INFLUENCE OF COMPOSITION AND HEAT TREATMENT ON TECHNOLOGICAL PARAMETERS OF LIVER PATE

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Abstract: The models of pate were constructed according to linear Complete Factorial Experiment, CFE. The models describe the dependence of Water Binding Capacity (WBC), Water and Fat Retention Capacity (WRC and FRC) of the protein and fat content in raw material. Protein influence positive FRC and FRC^t indexes. Fat Content has a negative influence on WRC.

Key words: pate, liver, proteins, lipids, water retention capacity, fat retention capacity.

Introduction

Attention of nutritionists and food industry experts on the problems of functional food are focused [1]. Quality and food safety is dependent on the quality of used raw and auxiliary materials, processing and storage conditions [2]. Reductions of nutritional and hygienic quality take place in the foods under the influence of physicochemical and biochemical factors during the technological flow and storage [8]. Degradation of micro and macronutrients can to begin in raw materials and to continue in time of manufacture of food and in the period of storage [9]. Thus, it is necessary to develop technologies to ensure product quality and safety [10]. For this, the raw materials tend to be used optimally so that the finished products to obtain high nutritive value, warrant hygienic and qualitative indicators.

Materials and methods

The technological properties of animal raw materials and by-products depend mathematically by a certain number of physicochemical characteristics [3]. Complexity of modelling of the studied systems is that initial levels of influence factors cannot be varied within very wide limits, nor they can be accurately reproduced [4, 5]. The mathematical models were constructed, based on experimental data obtained for bovine liver, pork tongue, kidneys and bovine diaphragm being characterized by values of influence factors, suitable for matrix composition planning [6, 7]. The models describe the dependence of Water Binding Capacity (WBC), Water Retention Capacity (WRA) and Fat Retention Capacity (FRC) of the protein and fat content in raw material. The calculations were made for raw materials in the natural state (without thermal degradation) and after heat treatment. Raw materials were coarse crushed to 3 mm Ø cutter or were finely grinded. The models were constructed according to the two-level, two-factor Complete Factorial Experiment, CFE 2^2, in linear approximation. Standard significance value $P = 0.95$ ($q = 0.05$) was postulated.

Results and discussions

System responces were analysed (Table 1) in order to deduce linear regressions according to general formula (1):

$$\mathbf{Y} = \beta_0 + \beta_1 \cdot X_1 + \beta_2 \cdot X_2 + \beta_{12} \cdot X_{12} \quad (1)$$

Table 1. Planning Matrix in encoded and real coordinates

N_{exp}	***Raw material***	***X_1 - Protein, %***		***X_2 - Fat, %***		***X_{12}***
1	Pork tongue	+	17.2±0.7	+	9.4±0.9	+
2	Bovine liver	+	17.6±0.7	–	3.4±0.9	–
3	Bovine diaphragm	–	15.1±0.7	+	6.6±0.9	–
4	Bovine kidneys	–	15.9±0.7	–	3.7±0.9	+

Water Retention Capacity in the feedstock before thermal treatment (WRC):

$$WBC_{3mm} = 80.3 – 9.2\ X_1 – 11.0\ X_2 + 1.5\ X_{12} \qquad b_{critical} = 4.3; \qquad (2)$$
$$WBC_{FG} = 82.3 – 4.2\ X_1 – 7.2\ X_2 + 1.2\ X_{12} \qquad b_{critical} = 4.8. \qquad (3)$$

Water Retention Capacity in the feedstock after thermal treatment (WRC^t):

$$WRC_{3mm}^t = 80.8 + 3.9\ X_1 – 9.9\ X_2 + 19.2\ X_{12} \qquad b_{critical} = 3.3; \qquad (4)$$
$$WRC_{FG}^t = 80.3 + 3.4\ X_1 – 5.8\ X_2 + 19.0\ X_{12} \qquad b_{critical} = 2.4. \qquad (5)$$

Fat Retention Capacity in the native raw material before thermal treatment (FRC):

$$FRC_{3mm} = 11.1 + 8.8\ X_1 – 3.1\ X_2 – 9.2\ X_{12} \qquad b_{critical} = 1.4; \qquad (6)$$
$$FRC_{FG} = 12.8 + 8.7\ X_1 – 2.9\ X_2 – 8.7\ X_{12} \qquad b_{critical} = 1.2. \qquad (7)$$

Fat Retention Capacity in the feedstock after thermal treatment (FRC^t):

$$FRC_{3mm}^t = 19.0 + 7.9\ X_1 – 3.7\ X_2 – 13.5\ X_{12} \qquad b_{critical} = 2.1; \qquad (8)$$
$$FRC_{FG}^t = 22.8 + 14.2\ X_1 + 1.4\ X_2 – 8.4\ X_{12} \qquad b_{critical} = 1.6. \qquad (9)$$

The influence of protein on FRC and FRC^t is positive due to the surfactant properties of the protein expressed by the attraction of the lipids by the hydrophobic parts of protein macromolecules. Coefficient β_1 change the sign passing from WBC to WBC^t. According to equations (2)…(9), WRC increases due to heat treatment. Probably, this happens by means of reorientation of protein macromolecules, especially of their polar parts. Fat content in all cases has a negative influence. The decrease of WRC and WRC^t is natural due to the hydrophobic properties of lipids. In almost all cases, the values of the influence factors β_1, β_2 and β_{12} are higher for rough grinding systems (3mm), which can be seen from the comparison of the first three pairs of equations. However, these differences are smaller than the respective values of parameters of statistical validity, $\beta_{critical}$. The exception is observed in the analysis of equations 6 and 7. The influence of protein content on FRC^t where in the case of finely grounded raw material is much higher than for coarse grounded raw material, exceeding respective values of $\beta_{critical}$. It was observed a strong influence of the interaction factor X_{12}. Thus, in equations 2…6, coefficient of β_{12} exceeds values of $\beta_{critical}$, β_1 and β_2. In our view, the lack of statistical significance of β_{12} in equations 2 and 3 for WBC and her appearance in Equation 4 and 5 for WRC^t it is due protein-lipid interactions. Because of these reconfirmations occurs the change of surface-active properties of the studied systems. Strong influence of the fat/protein ratio (F/P) on WRC and adhesiveness becomes even more obvious at graphical statistical analysis. Have been constructed the dependences WRC = f (F/P) and Adh = f (F/P) for liver pate, where the F/P ratio was modified using soy isolate. All obtained dependencies satisfy the assumption of strong linear influence of F/P ratio on system responses, with high values of Credibility:

$CRA_{Chişinău} = - 5.0G/P + 92.8;$	$R^2 = 0.99$	(10)
$CRA_{Noutate} = - 6.2G/P + 96.8;$	$R^2 = 0.82$	(11)
$CRA_{Studenţesc} = -7.2G/P + 102.9;$	$R^2 = 0.94$	(12)
$Adh_{Chişinău} = -2064.6G/P + 4039.7;$	$R^2 = 0.99$	(13)
$Adh_{Noutate} = - 868.2G/P + 2537.8;$	$R^2 = 0.87.$	(14)
$Adh_{Studenţesc} = -863.2G/P + 2026.6;$	$R^2 = 0.96.$	(15)

The presented relations demonstrate well-defined linear dependence of adhesiveness (Figure 1) and Water Retention Capacity (Figure 2) for pates "Chişinău", "Noutate" and "Studenţesc" of the ratio of fat per protein in each type of pate.

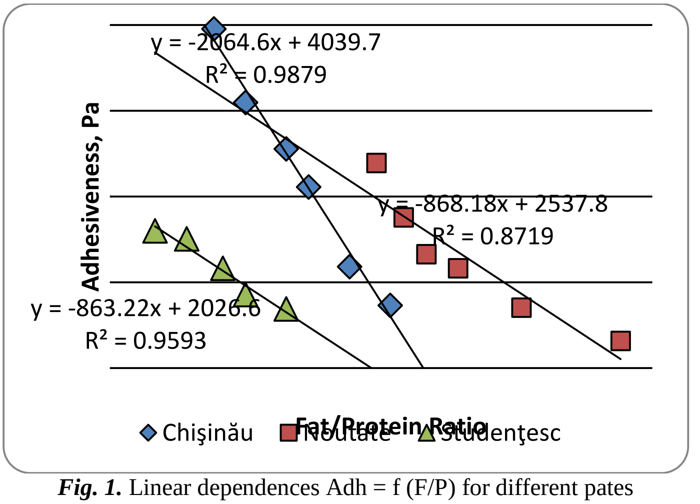

Fig. 1. Linear dependences Adh = f (F/P) for different pates

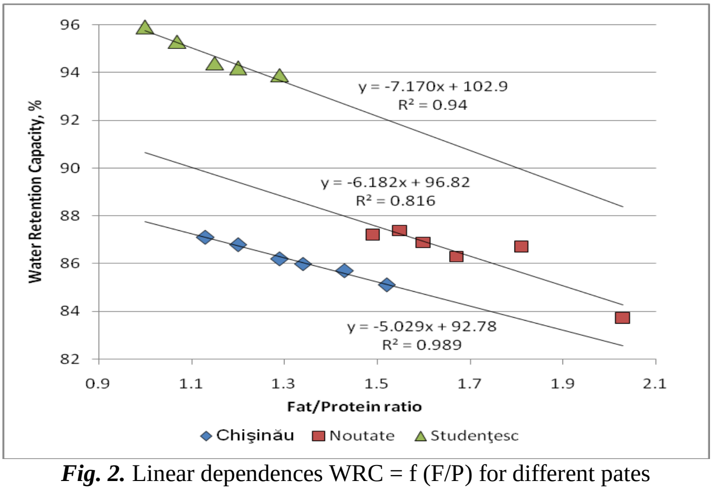

Fig. 2. Linear dependences WRC = f (F/P) for different pates

Conclusions

1. The influence of the chemical composition, particularly the protein and fat content, but also a heat treatment on the technological properties such as water retention capacity and fat retention capacity in the native raw material and after the heat treatment in the production of liver pate is obvious and is statistically appreciable;
2. Protein content influence positive on FRC and FRC^t indexes, which can be explained by the attraction between the lipids and the hydrophobic non-polar parts of protein macromolecules. These interactions take place due to the surfactant properties of the protein;
3. Fat Content has a negative influence. The decrease of WBC and WBC^t is explained due to the hydrophobic properties of lipids, therefore, its water-repulsion influence on the polar / non-polar interfaces in the pate's structure;
4. The ratio of fat / protein has a strong influence of the Water Retention Capacity and adhesiveness. These dependences are manifested as well-defined linear functions with significant values of credibility of approximation, $R^2 \in (0.82…0.99)$.

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