THE INFLUENCE OF COOKING METHOD AND PARAMETERS UPON THE DIETETIC PROPERTIES OF BABY-FOODS

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In cases of various gastro-intestinal tract diseases dieticians recommend, as an obligatory factor, chemically mild diets which restrict the supply of secretion stimulants, including nitrogen extractives of meat. In view of this, a method for removing extractives from baby- and dietetic meat products being developed was studied and optimised. The effect of meat comminution, cooking temperature and time upon meats dietetic properties was considered. Pre-cooking conditions ensuring process intensification and mechanisation due to short contact steam heating followed with the stabilisation of the chemical composition of the processed meat mass, were substantiated. It was established that the highest effect is achieved through loosening the links between proteins and water ions. It occurs during meat pieces pre-cooking in water at 75°C or minced meat steam cooking at 100-120°C.

Dietitians recommend that the level of secretion of stimulants when consuming baby- and dietetic foods be restricted. It concerns the foods destined for children suffering with diseases of the gastro-intestinal tract, in which case mechanically sparing effect should be combined with a mild chemical effect as an obligatory factor of diets.

At present extractives are removed from meat by means of pre-cooking meat pieces (100-200 g) in water or with contact steam cooking of minced meat followed with the separation of the liquid phase which consists of broth containing extractives, and fat (Oreshkin and Ustinova, 1986; Lukjanova et al., 1986).

When solving the problem of intensifying water pre-cooking and contact steam cooking, of importance is the extent of meat comminution and cooking temperature.

The purpose of the work was to develop a procedure and optimum parameters of meat heat treatment as related to meat comminution degree, cooking temperature and time which ensure the maximal removal of nitrogen extractives from the raw meat.

As the object of the study served beef and pork ground through different plates, viz., 3^{-3}m (Experiment I), 8^{-3}m (Experiment II) and 16^{-3}m (Experiment III). To compare the influence of comminution degree upon such quality parameters as nitrogen extractives content, WHC and pH, raw meat was cooked in water at 92°C ± 1°C for 600 s, water-to-meat proportion being 3:1.

When studying the effect of cooking parameters, raw meat ground through a 3^{-3}m plate was heated in water at 60-90°C (at 5°C increments) for 600 s and with steam in a thin layer (5 m) for 30, 60, 90, 120, 180 and 300 s.

The following indices were chosen as evaluation criteria: the level of nitrogen extractives, meat WHC, pH, cooking loss.

The total protein percentage was determined according to the Kjeldal method; the level of nitrogen extractives - according to the Kjeldal procedure after soluble protein precipitation with TCA (g/g of protein); moisture (%) - by means of drying down to the constant weight; WHC (g of non-pressed out moisture/g of protein) - with pressing under 1×10^5 Pa; pH - with a pH-meter 340; cooking loss (%) - by means of weighing.

The experiments carried out indicated that the WHC of minced beef and pork decreased with comminution: from 1·86 to 1·73 g/g of beef protein and from 1·93 to 1·65 g/g of pork protein. pH in the test samples increased with a higher degree of comminution.

The established correlation demonstrated an inverse close connection between these two parameters and was equal to -0·98 for beef and -0·64 for pork.

The packing of protein molecules during heating is known to be accompanied with soluble substances diffusion from the meat into the broth. This process proceeds quicker with finer comminution of the raw meat. The analysis of nitrogen extractives in raw meat indicated that a fall in WHC was accompanied with their significant decrease (R_{beef} = 0·95, R_{pork} = 0·8). The statistical processing of the derived data resulted in an inverse relation of pH to extractives level, i.e. with a higher pH the level of the latter was reduced (R_{beef} = -0·98, R_{pork} = -0·92).

Meat cooking loss decreases with a finer degree of comminution. The analysis of the obtained data allowed to conclude that at the constant cooking parameters, the maximum removal of nitrogen compounds was achieved in case of meat ground through a 3^{-3}m plate.

The influence of cooking parameters on the tested quality characteristics was studied on the samples of 3^{-3}m ground meat. A relation of the heating medium temperature to nitrogen extractives is described as follows:

$$y = ax + bx^2 + C,$$

where "a" and "b" are the first and second coefficients of regression; "C" is a free term; "y" and "x" are variable factors. It is represented as the following regression equations (1):

$$E_{beef} = (-0{\cdot}05 \times T_{h.m.} + 0{\cdot}000313 \times T^2_{h.m.} + 2{\cdot}23) \times 10^{-2}$$

$$E_{pork} = (-0{\cdot}0446 \times T_{h.m.} + 0{\cdot}000278 \times T^2_{h.m.} + 1{\cdot}97) \times 10^{-2}$$

where E is the amount of nitrogen extractives (g/g of protein); $T_{h.m.}$ is temperature of the heating medium. From the derived regression relationship the minimum level of nitrogen extractives was found in the meat precooked at $T_{opt} = -\frac{b}{2a}$, the latter equalling 75-80°C. The analysis of the regression equation, the derived coefficients of multiple correlation (R_{beef} = 0·98, R_{pork} = 0·97) and Fisher's ratio (F) (F_{beef} = 77·4, F_{pork} = 39·8) imply the adequacy of the given model and a high correlation among these factors.

The results on WHC of the raw meat revealed a direct relationship of the amount of non-pressed off moisture to temperature (Eq.2), i.e. higher temperatures caused greater drip loss and at the same time lower levels of nitrogen extractives in meat. The minimal value of WHC was recorded at 75°C.

The observed regularity is described with the following regression equation:

$$W_{beef} = -0.146 \times T_{h.m.} + 0.0009 \times T^2_{h.m.} + 7.55$$

$$W_{pork} = -0.148 \times t_{h.m.} + 0.000919 \times T^2_{h.m.} + 7.55 \qquad (2)$$

$$R_{beef} = 0.99,\ F_{beef} = 134$$

$$R_{pork} = 0.99,\ R_{pork} = 133,$$

where W is non-pressed off moisture (g/g of protein). The above coefficients show that the non-pressed off moisture in the minced meat depended greatly on the temperature of the heating medium. At the same time a rèlation of the level of nitrogen extractives to the quantity of non-pressed off moisture was estimated. Regression equations are as follows:

$$E_{beef} = (0.334 \times W_{beef} - 0.34) \times 10^{-2}$$

$$E_{pork} = (0.06 \times W_{pork} + 0.189) \times 10^{-2} \qquad (3)$$

$$R_{beef} = 0.99,\ F_{beef} = 385$$

$$R_{pork} = 0.97,\ F_{pork} = 104$$

The regression coefficients indicate a relation between the indices determined with the nature of a physical process under study.

Changes in pH-values allowed to establish that pH was gradually rising with temperature up to 75°C.

The results on cooking losses (Eq.4) demonstrated that they grew when cooking temperature rose from 60 up to 75°C. A further temperature increase had no significant effect on weight losses. Regression equations are as follows:

$$w.l._{beef} = 0.35 \times T_{h.m.} - 1.82$$

$$w.l._{pork} = 0.364 \times T_{h.m.} - 8.6 \qquad (4)$$

$$R_{beef} = 0.66,\ F_{beef} = 3.8$$

$$R_{pork} = 0.85,\ F_{pork} = 13.4,$$

where w.l. is weight losses of raw beef or pork.

The value of the coefficients relate the growth of the heating medium temperature up to 75°C to meat weight losses.

In addition, correlation coefficients are found that show meat cooking losses as related to pH ($R_{beef} = 0.8$, $R_{pork} = 0.68$), i.e. pH increased with higher losses.

Studying the effect of hot steam cooking of raw meat showed that the basic changes in the protein molecules were completed when the minced meat was heated up to 76 ± 1°C, it corresponding to the cooking time of 120 s.

It was found that, in case of steam cooking, the content of nitrogen extractives in meat decreased to a lesser degree as compared to water cooking. Thus, at water cooking for 120 s 70-75% of extractives loss (of the total level) was noted in case of 300 s cooking; a respective estimate for steam cooking was 13%. This may be attributed to different amounts of moisture involved in the extraction process. The regression equations are as follows:

$$E_{beef} = -0.0007 \times \tau + 0.0154$$

$$E_{pork} + 0.0006 \times \tau + 0.0145 \qquad (5)$$

$$R_{beef} = -0.93,\ F_{beef} = 27.3$$

$$R_{pork} = -0.84,\ F_{pork} = 9.2,$$

where τ is cooking time, min. The values of Fisher's ratio confirm the adequacy of the given model.

The results of this study and the derived regression equations showed that the optimum regimes of cooking are those in water at 75-80°C and with steam for 120 s (Eqs. 1-5).

The amount of non-pressed off moisture from raw meat changed in a similar way and decreased abruptly within the interval from 30 to 120 s, remaining at the same level with further cooking.

A relation between the quantity of non-pressed off moisture and cooking time is clearly reflected in the following regression coefficients:

$$W_{beef} = -0.048 \times \tau + 1.72$$

$$W_{pork} = -0.099 \times \tau + 2.32 \qquad (6)$$

$$R_{beef} = -0.77,\ F_{beef} = 5.7$$

$$R_{pork} = -0.87,\ F_{pork} = 12.4$$

Here it should be mentioned that raw meat pH was constantly growing and depended, as the regression models indicated, on cooking time:

$$pH_{beef} = 0.066 \times \tau + 5.3$$

$$pH_{pork} = 0.024 \times \tau + 6.93 \qquad (7)$$

$$R_{beef} = 0.99,\ F_{beef} = 165$$

$$R_{pork} = 0.83,\ F_{pork} = 9.2$$

Eq.8 characterises changes in meat weight losses due to steam cooking time and to the kind of meat. Lower WHCs of minced beef were accompanied with higher reductions of nitrogen extractives. Meat cooking losses are greater in case of longer heat treatment:

$$w.l._{beef} = 3.9 \times \tau + 5.3$$

$$w.l._{pork} = 4.9 \times \tau - 3.3 \qquad (8)$$

$$R_{pork} = 0.96,\ F_{pork} = 44.9$$

$$R_{pork} = 0.92,\ F_{pork} = 22.7$$

Thus, as judged by a complex of indices tested, the optimum processing conditions for minced meat are cooking in water at 75-80°C for 600 s (80% of nitrogen extractives removed) or steam cooking for 100-120 s (13% of extractives removed). Higher removal rates at steam cooking are possible if extra water is added, which can be further separated by means of centrifuging or pressing.

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