components in (S) were added. In the fourth portion (CN) instead of pyrophosphates was used sodium carbonate and in the last (CH) - sodium carbonate was replaced by sodium bicarbonate. Each group was divided into 4 parts. The part 1 had no pH adjustment, part 2 was adjusted to pH 5.6, part 3 - to pH 6.0 and the last part - to pH 6.4. The carbonates and bicarbonates were added to meat of the fourth and fifth portion respectively in the amount which ensured the required pH value. These compounds were not added to the first parts in the coresponding groups as no pH correction was performed in them. In the case of other samples treated with water, "S" and "P" curing mixturtes, the pH value was corrected by the use of 50% solution of lactic acid or 3 M NaOH. The end concentration of sodium chloride in cured meat was always 2%, sodium nitrite 0.015%, sodium ascorbate 0,03% and pyrophosphates in the P mixture - 0.125%. The pH value of meat was measured by using the pH-meter type N-511 equiped with combined electrode type SAgP-202W. The measurements were conducted directly in the muscle or meat containing curing mixture. The WHC of meat was performed using the centrifugal method (Hofmann et al. 1980). Samples (about 8 g) were centrifugated at 15,000 x g for 20 minutes at 2°C. The amount of centrifugal drip was used to estimate the WHC of meat. The higher value of centrifugal drip corresponded lower WHC of meat. The water binding capacity (WBC) was estimated by measuring the cooking loss from 20g samples cooked at 80°C for 20 minutes. The meat colour was measured on cooked samples from measurements of WBC. The L, a and b values were estimated using the Minolta CR-200 apparatus. On the basis of these three values the total difference in the colour (ΔE) of investigated samples was calculated (Glydestale 1978). As a reference sample in the case of these measurements was used the meat treated with sodium chloride, sodium nitrite and sodium ascorbate (S) with no pH adjustment. Additionaly the colour measurements were performed using the sensory analysis. The test panel consisted of 5 trained assessors. Samples were presented singly to panelists at room temperature. The colour acceptability was evaluated giving scores from 1 to 5. Responses of all panelists were averaged to give a single scores for each sample.

RESULTS AND DISCUSSION

The mean pH value of meat before salt addition was 5.59 and varied between 5.53 to 5.65. Values of centrifugal drip and cooking loss of investigated samples (Tab. 1) showed that the lowest WHC and WBC had meat to which only water was added. The highest binding of water was observed in meat treated with pyrophosphates and this was enhanced by the increase of the end pH value of meat. Somewhat lower water binding properties were noted in the case of carbonates (CN) and the lowest - for bicarbonates (CH); however, differences between these two curing mixtures were, in most cases, statistically not significant (Tab. 1). The comparison of values estimated from measurements of WHC and WBC of meat treated with S with those from the treatment with CN and CH indicates that the water retention of meat treated with these three mixtures was similar at the same end pH value. This points out that the increased WHC/WBC of meat treated with CN and CH is connected with the influence of these salts on the pH value of meat. The addition of CN and CH moves the pH value to the higher value and this movement, through the enhanced electrostatic repulsion, increases retention of water in meat. Higher WHC and WBC of meat treated with pyrophosphates in comparison with the remaining samples further indicate that pyrophosphates increase water retention of meat not only through the increase of meat pH value but also by means of other factors. They may comprise the chelating of divalent ions, dissociation of the actin - myosin complex and, as observed recently, the liberation of α-actinin from the Z - disk of sarcomeres (Grześ et al. 1996). The results also indicate that, of the two factors evaluated in this experiment influencing the water retention of meat, the most important are: the curing salts and then the pH value. The increase of pH value of meat treated with water had only slight effect on water retention. Moreover, the obtained results also point out that highest WHC and WBC at low pH value could be reached only when pyrophosphate were used. Objective measurements of meat colour showed small differences in the **L** and **a** values for meat treated with salts (Tab. 2). The highest **L** value and the lowest **a** value were observed in meat samples to which only water was added. The enhancement of pH value slightly increased the paleness of meat (**L** value) and decrease the redness index (**a** value). Somewhat bigger differentiation of samples was stated by measurements of yellowness

index (b value) of meat colour (Tab. 2). Significant differences ($P<0.05$) existed between meat to which only water was added (C) and all cured samples (higher values for C). The samples with higher end pH value (6.0 and 6.4) characterized usually lower yellowness index. The estimation of ΔE value confirmed the above described observations. The biggest and statistically significant ($P<0.05$) differences existed between the C samples and cured meat. Among the samples of cured meat slightly higher differences were found between meat treated with S mixture and pyrophosphates. Meat from the treatment with P obtained the highest notes for colour acceptability by the sensory evaluation.

CONCLUSIONS

1. Water retention of meat treated with three different mixtures S, CN and CH were similar at the same end pH value.
2. The use of pyrophosphates (P) resulted in the highest water retention at the low pH value of meat; at higher pH values water retention of meat treated by all curing salts was similar.
3. Of the two factors influencing the WHC/WBC of meat, the most important were the curing salts and then the end pH value of meat.
4. The pH value in the range 5.6 to 6.4 slightly influenced the colour of meat and the biggest, statistically significant differences were observed only for yellowness index

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ABSTRACT

The aim of the study was to compare the influence of four different compounds (sodium chloride, pyrophosphates, sodium carbonate, sodium bicarbonate) in their mixtures on water retention and colour of meat, the end pH value of which, after salt addition, was corrected to three defined levels i. e. 5.6, 6.0 and 6.4. The experiments were conducted on six chilled bovine m. longissimus dorsi. After mincing the meat was divided into five portions. Either water or solutions containing curing salts were mixed with each portion (60% by weight). To the first portion (C) water was added. The second portion (S) was treated the mixture containing sodium chloride, sodium nitrite and sodium ascorbate. To the third portion sodium pyrophosphate (P) plus components in (S) were added In the fourth portion (CN) instead of pyrophosphates was used sodium carbonate and in the last (CH) - sodium carbonate was replaced by sodium bicarbonate. Each group was divided into 4 parts. The part 1 had no pH adjustment, part 2 was adjusted to pH 5.6, part 3 - to pH 6.0 and the last part - to pH 6.4. The measurements of water retention and colour of meat were performed on all samples. The lowest WHC and WBC were recorded for meat to which was added only water. The highest retention of water was observed in meat treated with pyrophosphates (P). At higher pH values water retention of meat treated by all curing salts was similar. Of the two factors influencing the WHC/WBC of meat, the most important were the curing salts and then the end pH value of meat. The pH value in the range 5.6 to 6.4 slightly influenced the colour of meat and the the biggest differences were observed for yellowness index. The highest notes in sensory analysis were recorded for meat treated with pyrophosphate.

Table 1

Centrifugal drip (%) and cooking loss (%) from meat treated with various curing salts at different pH value

Type of sample	pH			
	without correction	5.6	6.0	6.4
C WHC	89.25d*	50.72d	49.80d	45.83d
S	33.42c	28.90c	5.97a	4.42a
P	26.72c	15.12b	1.20a	0.58a
CN	37.69c	26.79c	5.92a	2.34a
CH	34.91c	27.35c	11.29b	4.69a
C WBC	56.12c	53.08c	53.53c	53.25c
S	44.74b	42.16b	30.99a	25.93a
P	36.31b	32.22a	25.34a	20.31a
CN	46.63b	41.47b	29.86a	19.86a
CH	42.73b	41.25b	31.74a	25.70a

* different letters show the means differed statistically significant ($P<0.05$); comparisons are performed separately for each characteristic (WHC and WBC)

Table 2

Colour of meat treated with various curing salts at different pH value

Type of sample and colour characteristics	pH			
	without correction	5.6	6.0	6.4
C - L	62.98b	64.15b	63.45b	62.08b
S	52.83a	52.05a	50.40a	52.10a
P	51.93a	52.00a	50.33a	51.63a
CN	52.88a	52.85a	50.75a	51.78a
CH	52.83a	53.78a	51.13a	51.83a
C - a	8.73a	10.15a	10.40a	10.95a
S	19.55b	20.07b	18.25b	18.13b
P	20.08b	19.73b	19.48b	18.75b
CN	18.73b	18.65b	18.40b	18.40b
CH	19.28b	18.68b	18.65b	18.10b
C - b	14.05c	14.25c	14.20c	14.70c
S	10.20b	10.68b	9.18a	8.65a
P	9.93b	9.70b	8.68a	8.50a
CN	10.50b	10.43b	8.75a	8.45a
CH	10.95b	10.48b	9.50a	8.78a