EARLY ESTIMATION OF SEASONING LOSS IN PARMA HAM PRODUCTION

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SUMMARY: On a sample of 158 thighs to be processed into Parma ham the possibility of early estimating the seasoning loss through objective measurements taken at the slaughter-house and during ham salting was examined. Correlations between the seasoning loss and meat quality traits measured by 30 h post mortem resulted generally low while higher correlations have been found for the weight losses of hams during the 1st and 2nd salting. The best prediction equation to early estimate the seasoning loss of Parma ham was found to include the ham weight lost as weep during the 1st salting, m. biceps femoris colour measurements and carcass weight. In practical conditions the most suitable equation was found to be based on the weep loss of 1st salting and on L* and b* colour values taken on m. biceps femoris at 30 h after slaughtering.

INTRODUCTION: Raw, salted and seasoned ham represents the most prestigious and lucrative meat product processed in Italy. The annual production of typical seasoned ham, guaranted by a high quality trademark, amounts to 9.3 million of pieces and 81% of it is produced in the Parma area (ISMEA, 1990).

As this product requires a processing time ranging from 10 to 16 months, the meat industry is very interested in the early estimation of the yield of seasoned ham through objective parameters taken at the slaughter-house or during the first processing step. Such parameters would enable the industry to identify fresh hams not suitable for the seasoning process or those that require different treatments during such process.

In the seasoned ham production, the meat industry evaluates the technological yield by the seasoning loss calculated as the difference between the trimmed and seasoned ham weight and expressed as percentage of the trimmed weight. The aim of this research was to study the possibility of the early estimation of the seasoning loss through objective measurements taken at the slaughter-house or during the first process step, i.e. dry salting.

MATERIALS AND METHODS: In this study a sample of 158 left thighs to be processed into Parma ham was examined. Thighs were obtained from Large White heavy pigs slaughtered on four different days in the same commercial abattoir. After weighing and cutting the carcases, the hot ham weight (HW) at 45 min post mortem and the trimmed ham weight (TW) at 30 h post mortem were recorded. After 48 h from slaughtering, the hams were handed to a plant to be seasoned following the traditional steps, i.e. salting, resting, drying and ageing. The 1st and 2nd salting lasted 7 and 18 days respectively. During these periods the following weights were recorded:

1st salting
- TW + NaCl 1st salting= $1stSW_0$
- $1stSW_0$ after 7 days= $1stSW_7$
- $1stSW_7$ - NaCl 1st salting not absorbed= 1stBW

2nd salting
- 1stBW + NaCl 2nd salting= 2ndSW
- 2nd SW_0 after 18 days= $2ndSW_{18}$
- $2ndSW_{18}$ - NaCl 2nd salting not absorbed= 2ndBW

At the end of the seasoning process (394±22 days from slaughtering), the ham weights (SEW) were recorded and the seasoning loss was calculated as TW-SEW/TW*100.

The weight losses of ham during salting periods are due to the negative balance between the amounts of salt absorbed by the ham surface and the water lost as weep from the muscles due to osmotic exchange. In order to separate and to evaluate each component of the ham weight losses, at the end of the 1st and 2nd salting the amount of salt absorbed, the weep loss and the resulting weight loss were determined. The amount of salt absorbed was calculated as difference between the amount of the added and the residual salt at the end of each salting period. The weep loss was calculated as difference between the ham weight after each salt addition ($1stSW_0$ and $2ndSW_0$) and the ham weight before the respective salt removal ($1stSW_7$ and $2ndSW_{18}$). The ham weight loss at the end of each salting period was determined as difference between the ham weight before the salt

addition and after the salt removal. Salt absorbed, weep loss and salting weight loss were expressed as percentage of the ham weight at the start of each salting step.

As regards meat quality measurements, at 45 min post mortem pH_1 values of m.longissimus dorsi, at the level of the 7th (LD7th) and the last rib (LDlr), and of mm. semimembranosus (SM) and biceps femoris (BF) were recorded. Furthermore, on these muscles colour was objectively determined by measuring (CIELAB, 1976) L*, a* and b* values (L^*_1,a^*_1,b^*_1) with a portable colorimeter Minolta Chromameter II (light source C, 8mm diameter). At 30 h post mortem measurements of pH (pH_{30}) and colour (L^*_{30},a^*_{30},b^*_{30},) were repeated on the LD7th, SM and BF muscles. At 1 h after slaughtering, a slice 3 cm thick was removed from LD between the 9th and 10th rib. Samples were subsequentely packed and transported (0÷+2°C) to the laboratory where 4 h later water holding capacity (WHC), using Filter Paper Press method (GRAU and HAMM, 1957), and drip loss (HONIKEL, 1987) were assessed. WHC was expressed as ratio of meat film area and total area (M/T) (HOFMANN et al., 1982).

Simple correlations were computed between seasoning loss and all measurements taken at the slaughter-house and during each salting period. Regression equation to early estimation the seasoning loss were calculated by stepwise regression.

RESULTS AND DISCUSSION: In table 1 the average carcass weight and the results from the ham mesasurements are reported together with the respective correlation coefficients with the seasoning loss. As far as hot and trimmed ham weights are concerned, the sample of hams examined represents what is required for the Parma ham production by the processing industry (RUSSO et al., 1989). During the 1st salting the weep loss and the salt absorbed were found to be 3.9% and 2.7% whereas during the 2nd salting they were 5.4% and 2.5% respectively of the ham weight at the beginning of each step. The seasoning loss, equal to 26.2%, resulted as being included in the range of values usually found in the Parma ham production.

Carcass and ham weights resulted as being negatively correlated to the seasoning loss showing low but significant ($P<0,01$) coefficients. These relationships, even if weak, suggest that the trend to reduce carcass and fresh ham weights may lead to an increase in the weight loss during the seasoning process. The weep losses and ham weight losses after each salting period were found to be positively and significantly correlated to the seasoning loss. The coefficients resulted higher for the measurement taken in the 1st salting. During each salting the losses due to weep appear more strictly related to the seasoning loss than the weight losses due to the negative balance between the salt absorbed and the liquid lost. Low but significant correlation coefficients were found between the percentage of salt absorbed and the seasoning loss. In general, these results indicate that the weep loss of the 1st salting is the most interesting parameter for the early estimation of the seasoning loss in the Parma ham production. In fact, it shows the highest correlation coefficient ($r=+0.73$) and its determination can be done just 9 days after slaughtering.

In table 2 the results from meat quality measurements are reported together with the respective correlation that resulted statistically significant with seasoning loss. Average values were found to be included in the range regarded as normal for the meat destined to be processed.

In general, correlation results indicate that the relationship between meat quality traits and seasoning loss is very poor. Only a few parameters resulted significantly correlated altough showing low coefficients. The pH measured within 30 h from slaughter and the colour parameters taken at 45 min post mortem appear unrelated to the seasoning loss. A weak relationship exists between the latter and WHC, drip loss and ham colour measurements but these parameters result unsuitable as a single predictors of seasoning loss. Similar results were found in a previous study carried out on Parma ham (RUSSO, 1989).

In table 3 the prediction equations of seasoning loss, calculated with all measurements taken until the 2nd salting, i.e. within the 27th day from slaughtering (equation 1) and until the 1st salting, i.e. within the 9th day from slaughtering (equation 2) are reported. In equation 1 were included the weep losses recorded at the 1st and 2nd salting and b^*_1, L^*_{30} and b^*_{30} values measured on BF muscle. This accounted for 67% of the variation in the seasoning loss reducing by 42% the original s.d. of dependent variable. Equation 2 was found to include the

same parameters as the previous equation with the only replacement of the weep loss in the 2nd salting with the carcass weight. This equation was found to explain 65% of the variation in the seasoning loss with a 40% reduction of the original s.d.. Equation 2, even if less accurate than equation 1, would enable to estimate with sufficient accuracy the seasoning loss within the 9th day from slaughtering. Nevertheless, the practical use of this equation may be difficult because slaughtering measurements for each ham must be exactly combined with the others taken later in a plant process. As regards this problem, a further equation was calculated using as predictors the weep loss of the 1st salting and the colour measurements taken exclusively on trimmed ham. By stepwise regression, the best estimation of seasoning loss is given by the following equation:

seasoning loss = 11.662 + 2.319(weep loss of 1st salting) + 0.163(L^*_{30}BF) - 0.270(b^*_{30}BF) (R^2=0.62; RSD=1.76)

which includes, in addition to the weep loss, the L^*_{30} and b^*_{30} values measured on BF muscle. This was found to explain 62% of variability in the seasoning loss reducing by the 38% the original s.d. of the dependent variable. In practical use, this last equation appears particularly interesting as the reduction of accuracy in comparision to the previous equations is largely balanced by the possibility of measuring all predictors directly at the processing plant.

CONCLUSION: On the basis of the results here presented, the following conclusion may be drawn.

The percentage of weep loss determined in the 1st salting results as being the best predictor of the seasoning loss. The weep loss of the 2nd salting should improve the accuracy of the prediction but more time is requested to estimate the seasoning loss. Meat quality traits present a weak relationship with the ham loss weight at the end of the seasoning process. Only the colour measurements taken on BF muscle should improve the estimation of seasoning loss if combined with the weep losses. In practical conditions, the best equation to early estimate the seasoning loss is based on the weep loss of the 1st salting and on L* and b* values taken at 30 h *post mortem* on BF muscle.

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Table 1.- Carcass and ham measurements (mean ± s.d.) and respective correlation coefficients (r) with the seasoning loss (N=158).

			mean ± s.d.	r
Hot carcass weight		kg	136.8 ± 15.4	- 0.29 **
Hot ham weight	(HW)	kg	15.1 ± 1.5	- 0.28 **
Trimmed ham weight	(TW)	kg	12.6 ± 1.3	- 0.26 **
Ham weight after 1st salting	(1stBW)	kg	12.5 ± 1.3	- 0.29 **
Ham weight after 2nd salting	(2ndBW)	kg	12.1 ± 1.3	- 0.31 **
Seasoned ham weight	(SEW)	kg	9.3 ± 1.1	--
1st salting:				
- weep loss		%	3.90 ± 0.80	+ 0.73 **
- salt absorbed		%	2.67 ± 0.78	+ 0.22 **
- weight loss		%	1.23 ± 0.67	+ 0.57 **
2nd salting:				
- weep loss		%	5.42 ± 0.75	+ 0.47 **
- salt absorbed		%	2.55 ± 0.77	+ 0.21 **
- weight loss		%	2.87 ± 0.74	+ 0.16 *
Seasoning loss		%	26.22 ± 2.82	--

*: P<0.05; **: P<0.01.

Table 3.- Prediction equations of seasoning loss calculated by the stepwise regression (original s.d. of seasoning loss= ± 2.82).

	Coefficient	R^2	RSD (a)
Equation 1 (b):		0.67	1.64
intercept	8.854		
weep loss of 1st salting	1.934		
weep loss of 2nd salting	0.855		
L^*_{30} BF	0.177		
b^*_{30} BF	- 0.258		
b^*_1 BF	- 0.315		
Equation 2 (c):		0.65	1.69
intercept	16.964		
weep loss of 1st salting	2.199		
b^*_{30} BF	- 0.249		
L^*_{30} BF	0.148		
Hot carcass weight	- 0.222		
b^*_1 BF	- 0.360		

(a) Residual Standard Deviation;
(b) calculated by inclusion of the measurements taken until the 2nd salting (27 days from slaughtering);
(c) calculated by inclusion of the measurements taken until the 1st salting (9 days after slaughtering).

Table 2.- Meat quality measurements (mean ± s.d.) and respective correlations (r) with the seasoning loss resulted statistically significant (N=158).

	mean ± s.d.	r
pH_1:		
- m.long.dorsi 7th rib (LD7th)	6.31 ± 0.26	ns
- m.long.dorsi last rib (LDlr)	6.33 ± 0.29	- 0.16 *
- m.semimembranosus (SM)	6.40 ± 0.27	ns
- m.biceps femoris (BF)	6.36 ± 0.27	ns
Colour:		
- m.long.dorsi 7th rib (LD7th):		
L^*_1	39.16 ± 3.04	ns
a^*_1	6.58 ± 2.42	ns
b^*_1	3.93 ± 1.34	ns
- m.semimembranosus (SM):		
L^*_1	42.75 ± 3.60	ns
a^*_1	5.24 ± 1.83	ns
b^*_1	2.46 ± 1.00	ns
- m.biceps femoris (BF):		
L^*_1	39.43 ± 2.29	ns
a^*_1	7.36 ± 1.80	ns
b^*_1	3.48 ± 0.88	- 0.24 **
Filter Paper Press (M/T)	0.50 ± 0.16	- 0.23 **
Drip loss %	3.48 ± 0.88	+ 0.33 **
pH_{30}:		
- m.long.dorsi 7th rib (LD7th)	5.69 ± 0.15	- 0.17 *
- m.long.dorsi last rib (LDlr)	5.68 ± 0.14	ns
- m.semimembranosus (SM)	5.74 ± 0.14	ns
- m.biceps femoris (BF)	5.75 ± 0.14	ns
Colour:		
- m.long.dorsi 7th rib (LD7th):		
L^*_{30}	48.81 ± 0.15	ns
a^*_{30}	6.58 ± 0.14	ns
b^*_{30}	6.59 ± 1.98	ns
- m.semimembranosus (SM):		
L^*_{30}	46.61 ± 4.91	+ 0.30 **
a^*_{30}	9.04 ± 2.48	- 0.16 *
b^*_{30}	6.29 ± 1.89	- 0.21 **
- m.biceps femoris (BF):		
L^*_{30}	47.52 ± 3.44	+ 0.30 **
a^*_{30}	11.22 ± 2.88	- 0.25 **
b^*_{30}	8.30 ± 2.31	- 0.38 **

ns: not significant; *:P<0.05; **:P<0.01.