D26

THE INFLUENCE OF RETORTING CONDITIONS ON TEXTURE OF NATURAL AND RESTRUCTURED BEEF

STANISŁAW TYSZKIEWICZ*, HENRYK DAUN**, JOLANTA KOMOSA* AND ANDRZEJ BORYS*

* Meat and Fat Research Institute, 36 Rakowiecka Street, 02-532 Warsaw, Poland
** Rutgers, The State University of New Jersey, New Brunswick, NJ 08903, USA

Objective.

In the years 1992-1994 at Rutgers University a complex research was conducted on the influence of processing conditions on quality of beef stew as part of the Quality Quantification and Enhacement for Combat Rations Program. The objective of this work, being a part of the Program, was to establish principles of the selection of retorting parameters in order to obtain meat of desirable texture with an assumption that the raw material is the commercially available inexpensive grades of natural and restructured beef.

Experimental.

Experimental material consisted of beef chunks preserved in sauce in multilayer/foil pouches retorted at preselected temperatures for different time periods.

Code	Beef raw materials	Retorting temperature °F	Retorting time [min]	Remarks
1	Natural	220	25	All samples were prepared from a uniform raw material by the Food Manufacturing Facility of the Center for Advanced Food Technology at Rutgers University.
2	Natural	220	45	
3	Natural	235	25	
4	Natural	250	25	
5	Restructured	220	45	
6	Restructured	250	25	
7	Restructured	250	45	
8	Restructured	265	25	

For chemical characteristics of the product, phosphorus, protein and moisture contents were analysed. For the texture profile analysis (TPA) a Universal TA-XT2 Texture Analyzer manufactured by Stable Micro System (Haste Hill, Surrey) was used. Meat samples were cut into cylindrical form of 9 mm diameter and 10 mm height . The conditions of the measurements were as follows: Speed 10 mm/s, time 1 s, strain 50% . Calculated texture parameters included: Springiness (S50), Cohesiveness (C50), Chewiness (CH50), Gumminess (G50), Hardness (H50) and Modulus of Elasticity (M50). Additional measurements were made using strain 80% for determination of Springiness II (S80) and Cohesivenss II (C80). Maximal Force of Penetration (FP80) was also measured using probe with rectangular contact surface of size 2x8mm. Samples for these measurements were prepared with height of 10 mm, with remaining dimensions of meat chunks without changes.

Sensory analyses were done by an eight-member panel consisting of trained sensory judges at the Meat and Fat Research Institute in Warsaw. A profile analysis was used with unstructured graphical scale indyvidually calibrated by panel members. The following attributes were evaluated: Cohesiveness of Touch (SCT) and orally tested Hardness (SH), Springiness (SS) and Chewiness (SC).

Results and discussion.

The results (arithmetic averages) of instrumental measurements and sensory evaluations are shown in Table.

A strong, independent of the kind of meat, correlations were established between three texture parameters measured orally i.e. between Hardness (SH), Springiness (SS) and Chewiness (SC) and between those parameters and Force of Penetration (FP80). In the instance of joint consideration of natural and restructured beef none of the TPA parameters highly correlated to the sensory data. However, with a separate consideration of the two kinds of meat, high correlations were observed. This phenomenon can be explained by different behavior of natural and restructured beef in the TPA test.

To evaluate the influence of temperature and time of retorting on texture parameters, it was decided to apply empirical equations that describe well the dependence. Based on the principles of the theory of thermal reduction of the microorganisms during heat processing 250°F was selected as the standard sterilization temperature. For the temperatures T used in the experiments, lethality Lz was calculated according to the formula: $Lz = \mathrm{Log}^{-1}(T-250°F)/z$ for values z in the range from z = 20°F to z = 100°F . Next an attempt was made to find dependence between specific texture parameters Ni and a product of the time of sterilization t values Lz showing the highest correlation. For the data in the experiments the best fitting was obtained with the equation $Ni = A + B\ \mathrm{Log}(Lz \times t)$. The best fitting for the specific texture parameters of the natural beef can be obtained for z in the range from 30 to 40°F. It may be observed that the maxima for the correlation coefficient for the restructured beef can be obtained for the diversified values of z. Maxima for Hardness (H50) and Modulus of Elastisicity (M50) are obtained for z = 60 and 80°F, Cohesiveness I (CO50) and II (CO80) for z = 20°F and Force of Penetration (FP80) for z = 30°F. It may be explained as follows: pieces of meat in the restructured beef show a high thermo-resistance of structure but the protein glue that binds them has much lower resistance. This point of view is confirmed by a low z value for Cohesiveness I and II. In the TPA test, in which the sample is compressed to the 50% strain, it shows as high thermal resistance of parameters: Modulus of Elasticity (M50) and Hardness (H50). In the test for Force of Penetration (FP80) in which phenomena of cutting and compression occur simultaneously, the best fitting is for z = 30°F, which is a medium value. For the parameter Chewiness (C50) and Texture Parameters determined by sensory analysis, maximum for the correlation coefficients occur for z = 50 i 60 °F. This means that for the sensory properties the more important is the hardness of the meat particles than the way they are bound by a glue type compound. In Figure curves showing interdependence of Force of Penetration (FP80) and Hardness (SH) versus $\mathrm{Log}(L_{40} \times t)$.

Instrumental texture parameters								
Raw material	Natural beef				Restructured beef			
Parameter/Code	1	2	3	4	5	6	7	8
Hardness (H50) [N]	18.9	12.9	9.4	4.3	27.2	24.8	21.5	22.1
Modulus of Elasticity (M50) [$x10^5$ N/m^2]	1.40	1.00	0.73	0.64	2.47	2.40	2.17	2.18
Gumminess (G50) [N]	10.1	6.5	4.7	7.1	18.1	15.1	13.0	12.5
Chewiness (C50) [N]	5.6	3.9	2.9	4.3	15.0	12.7	10.8	10.1
Springiness (S50) [-]	.561	.584	.610	.551	.827	.828	.840	.808
Springiness II (S80) [-]	.659	.609	.610	.522	.838	.847	.831	.821
Cohesiveness (CO50) [-]	.548	.507	.492	.440	.670	.611	.608	.564
Cohesiveness II (CO80) [-]	.538	.517	.517	.444	.506	.473	.472	.471
Force of Penetration (FP80) [N]	33.5	24.8	19.4	9.4	15.3	11.2	10.2	9.9
Sensory texture parameters (100-point scale)								
Raw material	Natural beef				Restructured beef			
Parameter/Code	1	2	3	4	5	6	7	8
Cohesiveness of Touch (SCT)	75.6	63.6	56.6	27.5	70.1	66.8	53.3	49.2
Hardness (SH)	83.4	67.4	54.7	37.5	43.3	35.2	26.3	21.8
Springiness (SS)	88.2	73.4	56.7	51.2	49.7	43.6	30.1	31.3
Chewiness (SC)	83.1	76.2	56.6	49.2	47.8	38.0	25.0	21.4

Conclusions

1. Retorting conditions influence in a quite different way the texture parameters of natural and restructured beef. The restructured beef shows much lower dynamics of the changes. It should be related to the stabilizing action of the restructuring process including the influence of the polyphosphates on the meat structure and water binding by protein.

2. It is possible to describe well the interdependence of the most important texture parameters and time and temperature of retorting using mathematical formula based on the concept of lethality Lz. The analysis of value z, for which one obtains the best fitting of the dependence leads to a hypothesis that the restructured beef shows higher thermo-resistance for the texture changes as compared to the natural beef, but only in the range of parameters in which the internal structure of the meat and the gluing of the meat particles plays a role.

3. It was established that there is a good agreement between the results of texture measurements by instrumental and sensory methods. From the parameters determined instrumentally the most versatile agreement with the sensory data was shown by the Force of Penetration. Conditions of this measurement represent better than TPA the phenomena of biting and mastification in which cutting of fibrillar structure of meat plays a significant role.

RELATION OF FORCE OF PENETRATION AND HARDNESS TO Log(L_{40} x t)