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COMPARATIVE QUALITY EVALUATION OF FINELY COMMINUTED SAUSAGES PRODUCED WITH THE ADDITION OF PROTEIN PREPARATION AT DIFFERENT DEGREE OF REHYDRATION

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ABSTRACT

The aim of the paper was to investigate the effect of the MyoGel-animal origin protein used to production of experimental sausages both in dry form as well as preparation at different degree of rehydration (1: 3, 1:5, 1:7) on rheological properties of meat batter and the quality of finely comminuted sausages. Obtained results shown that 10% meat replacement with rehydrated MyoGel protein preparation significantly improved quality of batter and some sausages texture characteristics in comparison to the control sample. Better quality of batters and sausages was observed when rehydrated MyoGel protein preparation was applied in formula than by the use of this preparation in the dry form. Sensoric evaluation of experimental sausages does not indicate deterioration of their quality resulted from the use of MyoGel preparation. All obtained results show that initial rehydration of Myogel preparation increases technological usability of this preparation.

Key words: chicken meat, technological value, meat colour, digital image analysis

INTRODUCTION

Non-meat proteins are widely used in meat processing industry, primarily thanks to their physical and chemical properties. Water binding and fat emulsifying capacities, along with gel forming properties should be stressed

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here [4, 6, 16]. By adding those proteins, it is possible to limit the drip of fat and jelly as well as improve product stability. Functional properties of commercially available non-meat proteins are not uniform and they vary considerably. The amount of protein in finished products is also increased if they are added in the process of production. Non-meat proteins used in meat processing technology may be divided into two groups: (1) plant proteins, such as soy isolates, concentrates and texturates, soy flours, and isolates of pea or lupine proteins and (2) proteins of animal origin, such as plasma proteins, milk proteins or meat protein concentrates [4].

The use of protein preparations makes it possible to optimise such parameters as water and fat binding, emulsifying and texturization capacities. This in turn improves quality and commercial value of the product resulting from higher yield and lower costs. Moreover, protein preparations compensate for varying properties of meat raw materials and changeable conditions of thermal processing. The addition of protein preparations also facilitates more efficient use of frozen meat and raw materials characterised by inferior technological quality. Finally, they make it possible to reduce production costs [6, 9].

From technological point of view, the most interesting aspect is the interaction between proteins and water. Soluble proteins together with swollen myofibrillar proteins surround released fat and create a net during thermal processing, which prevents fat from accumulating and fixes or binds structurally all ingredients, e.g. connective tissue and non-meat proteins [8].

Gel forming ability seems to be one of the most important technological property of proteins. Thanks to gelling, the desirable texture of finely comminuted cooked sausages is obtained. During this process, protein particles, solvent and dissolved substances form a systematic three-dimensional structure. Gelling is significantly affected by protein concentration and thermal processing conditions [12]. Protein concentration determines not only the probability of gel formation, but also gel properties. As water content increases, gels become more affected by mechanical factors. Gel structure is characterised by a certain stiffness of arrangement, which results in a lack of fluidity. Non-meat proteins may interact synergistically with meat proteins in the process of gel formation.

Non-meat proteins bind added water, that may cause two diverse phenomena: by thickening slurry of muscle proteins they may strengthen the gel, but if the available water amount is insufficient it may be difficult or even impossible to form gel. Such a phenomenon results from protein competition for water and is considered extremely significant in establishing the desirable structure of meat batter and later on that of a final product [6, 8].

Proper use of individual proteins may improve the quality of processed products, in terms of their texture, stability, water binding capacity, etc. [7]. It also facilitates the development of new products with the required texture.

Non-meat proteins play a significant role in the process of emulsion formation and they affect its stability. Strong emulsion is characterised by the fact that all fat droplets are encased in a protein net. In this way fat is protected against accumulating and dripping during thermal processing. In the batter with a high fat content, especially at considerable degree of comminution, the surface of fat droplets is many times bigger. As a result, muscle proteins are not able to cover all of them. The use of soluble non-meat proteins makes it then possible to obtain a stable emulsion, as those proteins are distributed between the fatty and water phases in the process of batter comminution [9]. However, no correlation has been observed between the solubility of non-meat proteins and stabilisation of meat batter emulsion [4].

It was the aim of this paper to investigate the effect of the addition of selected non-meat preparation at different degrees of rehydration both on the quality of batter and final sausages, as well.

MATERIALS AND METHODS

The material used in the experiments was batter and model frankfurter sausage produced from pork class III (50%), ground fat (21.5%), water (28.5%), and salt with curing agents (2.5%), which constituted control sample.

In the experiment conducted during this study, 10% of the meat was replaced with the addition of MyoGel protein rehydrated with different amount of water. The MyoGel is an protein preparation of animal origin, commercially made by American Meat Protein Corporation (USA), which contents 60% protein, 35% fat and 5% water. Depending on the selected option, a protein preparation was added at the rehydration degree: 1:3, 1:5, 1:7, and alternatively also as a dry protein powder.

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It was assumed that the amount of protein, fat and water in the final product will be constant and in accordance with the control. The results of proximate analysis of all obtained experimental batters and sausages are presented in Table 1.

Sausages were produced under semitechnical conditions. Meat and fat were first comminuted separately in the W-82 type grinder using the 3 mm plate. Next the meat was cured with the use of 2.5% of curing blend ($NaNO_2$ – NaCl) for 24 h in temperatures equal to 4-6°C. Fat was stored under similar conditions as the meat. The raw material was next comminuted under controlled conditions (time: 8 minutes, temperature below 12°C) in the laboratory chopper, with adding a blend of spices, ice, NaCl and rehydrated MyoGel. Obtained meat batter were stuffed into natural casings with 30 mm in diameter, smoked at 60°C, and cooked at 72° in a smoking-scalding chamber. After 24 h of storage in the cooling room, sausages were tested.

Table 1. Basic composition of examined experimental meat batters and sausages

Option	Meat batter			Sausage		
	Water [%]	Total Protein [%]	Fat [%]	Water [%]	Total Protein [%]	Fat [%]
Control	60.25	10.79	31.14	60.11	11.82	30.82
Dry	58.96	11.06	30.44	58.88	11.62	31.55
Rehydration 1:3	59.40	11.49	30.13	59.37	11.48	30.79
Rehydration 1:5	59.92	11.26	30.04	59.76	11.86	30.82
Rehydration 1:7	60.07	11.24	30.71	59.85	11.74	30.78

*** mean values within each line do not have the same superscript letter are significantly different ($\alpha = 0.05$)**

In conducted experiment meat batters were analysed on the day chopping was performed. After determination of pH value by means of typical laboratory pH-meter, the free water content was determined by means of a blotting-paper method elaborated by Volovinska and Kelman [11]. Thermal drip was established on the basis of the amount of released water solution and fat during heating [10]. Apparent viscosity of the batter was investigated using a rotational viscometer Rheotest 2 type RV, at the chopping speed of $D = 1\ s^{-1}$ [5].

The INSTRON 1140 machine was used for evaluation of texture of experimental sausages. The samples were compressed twice to 50% of their initial height (the TPA test). The Warner-Bratzler knife was used for the cutting test. Single compression of samples to 80% of their initial height was also performed. Samples of diameters 2.5×10^{-2}m and heights of 2×10^{-2}m were used in the compression tests. The head speed applied in the TPA test was 5×10^{-2}m/min. Texture parameters were determined on the basis of the texture profile chart, as it was described by Bourne [1]. These parameters were as follows: maximum compression force of the first head run (hardness 1), and maximum compression force of the second head run (hardness 2), cohesion and elasticity. While samples were cut with the Wagner-Bratzler knife, maximum shear force (F_{cmax}) and shear work (A_c) were determined [14]. Knife speed equalled 0.5m/min. At the single compression of the sample to 80% of its initial height, head speed applied was 0.1m/min. The following parameters were determined using this test: yield point, compression stress, deformation limit, and force corresponding to the deformation limit. The INSTRON 1140 apparatus was connected to a computer by mean of an interface.

Three individual production charges were evaluated during this study with at least 3 multiplications for each parameter.

Sensory evaluation of the investigated sausages was conducted using the linear scale method. Quality parameters were as follows: consistency (soft-hard), juiciness (dry-very juicy), cohesion (weak-strong), comminution degree (improper-proper), and general evaluation (bad-very good). Sausages were evaluated each time by 10 persons.

DISCUSSION

As it results from data collected in Table 2 selected properties of experimental meat batters and sausages was significantly affected by rehydration degree of the protein preparation applied in the production. The highest batter pH value was observed in sample with preparation introduced in dry form and it statistically differed from samples, where preparation was rehydrated. With the increase of rehydration degree of preparation the pH value decreased going to the value similar for control sample. Thermal drip in batters containing rehydrated MyoGel preparation was smaller than in batter with the same preparation added in dry form. With the increase of preparation rehydration degree thermal drip increasing was observed, but the differences were not statistically significant. Free water content in batter manufactured with MyoGel preparation in dry form was the lowest and with the increase of rehydration degree of preparation it increased, too, but the differences were not statistically significant. Batter's viscosity with MyoGel preparation in rehydrated form was higher than that of batter with dry form preparation. It should be emphasised that independently from rehydration degree and form of which meat was replaced by MyoGel preparation, viscosity of batters was higher than this of control sample, while free water content and thermal drip were lower. In general, the quality of batters where 10% of meat was replaced with the MyoGel preparation improved in comparison to the control sample. (Table 2).

Table 2. Selected properties (mean values) of meat batters produced with the addition of MyoGel protein at different degree of rehydration

Parameter*	Option				
	Control	Dry	Rehydration		
			1 : 3	1 : 5	1 : 7
Viscosity [Pa × s]	477.3 ^{a}	493.1^{a}	507.4 ^{ab}	520.3 ^{b}	517.4 ^{b}
Free water [%]	6.93 ^{a}	6.17 ^{a}	6.70 ^{a}	6.84 ^{a}	6.91^{a}
Thermal drip [%]	8.99 ^{a}	7.33 ^{bd}	5.77 ^{c}	6.77 ^{cd}	7.13 ^{bc}
pH	5.69 ^{a}	5.87^{b}	5.77 ^{c}	5.67 ^{a}	5.66 ^{a}

*** mean values within each line do not have the same superscript letter are significantly different (α = 0.05)**

Statistically significant effect of form, in which the preparation was introduced to the batter and its rehydration degree on some texture characteristics such as: hardness 1 and 2, force corresponding to the deformation limit and yield point is illustrated with data shown in Table 3. Hardness 1 and 2 of sausages with preparation in rehydrated form statistically significantly differed and it was higher than hardness of sausages with preparation introduced to the batter in dry form as well as the value obtained for the control sample.

Table 3. Selected texture characteristics (mean values) for sausages produced with the addition of MyoGel protein at different degree of rehydration

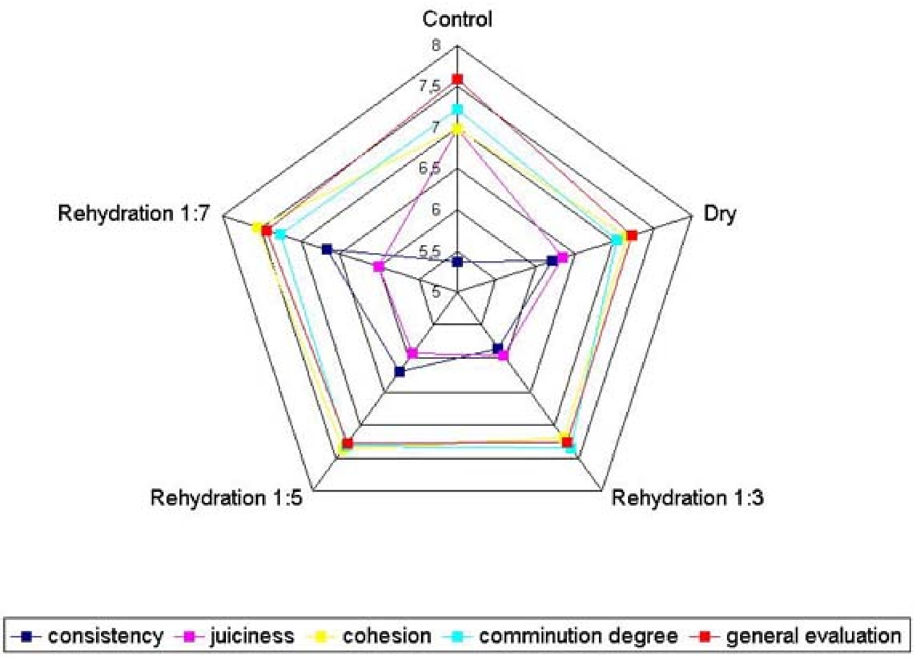
Parameter*	Option				
	Control	Dry	Rehydration:		
			1 : 3	1 : 5	1 : 7
Hardness 1[N]	31.49 ^{a}	33.40 ^{a}	37.31^{b}	38.96 ^{b}	37.41^{b}
Hardness 2 [N]	26.37 ^{a}	28.50 ^{b}	30.52 ^{c}	32.47 ^{d}	32.14 ^{d}
Cohesion	0.6027 ^{a}	0.6260 ^{a}	0.6053 ^{a}	0.6300 ^{a}	0.6100 ^{a}
Elasticity [mm]	7.12 ^{ab}	7.02 ^{a}	7.17 ^{ab}	7.23 ^{b}	7.22 ^{b}
Shear force [N]	3.92 ^{a}	4.39 ^{a}	4.18 ^{a}	4.31^{a}	4.26 ^{a}
Shear work [J]	0.0956 ^{a}	0.1020 ^{a}	0.1034 ^{a}	0.1009 ^{a}	0.1061^{a}
Deformationlimit [%]	50.29 ^{a}	50.59 ^{a}	50.33 ^{a}	51.12 ^{a}	51.03 ^{a}
Strain force [N]	32.81^{d}	35.81^{cd}	37.06 ^{bc}	41.62 ^{a}	40.37 ^{ab}
Yield point [N/m^{2}] × 10^{4}	6.58 ^{d}	7.18 ^{c}	7.43 ^{bc}	8.35 ^{a}	8.10 ^{ab}
Compressive stress off 80% deformation [N/m^{2}] × 10^{4}	10.32 ^{ab}	9.78 ^{bcd}	10.65 ^{ad}	11.17 ^{a}	9.17 ^{c}

*** mean values within each line do not have the same superscript letter are significantly different (α = 0.05)**

Among other parameters such as: force corresponding to the deformation limit and yield point statistically significant differences were noticed between sausages with rehydrated in 1:5 and 1:7 ratios MyoGel preparation and preparation added to batter in dry form as well as control sample. It should be also emphasised that mentioned above values of texture parameters of sausages containing protein preparation MyoGel either in rehydrated form as well as dry one, were higher than those of control sample. However, statistically significant effect (α = 0.05) of form as well as rehydration degree of preparation on other sausage texture parameters was not observed. They did not significantly differ from the control sample.

Obtained results show that MyoGel protein preparation is a good binding agent of fat and water, increases batter viscosity and after thermal processing it forms strong elastic gel, which improves sausages texture, and especially its hardness, resistance to deformation as well as yield point. This strong structure of gel prevents loss of water during thermal processing and immobilize fat particles. These properties of MyoGel protein preparation are especially useful during production of comminuted sausages, such as hot dogs or sausages of mortadela type. Rehydration of Myogel preparation resulted in better swelling and more stable water binding in comparison to preparation used in dry form. This observation confirm a competitive character of Myogel and meat proteins taking part in water binding during process of comminution. Proper quality effect of sausages can be obtained when the rehydration of preparation ratio is 1:5 or even 1:7. Simultaneously, during sensoric evaluation it was found no statistically significant differences ($\alpha = 0.05$) between investigated sausages variants with MyoGel and control sample (Figure 1).

Figure 1. Sensoric evaluation (mean values) of sausages produced with the addition of MyoGel protein at different degree of rehydration



Similar results were obtained by Prabhu [13] during production of breakfast sausages, where protein preparation MyoGel Plus (contains 70% of protein) rehydrated in 1:4 ratio replaced 5% and 10% of lean meat. Prabhu reports, that MyoGel protein better cooperates with meat proteins in comparison to other additives such as milk proteins or plant proteins that were used.

AMPC (USA) [11] carried out comparative investigation of gelation force and thermal drip after heating MyoGel preparation to 70°C temperature as well as soy isolate and concentrate. All of these proteins were rehydrated in 1:4 ratio. Investigations shown that MyoGel gelation force is 1.25 times stronger than the same one of soy isolate and concentrate, however thermal drip in sausages in which MyoGel preparation was added, was 1-2% smaller than in sausages with soy isolate and concentrate.

As it result from literature [2, 3], among proteins of animal origin, bovine blood plasma preparation AMP 600N produced by AMPC [2] and animal protein preparation VEPRO 95 HV of VEOS (Belgium) [3] demonstrate stronger gelation force than MyoGel preparation.

Animal protein preparation MyoGel, because of its functional properties, may be taken under consideration as a good functional component during creation meat products of new generation and their implementation on the market.

CONCLUSIONS

1. Form of animal protein preparation MyoGel applied as ingredient during production of experimental sausages and its rehydration degree were significant factors influencing quality of obtained batter and final product
2. The 10% meat replacement with MyoGel protein preparation significantly improved quality of batter and some characteristics of sausages in comparison to the control sample.

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3. Sensoric evaluation did not show statistically significant deterioration of quality of experimental sausages both if MyoGel protein preparation replacing 10% of lean meat was added in dry or in rehydrated form as well.
4. Animal protein preparation MyoGel, because of its functional properties, may be used as meat replacement in selected comminuted meat products.

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