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EFFECT OF ADDITION OF CELLULOSE PREPARATION ON THE QUALITY AND STRUCTURE OF FINELY GROUND MODEL PROCESSED MEAT PRODUCTS

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Abstract. The effect of addition of wheat cellulose preparation on the quality and structure of finely ground model products was tested. Apart from potassium tripolyphosphate, the wheat cellulose preparation WF-400 was added to the stuffing, at different levels of addition of technological water: 30, 50 and 80%. The testing of the model processed meat products covered: determination of heat leakage, evaluation of the basic composition in the preserved product block according to the relevant PN ISO standards, quality and profile sensory evaluation, analysis of texture profile and tensile strength of slices with the universal machine Zwick model 1445. The values of the evaluated parameters of texture profile and quality and sensorial profile of model products were substantially affected by the level of addition of technological water. The higher level of water addition substantially lowered the values of the tested parameters. The preparation of tripolyphosphate as well as tripolyphosphate and cellulose effectively reduced cooking losses and they had a structure-creating action, the cellulose preparation "strengthened" the action of phosphates. In result of the trial the use of cellulose preparation as a functional additive and/or with potassium tripolyphosphate to finely ground meat products was found reasonable and, in particular, to the products of different level of addition of technological water.

Keywords: cellulose preparation, phosphates, finely ground processed products, structure, quality, water binding

INTRODUCTION

The cellulose preparations available in the market are characterised with different water binding capacity which depends, among others, on the kind of the preparation and the degree of micronisation of its particles, which seems to have an undoubted effect on their functional properties in foodstuffs and, in particular, on their texture (Bacers and Noll 1998, Waszkowiak *et al.* 2001, Makała 2002, Makała and Olkiewicz 2004).

Phosphates have also a substantial, many-sided influence on quality of meat products, both during their production and distribution, which is connected with their favourable effect on the improvement of meat water-binding, improvement of certain rheological and sensory parameters. The most important technological effects of application of phosphates are, in particular, the reduction of heat leakage, increase of juiciness and tenderness, as well as improvement of slices binding (Klettner 2000a, b, Müller *et al*. 2000, Möller *et al*. 2001, 2003, Lesiów 2003).

The purpose of the work was to tests the effect of the addition of the selected cellulose preparation as regards potassium tripolyphosphate, at different levels of addition of technological water, on the quality and structure of finely ground model meat products.

MATERIALS AND METHODS

The trial material was formed by model, finely ground processed meat products. The basic recipe of the control variant (K) was as follows: beef meat 2nd class (33.3%), pork meat 3rd class (33.3%), fat in small pieces (33.3%), salt (1.8%), spices and, moreover, 30, 50 or 80% of water. In the tested variant to the stuffing 3 g P_2O_5 per 1 kg of the product of potassium tripolyphosphate (TPF) or 3 g P_2O_5 of potassium tripolyphosphate and 2% of wheat cellulose preparation WF-400 (TPF_B) were added, at the different levels of addition of technological water.

The raw materials for production of a model stuffing - beef meat 2nd class and pork meat 3rd class (tendon meat) and pork fat in small pieces of the temperature 0-2^{o}C – were ground in a grinder, through a mesh of 3 mm, and then processed in a cutter, adding to the cutter pan, in turn: meat, ice, potassium tripolyphosphate or potassium tripolyphosphate and cellulose preparation, fat, as well as pickling mix and spices. The processing in the cutter lasted about 8-10 minutes. The final stuffing temperature did not exceed 12°C. The stuffing was made in a 6-knife cutter of the pan capacity of 0.04 m^3. The technical parameters of the cutter were as follows: pan speed – 30 rpm, knife shaft speed – 3600 rpm, standard knives type EE of slip ratio λ = 1,5.

The cans of the capacity of 400 g were filled with stuffing and then, after closing them, pasteurised in water at the temperature of 75°C till the moment of reaching the temperature of 72°C in their geometric centre. The model products were stored in a cold store at the temperature of 4-6°C.

The testing of the model product covered:

- volume of thermal drip in the preserved product block, with the weight method (Makała and Olkiewicz 1997),
- basic composition: water contents according to PN ISO 1442:2000, protein contents according to PN-75/ A-04018, collagen contents according

to PN ISO 3496:2000, fat contents according to PN ISO 1444:2000, chlorides contents according to PN ISO 1841-1:2002 and total and added phosphorus contents according to PN-87/A-82060,

- slices tensile resistance with the universal machine Zwick model 1445 (Tyszkiewicz and Olkiewicz 1991),
- instrumental analysis of texture profile, determining hardness_i, gumminess_i, cohesiveness_i, springiness_i and chewiness_i, performed with the TPA method (Chrystall *et al.* 1994), at the following test parameters: deformation – 80%, test speed – 60 mm min^{-1}, sample thickness – 20 mm, diameter – 25.4 mm,
- sensory and profile quality evaluation. The desirability of colour, flavour, taste, consistency and general (total) product desirability were evaluated. In the profile analysis such parameters as hardness_s, elasticity_s, gumminess_s, chewiness_s and water binding_s were evaluated with the program ANALSENS 2005, by a team of trained judges (PN ISO 11035:1994, PN ISO 41219: 1998). The intensity of the parameters was marked on a 10 cm graphic scale of the relevant limit marks, the results were expressed in prearranged units from 0 to 10 points. The valuation was performed in the Sensorial Department of the Meat and Fat Industry Institute, keeping the standard PN ISO 8589:1998, using the computerised ANALSENS system.

The test was made in two replications. The test results were subject to statistical analysis using the Statgraphics program.

RESULTS AND DISCUSSION

The average results of the basic chemical composition, contents of water, protein, fat, NaCl, total and added phosphorous and collagen for particular variants of model products, depending on the level of addition of technological water, are presented in Table 1. The achieved results are in conformity with the assumptions of the experimental model. The increase of the addition of technological water resulted, in each variant, in increase in water contents with simultaneous decrease in protein and fat contents. At 50% and 80% addition of technological water a substantial decrease in protein content (below 10%) in the system was observed, affecting negatively the structure and binding of stuffing components, as described, among others, in the works (Makała *et al*. 2000, Olkiewicz *et al.* 2001).

Table 1. Characteristics of the basic chemical composition in model products

Variant	Level of water (%)	Water content (%)	Protein content (%)	Fat content (%)	NaCl content (%)	Total phos-phorous contents (%)	Added phosphorous contents (%)	Collagen content (%)
K		59.5[b]	10.1[a]	27.7[c]	1.50[a]	2.0[a]	0.0[a]	1.10[a]
TPF	30	60.0[c]	10.1[a]	26.2[b]	1.60[b]	4.3[b]	1.9[b]	1.22[a]
TPF_B		59.0[a]	10.2[a]	25.9[a]	1.60[b]	4.6[c]	2.3[c]	1.33[a]
NIR		0.22	0.24	0.37	0.09	0.09	0.09	0.28
K		63.6[a]	9.3[c]	24.5[c]	1.50[a]	1.7[a]	0.0[a]	1.39[a]
TPF	50	64.8[c]	9.0[b]	23.4[b]	1.57[b]	4.0[b]	1.9[b]	1.37[a]
TPF_B		63.8[b]	8.8[a]	22.1[a]	1.60[b]	4.1[b]	2.1[c]	1.41[a]
NIR		0.19	0.16	0.75	0,07	0.12	0.0	0.12
K		66.0[a]	8.2[b]	22.8[b]	1.57[b]	1.7[a]	0.0[a]	1.39[a]
TPF	80	69.3[c]	8.2[b]	20.2[a]	1.60[b]	3.9[b]	2.0[b]	1.29[a]
TPF_B		68.5[b]	7.9[a]	20.0[a]	1.50[a]	4.1[c]	2.3[c]	1.36[a]
NIR		0.39	0.22	1.02	0.07	0.09	0.067	0.12

[a, b] – average values in columns marked with different indices differ significantly ($\alpha \leq 0.05$).

The effect of the addition of potassium tripolyphosphate or potassium tripolyphosphate and cellulose preparation on water binding, i.e. the volume of heat leakage as well as slices tensile strength for particular variants of model products, depending on the level of addition of technological water, are presented in Table 2. The addition of phosphate resulted in a statistically significant, over 4-times reduction of heat leakage at 30 and 50% water addition and at 80% water addition – over 2-times reduction of heat leakage. The cellulose preparation strengthened (amplified) the action of potassium tripolyphosphate, resulting in an additional reduction of cooking losses and in strengthening of slices binding. The slices of products containing potassium tripolyphosphate and cellulose preparation, at 30 and 80% water addition, were the most resistant to tension.

Table 2. Characteristics of heat leakage and tensile strength of slices in model products

Variant	Level of water (%)	Thermal drip (%)	Slice strength (N m $^{-2}$)
K	30	2.3[b]	4.3[a]
TPF		0.5[a]	4.5[a]
TPF_B		0.3[a]	4.8[a]
NIR		0.26	0.62
K	50	4.6[b]	2.7[a]
TPF		1.4[a]	2.0[a]
TPF_B		1.1[a]	2.2[a]
NIR		1.08	0.91
K	80	12.7[b]	1.5[a]
TPF		5.7[a]	1.7[a]
TPF_B		5.4[a]	1.8[a]
NIR		0.70	0.32

[a, b] – average values in column parties marked with different indices differ significantly ($\alpha \leq 0.05$).

In the trial (Thebaudin *et al.* 1997, Waszkowiak *et al.* 2001) it was found that product texture is influenced by – among others – the hydration fibre capacities which depend on the kind of preparation applied. One could have expected that in the tested meat structure the said properties would be revealed in particular. In the evaluation of texture parameters evaluated instrumentally, like hardness, gumminess, cohesiveness, springiness and chewiness in the tested products, a substantial differentiation was noted, caused by the influence of both the addition of technological water and the presence of potassium tripolyphosphate and cellulose preparation. The average results are presented in Table 3 and an example is given in Figure 1. Increase in the addition of technological water resulted in a decrease in the values of the tested parameters: hardness, gumminess, elasticity and chewiness. The addition of cellulose preparation in the presence of potassium tripolyphosphate strengthened the structure of model products, in each variant with different water addition levels.

The values of the evaluated parameters of sensorial quality (Tab. 4) and sensory assessment of texture profile parameters (Tab. 5) were affected neither by the addition of potassium tripolyphosphate nor potassium tripolyphosphate and cellulose preparation.

Table 3. Characteristics of texture parameters determined instrumentally in model products

Variant	Level of water addition (%)	Hardness_i (N)	Gumminess_i (N)	Cohesiveness_i	Springiness_i (mm)	Chewiness_i (Nmm)
K	30	85.3^{a}	0.116^{b}	9.9^{b}	4.9^{b}	47.8^{b}
TPF		78.3^{a}	0.108^{ab}	8.5^{a}	4.2^{a}	35.2^{a}
TPF_B		99.4^{b}	0.100^{a}	10.0^{b}	3.8^{a}	38.0^{a}
NIR		9.99	0.011	0.71	0.40	4.71
K	50	60.7^{a}	0.110^{a}	6.7^{a}	4.1^{b}	27.6^{a}
TPF		60.1^{a}	0.105^{a}	6.3^{a}	3.7^{ab}	23.0^{a}
TPF_B		63.8^{a}	0.105^{a}	6.7^{a}	3.3^{a}	22.2^{a}
NIR		7.38	0.010	0.85	0.43	5.66
K	80	49.1^{ab}	0.111^{a}	5.5^{ab}	3.7^{b}	20.0^{b}
TPF		43.7^{a}	0.103^{a}	4.5^{a}	3.2^{a}	14.6^{a}
TPF_B		52.6^{b}	0.109^{a}	5.7^{b}	3.1^{a}	17.4^{ab}
NIR		6.76	0.0096	1.07	0.38	4.89

$^{a, b}$ – average values in column parties marked with different indices differ significantly ($\alpha \leq 0.05$).

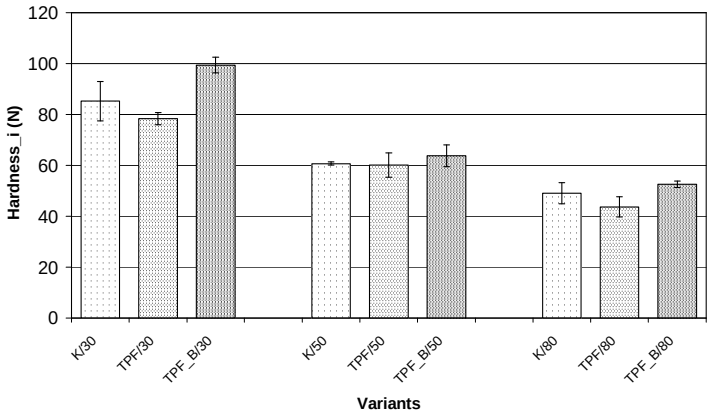

Fig. 1. Hardness of model products measured instrumentally

Table 4. Characteristics of sensorial quality parameters of model products

Variant	Level of water addition (%)	Colour desirability (p.)	Flavour desirability (p.)	Taste desir-ability (p.)	Consistence desirability (p.)	Total desir-ability (p.)
K	30	6.2 [a]	6.2 [a]	5.4 [a]	6.3 [ab]	5.5 [a]
TPF		6.7 [a]	6.0 [a]	5.8 [a]	6.7 [b]	6.0 [a]
TPF_B		6.4 [a]	5.5 [a]	5.5 [a]	5.6 [a]	5.5 [a]
NIR		0.28	0.66	0.29	0.86	0.51
K	50	6.7 [a]	5.6 [a]	4.6 [a]	4.3 [a]	5.0 [a]
TPF		6.6 [a]	6.3 [a]	5.3 [a]	5.1 [a]	5.3 [a]
TPF_B		6.5 [a]	6.3 [a]	5.1 [a]	4.6 [a]	4.9 [a]
NIR		0.22	0.70	0.73	0.55	0.39
K	80	5.6 [a]	6.0 [a]	3.5 [a]	3.3 [a]	3.4 [a]
TPF		5.6 [a]	5.5 [a]	4.2 [a]	4.0 [a]	3.8 [a]
TPF_B		5.5 [a]	5.8 [a]	3.4 [a]	3.4 [a]	3.9 [a]
NIR		0.32	0.55	0.85	0.71	0.53

[a, b] – average values in column parties marked with different indices differ significantly ($\alpha \leq 0.05$).
(p.) – points.

Table 5. Characteristics of sensorial texture profile of model products

Variant	Level of water addition (%)	Hardness_s (p.)	Elasticity_s (p.)	Gumminess_s (p.)	Chewiness_s (p.)	Water bindings_s (p.)
K	30	4.9 [a]	5.4 [a]	5.2 [a]	4.5 [a]	7.1 [b]
TPF		4.7 [a]	5.1 [a]	5.5 [a]	4.3 [a]	7.3 [b]
TPF_B		4.1 [a]	4.2 [a]	4.5 [a]	4.0 [a]	6.1 [a]
NIR		0.83	1.28	1.02	0.69	0.78
K	50	3.5 [a]	3.6 [a]	3.6 [a]	3.6 [a]	5.2 [a]
TPF		3.4 [a]	3.6 [a]	3.7 [a]	3.6 [a]	5.0 [a]
TPF_B		3.6 [a]	3.7 [a]	3.5 [a]	3.8 [a]	4.9 [a]
NIR		0.47	0.50	0.32	0.35	0.45
K	80	1.6 [a]	2.1 [a]	1.7 [a]	2.3 [a]	4.3 [a]
TPF		2.4 [a]	2.7 [a]	2.2 [a]	2.9 [a]	3.9 [a]
TPF_B		2.0 [a]	1.8 [a]	2.2 [a]	2.0 [a]	4.3 [a]
NIR		0.48	1.01	0.53	0.93	0.57

[a, b] – average values in column parties marked with different indices differ significantly ($\alpha \leq 0.05$).
(p.) – points.

The growing level of water addition was reflected in the falling desirability of taste, consistence and general (total) desirability. It also resulted in a substantial deterioration of values of all the evaluated texture profile parameters: hardness, elasticity, gumminess, chewiness and sensorial effect of water binding in the slices of the product. The lowest values of the parameters were recorded at 80% addition of technological water. These results confirm the texture parameters test results in instrumental tests.

The correlation between the parameters of basic composition and parameters of water binding, selected parameters of texture profile measured instrumentally and the sensory assessment of texture profile, were statistically very highly significant for $P<0.001$ (Tab. 6).

Table 6. Correlation coefficients between the parameters of basic composition and parameters of water binding, texture profile as well as quality and sensory determination of texture profile of model products

Parameter	Water content	Protein content	Fat content
Thermal loss	0.763 ***	–0.741 ***	–0.608 ***
Slice strength	–0.920 ***	0.909 ***	0.803 ***
Hardness_i	–0.953 ***	0.853 ***	0.853 ***
Chewiness_i	–0.959 ***	0.881 ***	0.919 ***
Consistency desirability	–0.792 ***	0.905 ***	0.838 ***
Total desirability	–0.752 ***	0.852 ***	0.809 ***
Hardness_i	–0.837 ***	0.892 ***	0.878 ***
Water bindings_s	–0.808 ***	0.855 ***	0.856 ***

***correlation statistically very highly substantial, for $P<0.001$.

CONCLUSIONS

1. The values of the evaluated parameters characterising water binding, texture profile and quality and sensorial profile of model products were significantly affected by the level of technological water addition. The higher level of water addition substantially weakened the values of the tested parameters.

2. The preparations of tripolyphosphate and tripolyphosphate and cellulose effectively reduced thermal drip and had a structure-creating action; the cellulose preparation "strengthened" the action of phosphates. In result of the trial the use of cellulose preparation has been found reasonable, instead of or jointly with phosphate preparations, in particular as regards products with different levels of addition of technological water.

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WPŁYW DODATKU PREPARATU BŁONNIKA NA JAKOŚĆ I STRUKTURĘ MODELOWYCH DROBNO ROZDROBNIONYCH PRZETWORÓW MIĘSNYCH

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S t r e s z c z e n i e . Badano wpływ dodatku preparatu błonnika pszennego na jakość i strukturę modelowych drobno rozdrobnionych wyrobów. Do farszu obok trójpolifosforanu potasu dodawano preparat błonnika pszennego WF-400, przy zróżnicowanym poziomie dodatku wody technologicznej: 30, 50 i 80%. Badania modelowych przetworów mięsnych obejmowały: oznaczenie wycieku cieplnego, ocenę składu podstawowego w bloku konserwy wg odpowiednich norm PN ISO, jakościową i profilową ocenę sensoryczną, analizę profilu tekstury oraz wytrzymałość na zrywanie plastrów za pomocą uniwersalnej maszyny Zwick model 1445. Na wartość ocenianych wyróżników profilu tekstury oraz jakości i profilu sensorycznego modelowych wyrobów istotny wpływ miał poziom dodatku wody technologicznej. Wyższy poziom dodatku wody istotnie osłabiał wartości badanych wyróżników. Preparaty trójpolifosforanu oraz trójpolifosforanu i błonnika skutecznie ograniczały ubytki cieplne i miały działanie strukturotwórcze, preparat błonnika „wzmacniał" działanie fosforanów. W wyniku badań stwierdzono zasadność użycia preparatu błonnika jako dodatku funkcjonalnego i /lub z polifosforanem potasu do drobno rozdrobnionych przetworów mięsnych, szczególnie do wyrobów o zróżnicowanym poziomie dodatku wody technologicznej.

S ł o w a k l u c z o w e : preparat błonnika, fosforany, przetwory drobno rozdrobnione, struktura, jakość, wiązanie wody