THE INFLUENCE OF COMPOSITION AND RETORTING CONDITIONS ON THERMAL LOSS AND RHEOLOGICAL PROPERTIES OF CANNED LUNCHEON MEAT

Tyszkiewicz S., Kłossowska B., Olkiewicz M., Borys A., Moch P.
Meat and Fats Research Institute, 04-190 Warsaw, Poland

Background

Luncheon meat is a product that is most frequently sold in a form of slices packed in film bags. To ensure its microbiological keeping quality, independently from a high hygiene of packing, we should employ an effective heat treatment: pasteurisation or sterilisation. On the other hand, the heat treatment should be possibly mild as not to cause thermal loss and not to cause the breakdown of the slices during slicing process as well as to ensure their proper firm texture.

Objectives

The aim of the undertaken studies was to examine the effect of pasteurisation in the range of retorting temperatures (Tp) from 75°C to 95°C and of sterilisation, in the retorting temperature (Ts) range from 104°C to 129°C on the level of thermal loss (TL) and rheological properties of the cooking luncheon meat. The experimental cooking meat products were manufactured from meat with a variable fat content (FC) from 6% to 32%, with the use of polyphosphates additive, as binding water factor in meat and improving the consistency of the heat-treated meat. In Poland, the use of polyphosphates in meat processing was forbidden, or conditionally allowed to some products by health authorities (the limit was 1500 ppm P_2O_2). Recently, according to a partial harmonisation of food law with the rules of the EU countries, the limit of polyphosphates to be used in the meat products, has been increased up to 5000 ppm P_2O_5.

Methods

The preserved products of luncheon meat type were manufactured in 850 g cylindrical cans with dimensions 99 mm x 112 mm in a half-technical scale. The raw material included cured pork meat, containing fat in the following quantities: 6-8% (variant A), 12-14% (variant B), 18-20% (variant C), 24-26% (variant D), 30-32% (variant E) and also, potato starch, being added as supplementary raw material in the quantities from 2% to 3%. The polyphosphates were used in the rates from 0 (variant 1), 1500 ppm P_2O_5 (variant 2), 3000 ppm P_2O_5 (variant 3) and 5000 ppm P_2O_5 (variant 4). Pasteurisation was conducted at the temperature of retort equal to75°C, 85°C and 95°C till obtaining the temperature of 72°C in the middle of the can. Sterilisation was carried out at the temperatures of retort, equal to 104.4°C (220°F), 112.7°C (235°F), 121,1°C (250°F) and 129,4°C (265°F) for the period of time, necessary to obtain the sterilisation value of F_o - 1min. Thermal loss (TL) was determined by the weighing method and the chemical composition of the preserved meat bloc was determined by traditional analytical methods with the aim to determine the real fat content (RFC) in the meat and the quantity of the added phosphates. The rheological properties were studied by the Continually Alternating Stress-Relaxation Analysis (CASRA), described by Tyszkiewicz et al. (1997), determining the following parameters: plasticity (P), elasticity (E) and fluidity (F), using Zwick Universal Testing Machine. The conditions of the method's application were as follows: cross head velocity: between the bites – 120 mm/min and within the bite – 2 mm/min., unit force F_1=0,2N, force increment 0,2N for each next bite, duration of stress and relaxation periods t_o =15 s each, rectangular punch (2 mm x 8 mm) S=1,6 x 10^{-5} m^2, modular stress σ_1=1,25 x 10^4N/m^2. The obtained results were statistically analysed by the ANOVA method and multiple correlation method.

Results and discussion

Real fat content (RFC). The real mean fat content in the meat was as follows: variant A – 7,5%, B – 12,5%, C – 19,1%, D – 24,8% and E – 28,0%. The lower fat content than the assumed one in variant E results, first of all, from fat loss in the meat due to thermal loss.

Thermal loss (TL) in variant without the addition of polyphosphates (1) for different temperatures had values from 0 to few percent. In variants with the addition of polyphosphates (2, 3 and 4) and with a relatively low fat content (A, B, C) thermal losses were reduced to zero for all temperatures of pasteurisation and sterilisation. For variants D and E with a high fat content in which the exuded fat was dominating in the loss, the quantities of the loss were considerable and the addition of polyphosphates reduced them, but not completely.

All the examined factors had a statistically significant influence on the parameters characterising rheological status of the meat:

Plasticity of the meat (P) is the most important rheological parameter, determining the force necessary to destroy the structure of the material. Values of this parameter were the highest for the meat of pasteurised products and the temperature did not have any significant effect on these values. In case of sterilised products, the highest value of plasticity was found for the meat sterilised at the temperature of 129,4°C and the lowest one- for the meat sterilised at the temperature of 104,4°C. The addition of polyphosphates increased value of plasticity but the quantity of the polyphosphates added did not have any significant influence. The plasticity of the meat was significantly dependent on fat content: the less fat, the higher plasticity was. The relationship of the meat plasticity on fat content (FC) and temperature of cooking is given variant 1 without addition of polyphosphates in the figure no 1.

Elasticity (E) is a rheological parameter, informing about the susceptibility of the material to the reversible changes of the shape. Values of the meat's elasticity were the highest in case of sterilisation at the temperature of 104,4°C. In the remaining variants, both sterilised and pasteurised ones, the elasticity of the meat did not differ significantly. The addition of polyphosphates increased the elasticity of the meat but only inconsiderably and in case of higher rates. The elasticity of the meat was significantly correlated with fat content: the less fat, the higher the elasticity was. The relationship of the meat's elasticity on fat content (FC) and temperature of cooking for the variant 1 without addition of polyphosphates is given in the figure no 2.

Fluidity (F) is a rheological parameter, informing on the susceptibility of material to irreversible changes of the shape. The lowest value of fluidity was found for the meat of pasteurised meat products, irrespectively of the temperature of pasteurisation. The highest value of fluidity was found for the preserved meat products, pasteurised at the temperature of 104,4°C. It differed significantly from the fluidity of meat of the other sterilised variants. The addition of polyphosphates lowered fluidity, but the quantity of the polyphosphates added did not have any significant influence. Values of the meat fluidity were significantly dependent on fat content: the less fat, the fluidity was lower. The elasticity (E) and fluidity (F) of meat are strongly correlated.

The multiple correlation was calculated to examine the relationship between the parameters, characterising the rheological properties of the meat (P, E and F), thermal losses (TL), determined fat content (RFC) and the determined phosphorus content (PM), separately for pasteurised and separately for sterilised products. Values of the correlation coefficients are given in table. The diagrams of relationships in the system of the principal components (biplots for variables in multivariate space) are shown in fig. no 3 and no 4.

Table. Correlation coefficients

Variables	Cooking temperature (T)		Real fat content (RFC)		Phosphorus content (PM)	
	Pasteurisation (Tp)	Sterilization (Ts)	Pasteurisation (Tp)	Sterilization (Ts)	Pasteurisation (Tp)	Sterilization (Ts)
Plasticity (P)	-0,038	$0,359^{xx}$	$-0,918^{xx}$	$-0,748^{xx}$	0.516^{xx}	$0,465^{xx}$
Elasticity (E)	-0,240	$-0,320^{xx}$	$0,868^{xx}$	$0,697^{xx}$	$-0,440^{xx}$	$-0,376^{xx}$
Fluidity (F)	-0,24	$-0,277^{x}$	$0,807^{xx}$	$0,633^{xx}$	$0,450^{xx}$	$-0,375^{xx}$
Thermal loss (TL)	0,159	0,030	$0,501^{xx}$	$0,532^{xx}$	$-0,326^{x}$	$-0,380^{xx}$

xx – significant at $\alpha = 0,01$ x – significant at $\alpha = 0,05$

Fig. 1 Plasticity (P), addition polyphosphate 0 ppm P_2O_5

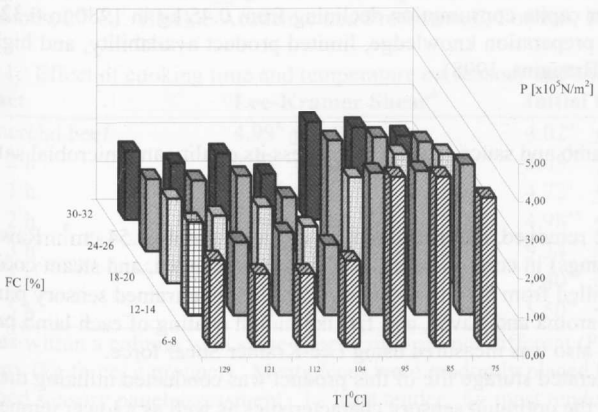


Fig. 2 Elasticity (E), addition of polyphosphates 0 ppm P_2O_5

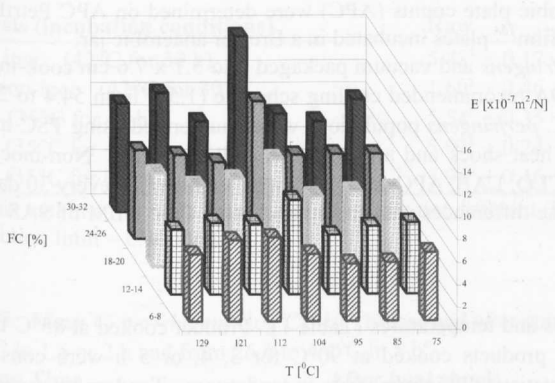


Fig. 3 Biplot for pasteurized luncheon meat

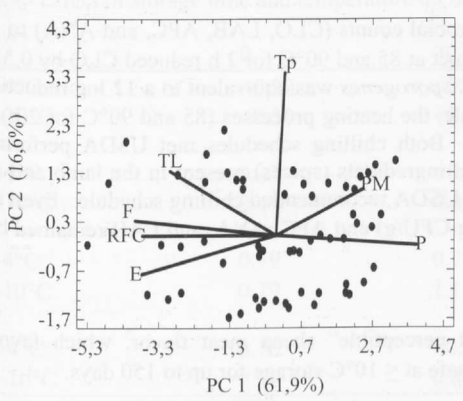
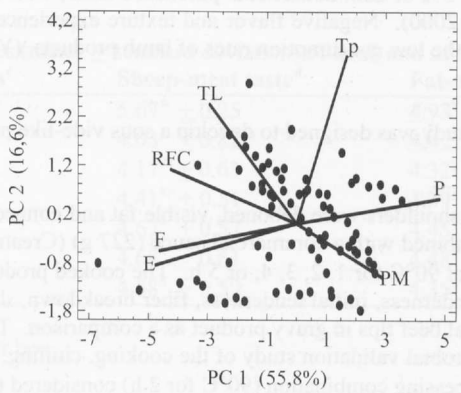


Fig. 4 Biplot for sterilized luncheon meat



Conclusions

1. The best rheological properties of luncheon meat destined for slicing are found for pasteurised variants, irrespectively of the temperature of pasteurisation.

2. In case of sterilised variants, the better rheological properties were found for the meat from variants, treated shortly at high temperatures.

3. The addition of polyphosphates improves the rheological structure of meat and lowers thermal losses, the efficiency of action is not increasing significantly together with the rise of the rate above 1500 ppm P_2O_5.

4. The increase of fat content causes a deterioration of the rheological properties of meat and in case of the level above 25%, a significant increase of thermal losses takes place and it cannot be limited efficiently by the addition of polyphosphates.

5. All the studied parameters, characterising of the manufactured experimental luncheon meat demonstrate a high degree of mutual relationship and dependence. The analysis of these relationships will be the subject of a separate publication.

Pertinent literature:

1. Tyszkiewicz S., Olkiewicz M., Daun H. Multiparametric method for the rheological evaluation of meat and other solid foods. Journal of Texture Studies 28 (1997) 337-348.