EFFECTS OF TUMBLING AND COOKING METHODS ON THE YIELD AND ACCEPTABILITY OF COOKED HAM FROM THIGHS WITH DIFFERENT CHARACTERISTICS

A. PIZZA and R. PEDRIELLI

Experimental Station for the Food Preservation Industry - Via Tanara 31/A - Parma - Italy

SUMMARY

The effect produced on the meat tissue by the massaging and tumbling procedures may be vigorously influenced by raw materials used. The relationships between the finished products characteristics and the use of intermittent tumbling technique was investigated, for two cooking methods, over a group of approximately 200 pig thighs, of Cotswald breed, from PSE to DFD properties, recorded by means of pH, Fop and Hunter values measures. The intermittent tumbling process alternated the following movement and rest time (min): 2/190 , 4/190, 8/180, 15/160. The two cooking procedures were a slower one (F70 = approximately 40 min.) and another one, generally adopted in our country, giving a calculated F70 value of 110 min., at the core of the product.

The relationship between the yield and time of tumbling was not linear, the best results beeing obtained with 4-8 min. of movement time. Both yield and cooking losses were highly influenced by tumbling parameters and raw materials characteristics for standard cooking method. For slow cooked products the influence of raw materials is less important. The resting times seem to be much more important to sensory acceptability, in particular to cohesion characteristics (R=.74** for standard cooking and .87** for slow cooking).

INTRODUCTION

Many researchers have focused on the effects produced on meat tissue by massaging and tumbling techniques (KRAUSE et al 1978, OCKERMAN et al,1978, MOTYCKA et al 1983). This processing method is used for different reasons: the massaging process usually involves movements of meat tissues with other meat tissues and the smooth surface of a stationary drum with paddles rotating around a vertical axis. The tumbling technique is more rigorous: in the rotating drum, the meat falls against metal walls causing rupture of cell membranes.

Massaging involves frictional energy and tumbling involves impact and frictional energy. This energy is sufficient to cause the rupture of the sarcolemma and to extract protein exudate that guarantees: -better cohesion characteristics,- better yields of the finished products, -better organoleptic quality, for juiciness and texture. Many massaging and tumbling methods are described:REICHERT (1982) reports tumbling losses and yields for different tumbling speeds and times on hams cooked at a constant temperature and for Delta-T-Cooking, giving particular importance to resting periods in the tumbling procedure.

On the other hand the effect of these techniques may be vigorously influenced by the raw materials used: in the meat industries the main faults are known as PSE (pale, soft, exudative meats) and DFD (dark, firm, dry meats). The use of different raw materials, from extreme PSE to DFD cases, on a cooked ham production line, greatly influences the binding properties of the resulting system in all the phases of production, and the organoleptic characteristics in the finished product. The water binding capacity is of great importance also for the yield, a critical parameter from the economical point of wiew. Many authors (SHEID, 1986 and WIRTH 1986) recommend the use of normal or tendencially DFD meats for cooked ham and the pH 5.5-5.6 is considered the limit value for this process. Some recent reports on cooked ham made both on PSE and normal meats (HONKAVAARA, 1988 and 1989) give almost twelve points of difference between the technological yields of the two classes of products, and also a poorer organoleptic quality for the cooked PSE product.

Different cooking techniques on quality characteristics were also examined: these effects where well synthetized for fresh pork roasts by HEYMAN et al. (1990), both for texture, colour, and aroma characteristics in the finished products.

The purpose of our research was to examine a batch of approximately 200 thighs from Cotswald cross-breed pigs, over a range of pH 45' between 5.7-7, or pH 48 h between 5.3-6.4, for their suitability for cooked ham processing, without using poliphosphates.

MATERIALS AND METHODS

For this investigation were processed 200 thighs, from Cotswald cross-breed pigs. No thigh was pale, soft, exudative or dark, firm and dry in appearence. Each carcass weighed 135-150 kg: muscles were chosen with pH 45' between 5.7 and 7 (giving pH 48 h p.m. between 5.3 and 6.4), all from a commercial class, with moderate marbling and percentage of backfat that is generally used for cooked ham processing.

Chemical and Physical analysis. At various handling times the measurements of pH were taken using a Hanna instrument pH-meter, the FOP values with the apparatus described by McDougall (1984) and L,a, b parameters were recorded with a Minolta Colorimeter. The parameter Ct is the chilling loss relative to the 20 hours rest time before the brine injection.

Technology of curing and tumbling. A brine formulation: water 85.7%, salt 10.5%, sugar 3%, TPP 0.3%, Na-nitrite 0.09%, Na-ascorbate 0.3%, was adopted for injection into deboned hams with a multineedle apparatus, up to the addition of 20% on initial defatted deboned muscle weight. Cured meats were then tumbled in a rotative unit under vacuum: the intermittent tumbling process alternated the following rotation and rest time (min):2/190, 4/190, 8/180 and 15/160, for a tumbling time of ca 48 hours, at a temperature of 6°-7° C (Fig.1).

Cooking procedure. The products were cooked in a saturated steam oven, in two different ways: standard cooking, up to the value F70=112 min (21) the core of the product and a slow cooking method up to the value F70=40 min (cf. Fig.2 and 3 for cooking profiles), then they were refrigerated and controlled for the cooking loss (CL) and technological yields (TY):

CL=(weight before cook - weight after cook/weight before cook)*100

TY=(weight cooked + chilled)*100/weight deboned.

Sensorial analysis. Approximately 25 % of processed products were examined also from the organoleptic point of wiew. A panel of 7-8 members, with no previous training but expert on meat products, evaluated cooked hams for cohesion quality, tenderness and occurrence of some defects, such as the presence of holes and fissures on 1 mm thick slices on the basis of a 9 point score sheet.

Statistical procedures. Technical yields, cooking losses, chemical composition, cohesion quality and organoleptic scores constitute the group of the dependent variables: these have to be correlated with the quality of raw materials, expressed as pH, FOP, L, a , b values, and moreover with some technological parameters such as tumbling and resting time, for two different methods of cooking (cf. Fig.1). The results of the eight trials were analyzed with Anova and Multiple linear regression, executed with the statistical package SPSS, in the personal computer version, which in our case is a Hewlett Packard Vectra PC. The procedure G3GRID of SAS-Graph, with the interpolation option was used for the tridimensional graphics.

RESULTS AND DISCUSSION

As specified in the previous section only a slight percentage of processed hams had severe PSE or DFD characteristics. A high percentage was nevertheless tendencially PSE, on the basis of pH measurements and Hunter coordinates (L generally is >49 and a <8.2), Fop values being in the range of normal meats (.25- .40). Table 1 reports the instrumental values registered on raw materials, at various handling times, 45 min, 24, 48, 72, 96 and 144 hours post mortem. The measurements recorded at 45' after slaughter highlight only PSE meats, so the most useful information on meat quality is given by post rigor measures, because PSE and DFD are only extreme conditions, among which there are many situations that correspond to different processing responses: Tab.2 indicates the correlation coefficients between yield (and cooking losses) and raw material characteristics. The difference between the two method of cooking is clear, the traditional one depending on the raw material. We have also verified significative differences between the four tumbling parameters adopted for this research (Tab.3) .

Yield data were analyzed with ANOVA ONE-WAY option, and Duncan' test of SPSS: the best results are obtained for 4-8 rounds per cycle, with standard cooking conditions, generally the yields are higher for slowly cooked products, but also in this case intermediate times of tumbling are preferable.

We can represent all the data in threedimensional graphs, in which x and y are the pH 48 h measurements and the number of rounds in the tumbler for cycle: there are two response surfaces for z (yield values), considerably different for standard and slow cooking procedures. What is evident from these figures, is the clear influence on the yield of both the raw materials and tumbling parameters, for the cooking conditions that are commonly used in our country and that correspond to a high F-value, equivalent to 100 min of heating at constant temperature (taking z= 10°C and T ref=70°C). This F-value is retained sufficient for the destruction of D-Streptococcaceae, the most heat resistant vegetative species, for cooked meat products (PIZZA, 1987). For the second cooking technique, only an F70=40 min has been reached, that is for our technology, sufficient for destroying common vegetative flora, but not some D-Streptococcaceae. So this has to be considered a limit cooking technique, from the keepability point of wiew. The Yield response surface, for the slow cooking method, is quite different, as the influence of raw material is rather less important in respect of standard cooking conditions. The smoothing procedure generally gives an interesting and satisfactory visualization of both raw materials and tumbling technique effects. Our choices of tumbling and cooking parameters derived from preceeding investigations and experience in the field of Italian cooked meat products: we focused our attention on values generally adopted and other unusual ones, considered as interesting limit conditions.

Tumbler short working phases were alternated with longer resting periods, so the real massaging time is severely reduced in respect to our other works (PEDRIELLI et al,1988) and resting time increases, which appears much more important for system cohesion : R = .74 for standard cooked and .87 for slow cooked products (cf. Tab 4). If we compare these results with those of Table 2, we have only a slight dependence of organoleptic scores from the raw material (except the correlation found between the cohesion score and Ct value).

We are actually directing our researches towards the study of the relations between organoleptic acceptance and technological parameters, bearing in mind the possible interactions of the quality of prime materials.

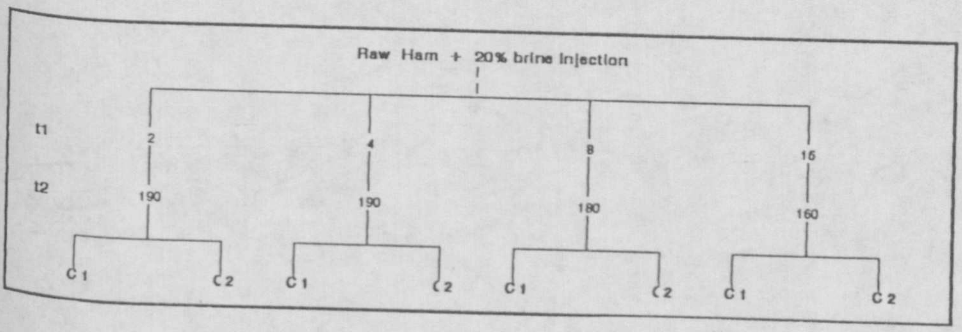

Fig. 1 – Schema of tumbling and cooking operations.

t1 : tumbling time for cycle (min.)
t2 : resting time for cycle (min.).
C1 : standard cooking.
C2 : slow cooking.

	C1		C2	
	Xm	SD	Xm	SD
pH45	6.38	0.28	6.34	0.27
pH24	5.59	0.12	5.62	0.16
pH48	5.60	0.12	5.63	0.17
FOP48	34.1	6.3	33.9	5.2
L48	51.0	3.3	51.2	1.9
a48	8.1	1.6	7.9	1.5
b48	1.4	1.4	1.3	0.97
pH72	5.56	0.12	5.63	0.17
pH96	5.57	0.12	5.60	0.17
pH144	5.58	0.12	5.61	0.17
FOP144	36.2	6.8	36.2	5.8
L144	52.0	3.5	51.8	2.6
a144	9.0	1.6	8.8	1.7
b144	3.5	2.1	3.8	1.9
Ct	0.73	0.46	0.66	0.32

Tab.1 – Raw materials characteristics (mean values and standard deviations) of the two lots of thighs assigned to C1 and C2 cooking methods.

~pH,Fop and Hunter coordinates were measured at 45 min., 24,48,72,96,144 hours p.m.
~Ct : weight loss in the tempering cell (5°–6°C);
~C1 : standard cooking;
~C2 : slow cooking.

	C1			C2				
	pH	FOP	L	Ct	pH	FOP	L	Ct
cookloss	–.5669**	.7249**	.3181**	.6646**	–.3127*	.0110	.2811	.5282**
yield	.5183**	–.5746**	–.2716	–.6688**	.3956*	–.0524	–.1682	–.5789**
holes	.1301	–.0115	.1987	–.0446	.0203	.0285	.1231	–.2552
fissures	–.0008	–.0033	–.0563	–.1840	.3619*	–.2449	–.0705	–.4794**
cohesion	–.0265	.1554	.0432	–.1467	.2674	–.0832	–.1365	–.5612**
Juiciness	.2556	–.2020	.2131	–.3026*	.2949	–.1315	–.0332	–.3858**

Tab.2 – Correlation coefficients between some characteristics of the product and the quality of raw materials pH, FOP, L coordinate measured at 48 hours p.m. and weight loss of tempering (Ct).

1–tailed Signif : * = .01 ; ** = .001

	C1				C2			
	2	4	8	15	2	4	8	15
cookloss	17.56 a	17.35 a	17.85 a	18.92 b	11.81 a	11.82 a	12.00 a	15.08 b
yield	92.34 a	96.99 b	95.39 b	87.73 c	101.13 a	102.70 a	105.00 a	91.00 b

Tab.3 – Mean values of cookloss and yield for the two cooking procedures (C1 and C2) and the four tumbling times (2,4,8 and 16 min.).

Data must be read separately for the two cooking methods : different letters in each row denote pair of data significatively different at the 0.05 level.

	C1		C2	
	t1	t2	t1	t2
cookloss	–.0489	–.0415	.7557**	.7812**
yield	–.1994	.3288**	.6801**	–.7270**
holes	–.3544**	.3444**	–.4973**	.5803**
fissures	–.4711**	.5463**	–.5168**	.5556**
cohesion	–.6373**	.7450**	–.7762**	.8732**
juiciness	–.3020	.3555	–.0700	.1406

Tab.4 – Correlation coefficients between some organoleptic characteistics of the products and the tumbling (t1) and resting time (t2),for standard (C1) and slow (C2) cooking conditions.

1–tailed Signif:* – .01 ** – .001

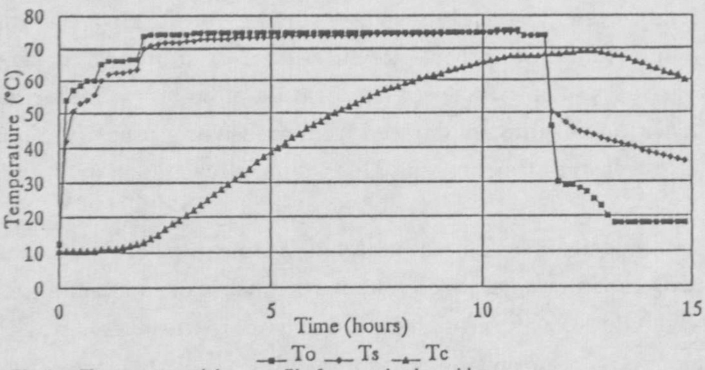

Fig.2 – Temperature / time profile for standard cooking.
To=oven temperature ; Ts=surface temperature ; Tc=core temperature.

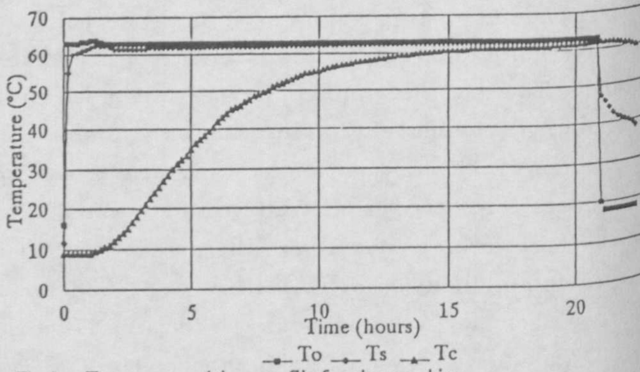

Fig.3 – Temperature / time profile for slow cooking.
To=oven temperature ; Ts=surface temperature ; Tc=core temperature.

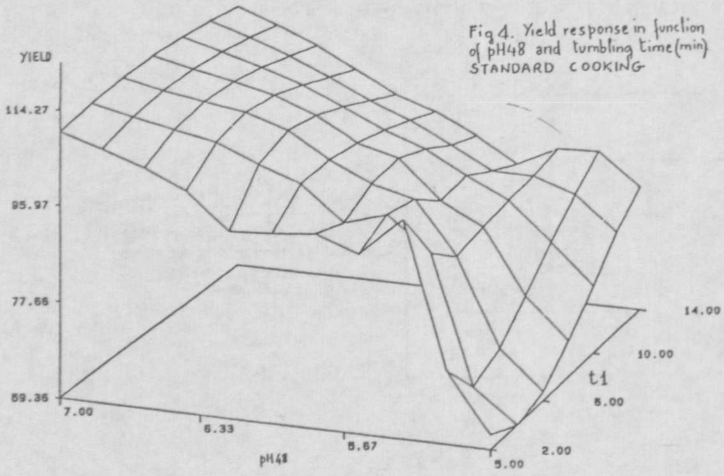

Fig 4. Yield response in function of pH48 and tumbling time (min) STANDARD COOKING

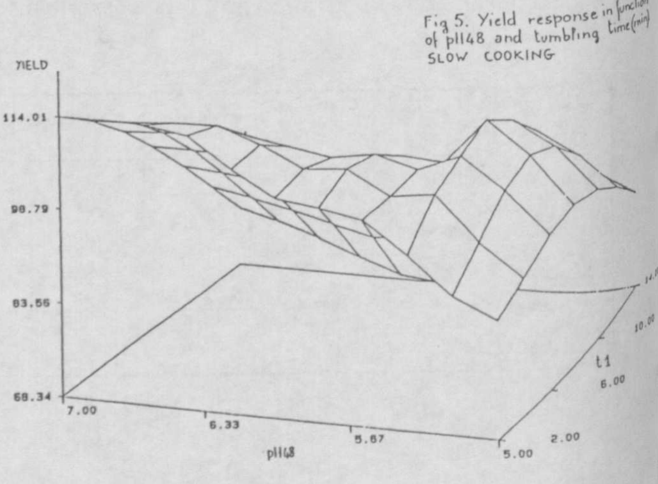

Fig 5. Yield response in function of pH48 and tumbling time (min) SLOW COOKING

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