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FUNCTIONAL EFFECT OF CARBOHYDRATES IN SOYBEAN PREPARATIONS — A MODEL STUDY*)

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Key words: soybean protein, carbohydrate compounds, functional properties of protein preparations.

The effect of carbohydrate compounds of soybean protein preparations on their functional properties in meat model systems with 20 and 40% of meat protein replaced by soy protein was investigated. The ratio soy protein — carbohydrate compounds in soybean additives was regulated. Significant influence of mixture of soy protein — carbohydrate compounds was observed at a 40% substitution level, but carbohydrates seemed to play a secondary role as a factor influencing the functional properties of soybean protein preparations.

There are very few data concerning the influence of soybean carbohydrates on the functional properties of soybean protein preparations; the existing literature contains suggestions rather than experimental results [2, 3, 5, 7].

The difficulty of studying the effect of the amount of carbohydrate compounds in soybean protein preparations on their functional properties in meat products (or in the meat model systems) is primarily connected with the fact, that during processing simultaneous changes take place in the content and composition of carbohydrates. The processing influences also the main functional components of preparations i. e. proteins.

Although the proteins are considered as the main functional substances, the possible influence of carbohydrates in such protein preparations as defatted meals, soy grits and soy meal-based texturates and, to some extent, soy protein concentrates should not be neglected.

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The content of carbohydrates in the defatted soy meal is about 30%, 15% being represented by oligosaccharides. Main oligosaccharides in this product are: sucrose, stachyose and raffinose. Polysaccharides are represented by arabinans, arabinogalactans, hemicelluloses and cellulose [1]. The saccharides vary widely in terms of their solubility. During concentrates and isolates production, depending on the processing method used, the total amount of carbohydrates decreases and the ratio between their components changes.

The above factors, together with many uncontrolled variables, which occur in meat products, make the investigation of functional effects of carbohydrates in original meat products very complicated and the results obtained uncertain.

The investigations carried on the model systems offer more uniform conditions to observe the existing relationships and are an efficient way of overcoming the mentioned difficulties.

The aim of this work was to elucidate the effect of carbohydrates in soybean preparations on the functional properties of specially elaborated meat model systems.

EXPERIMENTAL

Two meat model emulsions (MME) of a composition given in Table 1 have been elaborated for experiments. The difference between MME I and MME II consisted in various levels of protein additives (2% and 4%, per dry preparation respectively), which replaced an equivalent amount of meat protein.

Table 1. Composition of meat model emulsions

MME components	% of components	
	MME I	MME II
Lean meat*)	35.8	26.9
Fat (soybean oil)	23.9	23.9
Added water	36.5	43.4
NaCl	1.7	1.7
Soybean additives (protein + carbohydrates)	2.0	4.0

*) Lean beef meat of pH = 5.4

Depending on the type of additive (isolate, concentrate, meal), the above 2% or 4% represented various protein to carbohydrates ratios (Table 2). Two sources of protein and carbohydrates delivery were applied: a) Protein isolate Promine D and a specially prepared carbohydrates mixture

Table 2. Type and quantity of soybean protein and carbohydrate additives

Simulation of type of additives	amount realised by:	MME I total	MME I including protein	MME I including carbohydrates	MME II total	MME II including protein	MME II including carbohydrates
Isolate (1)	Promine D*)	2.0	1.8	—	4.0	3.6	—
Concentrate (2)	Promine D*) + carbohydrate mixture	2.0	1.3	0.5	4.0	2.7	1.0
Defatted meal (3)	Promine D*) + carbohydrate mixture	2.0	1.1	0.8	4.0	2.1	1.6
Isolate (1′)	Promine D	2.0	1.8	—	4.0	3.6	—
Concentrate (2′)	Promine D + Soybean flakes	2.0	1.2	0.5	4.0	2.4	1.0
Defatted meal (3′)	Soybean flakes	2.0	1.0	0.6	4.0	2.1	1.3

*) In the additional experiment (in MME II) isoelectric protein isolate Promine R instead of Promine D was used

(sucrose — 50%, cellulose — 25%, wheat starch — 25%), in respective ratios; b) Defatted soybean flakes and isolate Promine D in respectives ratios. The first variant offered a fixed origin and ratio of protein and carbohydrates components, more appropriate for studying the effect of quantitative changes; the second variant coresponded more closely to the natural soybean carbohydrates composition. The type and amounts of additives to the investigated MME is shown in Table 2.

In the additional experiment all proportions of constituents and the conditions of preparation remained the same as in the main experiment for MME II, except that. Promine R instead of Promine D was used as a protein source in simulated protein preparations. This isoelectric protein isolate was recognized as having extremely poor functional properties [4].

Meat model emulsions were prepared by mixing meat, oil, salt, water and soybean additives in a laboratory cutter, applying a special schedule [4]. Raw MME were investigated by measuring their viscosity and forced outflow. The viscosity of meat emulsion was measured on Rheotest-2 viscometer, at the shear rate of $Dr = 48.6\ sec^{-1}$ and 20°C. The forced outflow was determined as the area of spot on the filter paper obtained after loading the uniform sample of MME, covered by a glass plate, with a 5 kg weight during 1 min [4]. After standard thermal processing of MME (70°C, 30 min), thermal weight losses by the modified method of Towsend et al. (4) and texture on Allo-Kramer Shear Press using multi shear element were measured [4].

RESULTS AND DISCUSSION

The characteristics of the viscosity and water holding capacity (measured as forced out-flow) of a raw (thermally untreated) MME are shown in Fig. 1. In the MME I, in which soybean protein preparation replaced only about 20% of the meat protein, no effect of increasing ratio of carbohydrates was observed, independently of the composition of carbohydrates (model sucrose : starch : cellulose mixture or natural carbohydrates from soybean flakes).

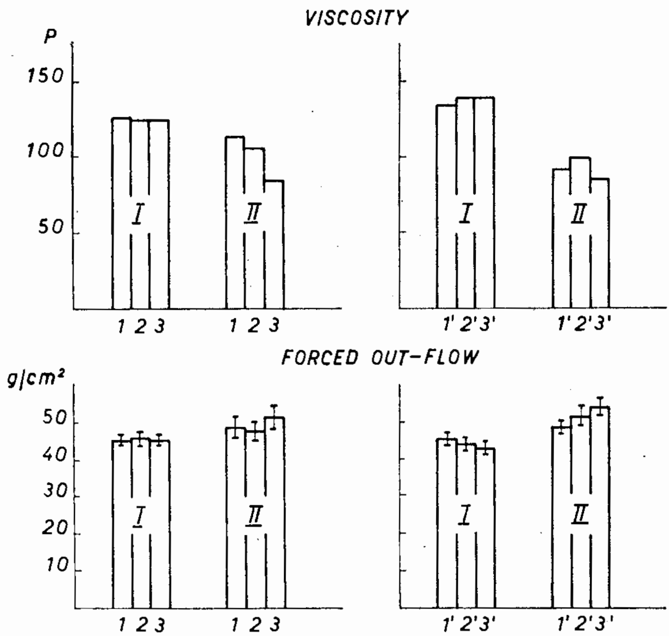

Fig. 1. Viscosity and water holding capacity (measured as forced outflow) of raw model meat emulsions (MME), containing soybean protein additives of various protein/carbohydrates ratio and various carbohydrates composition I — MME with 20% level of exchange of meat protein II — MME with 40% level of exchange of meat protein; detailed composition of MME — see Table 1; 1, 2, 3 and 1′, 2′, 3′ — explanation in the Table 2

One may presume, that at this level of substitution, the functional properties of meat proteins are dominating to such an extent; that the functional properties of the preparation have practically no influence on the whole functional behaviour of the system.

However, when the substitution increases to a level of 40% of the exchange of meat protein on preparation dry substance, the functional properties of the additive become important. The tendency of the decrease

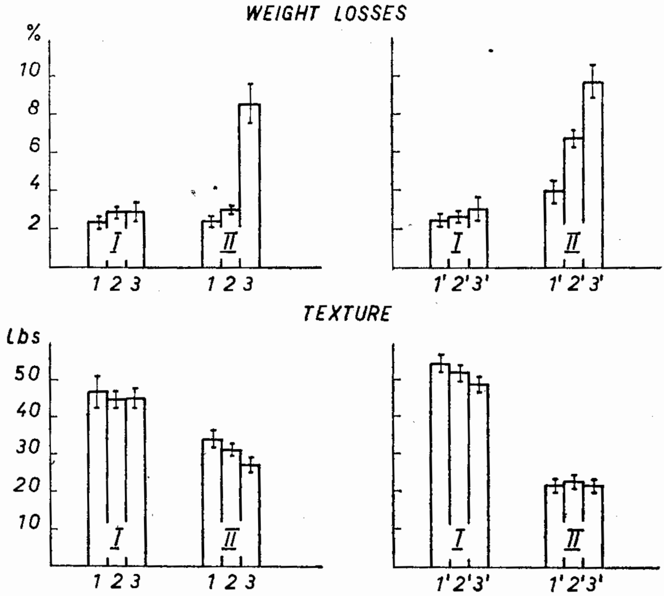

Fig. 2. Weight losses and texture after standard thermal treatment in meat model emulsions (MME), containing soybean protein additives of various protein/carbohydrates ratio and various carbohydrates composition; explanations — see Fig. 1

of viscosity (20-40 P compared with MME I) accompanied by an increase of forced outflow can be observed with the rising ratio of carbohydrates within the additives. It may result from the influence of an increasing amount of carbohydrates or decreasing amount of protein in the preparations added, or both factors together.

The tendencies observed become much more pronounced after thermal treatment of the samples (Fig. 2). The weight losses in MME I were almost uniform independently of the composition of preparations added and amount of carbohydrates in them. But when the additives were applied at a 40% level (MME II), a clear rise of the losses with an increasing ratio of carbohydrates in preparation added was observed (independently of the composition of carbohydrates).

Similar relations were observed in relation to the texture (in the variant with model carbohydrates mixture added — samples 1, 2 and 3 for MME II) although they were not so pronounced as in the weight losses.

Again, there may be two causes: the increasing amount of carbohydrates, possessing lower properties of water binding and water holding capacity than protein or a decreasing amount of protein in the whole model system, not sufficient to bind water in the way meat protein do.

In order to explain the share of each of the two above mentioned factors, an additional experiment was made. The results of the experiment are illustrated in Fig. 3. The weight losses after thermal treatment increased substantially, by about 20% (compared with 2-3% when Promine D as a source of protein in preparation was applied). Also the texture was less firm, although here the differences were rather small. It shall be mentioned however, that it was a texture of this part of the sample, which remainded after separation of the juices, which means that it was measured on a sample of much higher dry substance content then in the main experiment.

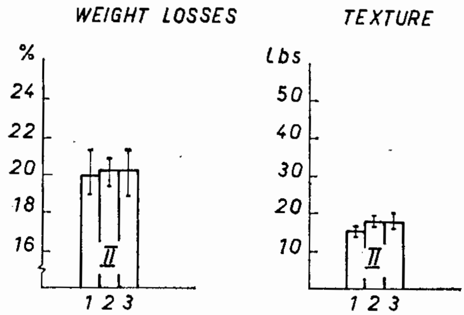

Fig. 3. Weight losses and texture after standard thermal treatment in meat model emulsion (MME — II), in which protein isolate Promine D has bean replaced by isoelectric isolate Promine R; explanations — see Fig. 1

The above results suggest, that the functional influence of carbohydrates in the soybean protein preparations is of a minor importance, even when their ratio in the preparation is about 30%, as it is the case in meal-based preparations.

The amount and physico-chemical state of the protein is definitely a functional factor of the main importance.

CONCLUSION

The results of the study suggest, that carbohydrates play a secondary role as a factor influencing the functional properties of soybean protein preparations in meat systems. The main factor seems to be the protein, its quantity and physico-chemical characteristics.

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WŁAŚCIWOŚCI FUNKCJONALNE WĘGLOWODANÓW PREPARATÓW SOJOWYCH — BADANIA MODELOWE

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Streszczenie

Przeprowadzono badania nad wpływem węglowodanów występujących w sojowych preparatach białkowych na ich funkcjonalność w mięsnych układach modelowych symulujących produkt mięsny. Badania wykonano dla dwóch poziomów substytucji białka mięsa (20 i 40%) białkiem preparatu sojowego (Promine D), przy uwzględnieniu w układach modelowych różnych stosunków białka sojowego do składników węglowodanowych. Jako źródło węglowodanów, dodawanych łącznie z białkiem sojowym stosowano mieszaninę węglowodanów (50% sacharozy, 25% celulozy, 25% skrobi) lub płatki sojowe, bardziej zbliżające układ doświadczenia do naturalnego.

Mięsne układy modelowe z dodatkami białkowo-węglowodanowymi, imitującymi różne preparaty sojowe oceniano pod względem lepkości i poziomu wycieku wymuszonego, a po poddaniu ich standardowej obróbce termicznej również pod względem konsystencji i ubytków cieplnych.

Stwierdzono, że dodatki węglowodanowe stosowane łącznie z białkiem sojowym powodują istotne zmiany właściwości mięsnych układów modelowych (wzrost poziomu wycieku wymuszonego, wzrost ubytków termicznych) tylko przy wyższym poziomie substytucji — 40% białka mięsa.

Zastąpienie w doświadczeniu rozpuszczalnego białka sojowego (Promine D) białkiem izoelektrycznym (Promine R) wykazało, że głównym czynnikiem zmian właściwości układów mięsnych jest ilość i stan fizykochemiczny białka sojowego. Natomiast składniki węglowodanowe odgrywają drugorzędną rolę w kształtowaniu właściwości funkcjonalnych preparatów sojowych.