EFFECT OF ADDITION OF MALTODEXTRINS TO STARCH GELS ON SOME TEXTURAL AND COLOUR PARAMETERS

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Abstract. Systems of potato starch and potato maltodextrins saccharified to various degrees (low, medium, or high) were investigated to understand the effect of maltodextrin addition on some rheological properties of starch pastes and on chosen textural properties and colour parameters of starch gels. The samples for the study were 10% water pastes of starch alone and starch with maltodextrin added in amounts constituting 10, 20, 30, 40 or 50% (w/w) of the starch. The rheological investigations included determination of flow curves at a temperature of 50°C. The flow curves obtained were described using the Herschel-Bulkley model. The gels were subjected to texture profile determination and to colour analysis in the CIELab space using D_{65} illuminant and 10° observer. It was found that maltodextrin affects the properties of starch gels even if it replaces as little as 10% of starch in the system. As the proportion of maltodextrin in the gel increases, its flow strength decreases, the thinning degree increases, and the textural parameters change. The changes, however, are not proportional either to the saccharification degree or to the proportion of maltodextrin in the gel. Maltodextrin present in starch gels, regardless of its amount, influences also the values of colour parameters in the CIELab system.

Keywords: starch, maltodextrins, rheological parameters, colour parameters

Abbreviations used in the work:

DE – Dextrose Equivalent
Ml – low-saccharified maltodextrin (DE = 7.00)
Mm – medium-saccharified maltodextrin (DE = 17.18)
Mh – high-saccharified maltodextrin (DE = 20.75)
10-50% – amount of starch replaced with maltodextrin

INTRODUCTION

Starch is one of the most functional raw materials in the food industry, giving the final products specific physicochemical and sensory properties. The manufacturing process of starch-containing foods, which includes both mechanical processing (mixing, homogenisation) and thermal treatment (cooking, sterilisation, pasteurisation, baking), has an effect on the physicochemical properties of starch (Nayouf *et al.* 2003, Spade *et al.* 2004). Having a low stability and poor shear strength, showing syneresis and retrogradation, and exhibiting a high susceptibility to changes in pH, pressure and temperature during the technological processes and storage of final products, starch is rarely used in a non-processed form (Be-Miller 1997, Davies 1995, Fortuna and Rożnowski 2002, Walkowski and Olesienkiewicz 2005, Wurzburg 1987). Therefore, there is a growing demand from the food industry for modified starches. Modification enhances certain properties of this biopolymer or gives it new desirable functional characteristics, thus contributing to improvement in the technological and sensory properties of the food product (Golachowski 1998, Krygier 2005, Swinkels 1985, Wurzburg 1987).

Almost all sectors of the food industry commonly use maltodextrins – products obtained through partial hydrolysis of pasted starch (Golachowski 1998, Krygier 2005, Słomińska 1995, Swinkels 1985, Wang and Wang 2000), having a dextrose equivalent of under 20 (Roller 1996). Although this equivalent is a basic characteristic of maltodextrins, it does not define accurately their oligosaccharide composition, so products with the same DE value may have different physicochemical properties (Atkins and Kennedy 1985, Golachowski 1998, Kuntz 1997, Wang and Wang 2000). Since maltodextrins are not homogeneous products of hydrolysis, their properties largely depend on the degree of starch depolymerisation.

Studying starch-maltodextrin systems seems appropriate in the sense that adding the hydrolysates in question to starch may considerably influence its swelling power, water solubility, pasting characteristics, retrogradation properties, hydrolysability and other functional properties. As a result, food products with new features may be obtained. When used for the production of instant desserts, such systems would strengthen the taste and aroma of the products, besides, they can improve their digestibility due to the fact that starch hydrolysates are more prone to the action of digestive enzymes than starch itself. Moreover, the use of starch-maltodextrin systems may lead to a more velvety consistency of starch-based desserts. It can also be expected that the presence of maltodextrin in starch products subjected to thermal treatment will result in a more desirable golden colour due to the caramelisation of short-chained fragments during the technological process. In addition, the presence of maltodextrins would enhance the sweetness

of cakes and pastries, and lower the calorific value of the latter products and instant desserts.

The present study was designed to investigate the effect of potato maltodextrins with different degrees of saccharification, added to potato starch in amounts accounting for 10-50% (w/w) of starch, on chosen textural properties and colour parameters of starch systems.

MATERIALS AND METHODS

Commercial potato starch was produced by PEPEES S.A. (Łomża, Poland), and commercial potato maltodextrins (low-, medium-, and high-saccharified) were manufactured by "Nowamyl" S.A. (Łobez, Poland).

The samples used for viscosity studies were 10% water pastes of potato starch and starch-maltodextrin systems. The starch paste was obtained by adding 90 g of water to 10 g of potato starch. To produce pastes containing starch hydrolysate, part of the latter amount of starch (10, 20, 30, 40 or 50%) was replaced with maltodextrin, i.e. such pastes were obtained by adding 90 g of water to 9, 8, 7, 6 or 5 g of starch with 1, 2, 3, 4 or 5 g, respectively, of maltodextrin. The suspensions were mechanically stirred at 300 rpm for 5 min at room temperature, and then they were heated on a water bath at a temperature of 95±0.5 °C for 30 min with continuous stirring at 300 rpm.

The samples used for determining texture and colour parameters were gels obtained from freshly produced pastes (not subjected to rheological analysis). The pastes were poured into cylindrical plastic containers 60 mm in diameter and 30 mm in height, placed in a refrigerator at a temperature of 8°C, and stored for 24 hours. Prior to analysis, the samples were removed from the refrigerator and the containers.

Determination of flow curves

Immediately after preparation, the pastes were placed in the measuring element of a rotational rheometer, Rheolab MC1 (PhysicaMesstechnik GmbH, Germany) with coaxial cylinders, as a measuring system (gap diameter 2.12 mm) and thermostated for 10 min to the measurement temperature of 50±0.5°C. Both the rheometer and the thermostat were controlled by the US200 program (PhysicaMesstechnik GmbH, Germany). The rheological investigations included determination of flow curves according to the following regime: increasing shear rate in the range 1-300 s^{-1}, constant shear rate of 300 s^{-1}, and decreasing shear rate in the range 300-1 s^{-1}. The curves were described using the Herschel-Bulkley model:

$$\tau = \tau_0 + K\gamma^n$$

where: τ – shear stress (Pa), τ_0 – yield stress (Pa), γ – shear rate (s^{-1}), K – consistency coefficient (Pa s), n – flow index (dimensionless).

Textural properties

The textural properties of starch and starch-maltodextrin gels were studied using an EZ TEST texture meter (Shimadzu), computer-controlled through the RheoMeter Software v. 2.04. The gel samples (60 mm diameter, 35 mm height) were compressed twice between two flat plates, and the force exerted on the measuring element was recorded. The measurement parameters were as follows: compression rate: 50 mm min^{-1}; reversal rate of the measuring element: 50 mm/min; first relative deformation: 50% of the initial height of sample; second relative deformation: 30% of the initial height of sample.

The curves describing the force-time relationship were used to determine textural parameters: hardness (N), cohesiveness (dimensionless), adhesiveness (N s), elasticity (dimensionless), and gumminess (N).

Colour analysis

The starch and starch-maltodextrin gels were analysed using an X-Rite Color i5 spectrophotometer (Invert Systems) with a D_{65} illuminant, d/8 measuring geometry, and an additional observer deflected by 10°. The measuring gap was 10 mm.

The starch gel constituted a reference for the starch-maltodextrin systems.

Colour analysis of the gels in the CIELab space was performed in the specular included (SPIN) mode (Chen *et al.* 2002, Du and Sun 2004, Rożnowski 2006, Russ 2005, Yam and Papadakis 2004). The X-Rite Color Master program was employed for determining the values of colour parameters: L*, a* and b*. The a* and b* parameters were used to compute colour saturation (C) and hue angle (h°).

Parameter C measures the distance of the a* and b* coordinates from the origin of the coordinate system, and is calculated from the formula:

$$C = \sqrt{a^{*2} + b^{*2}}$$

Parameter h° measures the angle from the "red" axis, and is computed according to the formula:

$$h^{\circ} = \text{arc tg}(b*/\, a*)$$

Data analysis

All statistical significance tests were calculated using Statistica 9.0 (ANOVA, Duncan test, $\alpha = 0.05$)

RESULTS AND DISCUSSION

The results of rheological investigations are presented in Figures 1 to 3, displaying the obtained flow curves, and in Table 1 showing the calculated values of parameters for 10% pastes of starch and starch- maltodextrin systems.

As can be seen from the flow curves, all the starch pastes exhibited non-Newtonian flow and shear-thinning behaviour with yield stress (Figs 1-3). In most cases, the presence of maltodextrins caused a decrease in shear stresses, compared to the paste of starch alone, except for a 10% addition of medium-saccharified maltodextrin which did not affect their value (Fig. 2). The greater the proportion of maltodextrins, regardless of their depolymerisation degree, the lower were the values of shear stresses.
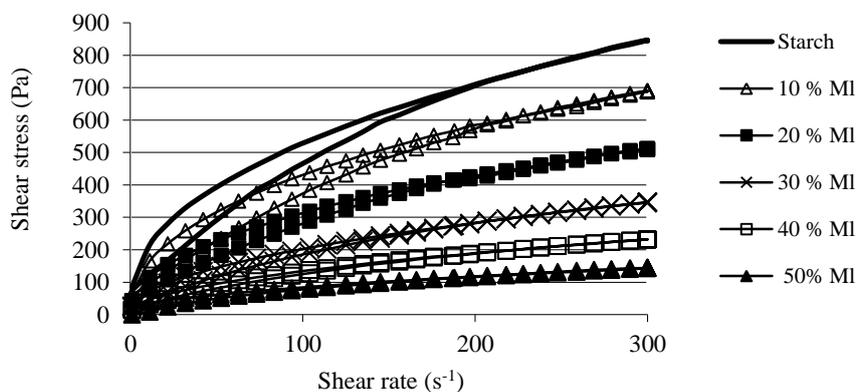
Fig. 1. Flow curves of 10% water pastes of starch and starch-low saccharified (MI) maltodextrin systems
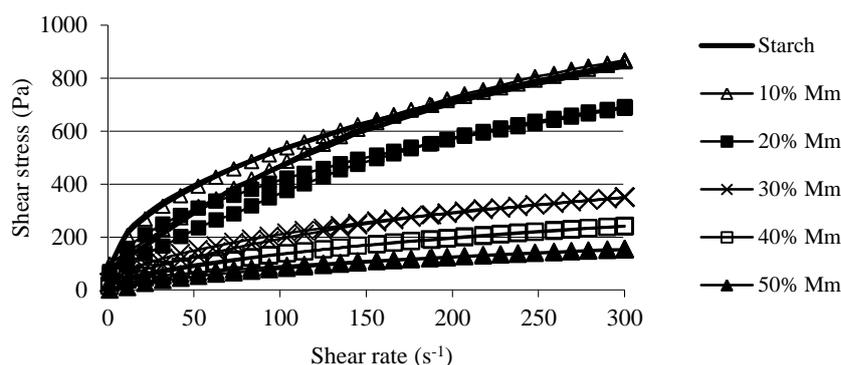
Fig. 2. Flow curves of 10% water pastes of starch and starch-medium saccharified (Mm) maltodextrin systems
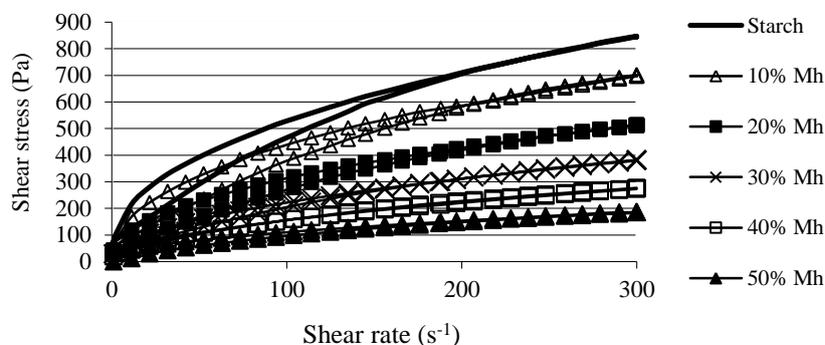
Fig. 3. Flow curves of 10% water pastes of starch and starch-high saccharified (Mh) maltodextrin systems

The experimental flow curves were described using the parameters of the Herschel-Bulkley model (Tab.1).

As follows from a comparison of the yield stresses (τ_0) of the pastes, adding maltodextrin caused the value of τ_0 to decrease. The exception to this rule was medium-saccharified maltodextrin whose proportion in the system with starch was 10% (Tab. 1) – such a paste had the highest yield stress among all the pastes.

The yield stress tended to decrease with increasing proportion of maltodextrin in the starch system. It also depended on the degree of saccharification of malto-dextrins. This suggests that maltodextrin addition affects the structure of starch paste and reduces its flow resistance.

Pastes containing low-saccharified maltodextrin had generally lower values of yield stress than the other maltodextrin-containing pastes (Tab. 1). The value of τ_0 for starch systems varied in relation to the proportion of the hydrolysate in the paste. Among the starch pastes containing from 30 to 50% of differently sacchari-fied maltodextrins, no significant differences of the yield stresses were noted. In the case of 10 or 20% addition of maltodextrin the values of τ_0 were higher for medium-saccharified hydrolysate (Tab. 1).

The values of flow index (*n*) for starch systems with maltodextrin-containing pastes were lower than for samples of starch without maltodextrins. It suggests that the samples with maltodextrins were much more shear-thinned than the sam-ples without any addition of hydrolysates in the paste. Using a larger proportion of maltodextrins in starch systems decreased the flow index value compared to the paste of starch alone (Tab. 1).

Comparison of the values of consistency coefficients (K) showed that pastes containing 10 or 20% of hydrolysates did not differ from the paste of starch alone, but samples with 30, 40 or 50% of maltodextrins had considerably lower value of this parameter (Tab. 1). Among the pastes with the same proportion of maltodex-

trin, but different degree of hydrolysis, no significant differences of consistency coefficient were observed (Tab. 1). These results are in contrast with the findings of other authors who indicate that the viscosity of hydrolysate solutions decreases as the degree of starch hydrolysis rises, which is due to the stabilising and binding forces (Gawęcki 2001, Kuntz 1997, Roller 1996, Słomińska 1995).

Table 1. Parameters of Herschel-Bulkley model of 10% water pastes of starch and starch-malto-dextrin systems; Ml, Mm, Mh – low-, medium-, high-saccharified maltodextrin, respectively

Samples		Parameters of Herschel-Bulkley model			
		τ_0(Pa)	K (Pa s)	n (–)	R^2
Potato starch		57.01±0.52	13.06[a]±0.85	0.74[a]±0.01	0.993
Ml	10%	46.43[a]±0.10	10.07[a]±0.08	0.74[a]±0.01	0.995
	20%	30.83±1.41	8.82[a]±1.41	0.71[a]±0.03	0.996
	30%	17.04[c]±1.92	7.54[b,c]±0.66	0.67[b]±0.01	0.998
	40%	7.58[e,f]±0.17	7.09[b,c]±2.02	0.62[c]±0.05	0.998
	50%	2.30[h]±0.14	5.66[c,d]±0.36	0.58[c]±0.03	0.995
Mm	10%	66.49±2.00	10.01[a]±0.04	0.75[a]±0.01	0.996
	20%	40.38±0.03	8.50[a]±0.06	0.74[a]±0.03	0.997
	30%	18.66[b,c]±2.92	7.04[b,c]±1.03	0.68[b]±0.01	0.997
	40%	9.69[d,e]±1.08	6.43[b,c,d]±0.09	0.64[c]±0.01	0.998
	50%	4.39[g,h]±0.08	4.95[d]±0.16	0.60[c]±0.01	0.999
Mh	10%	45.14[a]±0.36	10.01[a]±0.21	0.75[a]±0.01	0.994
	20%	33.10±0.16	7.79[b]±0.40	0.74[a]±0.01	0.995
	30%	19.76[b]±0.40	7.28[b,c]±0.26	0.69[a,b]±0.01	0.997
	40%	11.68[d]±1.36	6.77[b,c,d]±1.70	0.66[c]±0.05	0.998
	50%	5.76[f,g]±0.21	5.54[c,d]±0.03	0.65[c]±0.04	0.999

Values denoted with small letters in columns do not differ statistically significantly at p = 0.05.

The texture-forming properties of starch gels depend largely on the botanical origin of starch which determines the internal structure of the gel and decides about the presence of non-carbohydrate substances. Interactions between the components accompanying starch granules as well as between the dispersed phase and the continuous phase of a starch system influence the textural parameters of starch gels. An important factor contributing to the properties of starch gels is also the water content of the systems (Choi and Kerr 2003, Karam *et al.* 2005).

As follows from the analyses, maltodextrin addition influenced the textural parameters of potato starch gels. Most hydrolysate-containing systems produced gels with reduced hardness, compared to starch alone, with the exception of the

20% addition of medium-saccharified maltodextrin which had no significant effect on this parameter (Tab. 2). Hardness tended to decrease with the increasing proportion of maltodextrins in gels. More specifically, when this proportion exceeded 40%, such gels exhibited higher hardness than those with 10% of maltodextrin or with no addition of the hydrolysate. For low- and high-saccharified maltodextrins, the gels with their 40% and 50% proportion did not differ in hardness. Interestingly, the gels containing medium-saccharified maltodextrin showed higher hardness than those with the same amounts of low- or high-saccharified hydrolysate (Tab. 2). This may suggest that medium-saccharified maltodextrin contains a larger amount of starch granules, which considerably influences the structure of gels, making them harder (Mandela *et al.* 2002. Some authors (Fortuna *et al.* 1998, Golachowski 1998, Nebesny *et al.* 1998, Nowakowska and Skalski 2000) report that maltodextrins with a lower DE have a greater thickening ability, however, such an observation was not confirmed for their systems with starch.

Table 2. Texture parameters of 10% water pastes of starch and starch-maltodextrin systems; Ml, Mm, Mh – low-, medium-, high-saccharified maltodextrin, respectively

Samples		Texture parameters				
		Hardness (N)	Cohesiveness (–)	Adhesiveness (N mm)	Elasticity (–)	Gumminess (N)
Potato starch		$22.71^a \pm 1.43$	$0.74^a \pm 0.44$	$-1.48^a \pm 0.65$	$0.86^a \pm 0.08$	$19.53^a \pm 2.55$
+ 10 %	Ml	$15.89^b \pm 2.61$	$0.45^{a,b} \pm 0.08$	$-1.95^a \pm 0.52$	0.66 ± 0.09	$11.28^{b,c} \pm 2.06$
	Mm	$20.21^a \pm 0.41$	$0.67^c \pm 0.05$	$-1.36^a \pm 0.05$	$0.85^a \pm 0.02$	$17.18^a \pm 0.77$
	Mh	$17.08^b \pm 0.57$	$0.59^{c,d} \pm 0.02$	$-1.06^a \pm 0.29$	$0.80^{a,b} \pm 0.03$	$13.66^b \pm 0.03$
+ 20 %	Ml	$10.97^{c,d} \pm 2.00$	$0.37^{a,b} \pm 0.04$	$-6.96^{b,c} \pm 1.68$	$0.74^b \pm 0.09$	$8.12^d \pm 1.72$
	Mm	$22.51^a \pm 1.33$	$0.72^{c,d} \pm 0.06$	$-0.71^a \pm 0.09$	$0.85^a \pm 0.13$	$19.13^a \pm 3.99$
	Mh	$12.33^c \pm 0.98$	$0.48^e \pm 0.06$	$-2.96^{a,b} \pm 0.78$	$0.72^b \pm 0.01$	$8.88^{c,d} \pm 0.76$
+ 30 %	Ml	$7.15^d \pm 1.54$	$0.31^b \pm 0.05$	$-8.22^c \pm 1.47$	$0.78^{a,b} \pm 0.02$	$5.29^{d,e} \pm 0.69$
	Mm	$16.53^b \pm 4.07$	$0.51^{d,e} \pm 0.09$	$-2.65^{a,b} \pm 0.77$	$0.74^b \pm 0.02$	$12.23^{b,c} \pm 3.24$
	Mh	$11.41^c \pm 0.02$	$0.48^{d,e} \pm 0.02$	$-3.39^{a,b} \pm 0.73$	$0.80^{a,b} \pm 0.01$	$9.13^{c,d} \pm 0.10$
+ 40 %	Ml	$3.93^{e,f} \pm 0.71$	$0.23^f \pm 0.03$	$-3.67^b \pm 0.12$	$0.78^{a,b} \pm 0.06$	$2.88^e \pm 0.37$
	Mm	$12.74^c \pm 1.43$	$0.38^e \pm 0.03$	$-5.83^c \pm 0.95$	$0.73^b \pm 0.02$	$9.30^c \pm 0.87$
	Mh	$7.35^d \pm 0.56$	$0.36^e \pm 0.04$	$-5.29^{b,c} \pm 0.81$	$0.70^b \pm 0.03$	$5.15^e \pm 0.15$
+ 50 %	Ml	$3.18^f \pm 0.36$	$0.20^f \pm 0.03$	$-2.43^a \pm 0.15$	$0.79^{a,b} \pm 0.02$	$2.51^e \pm 0.32$
	Mm	$6.50^{d,e} \pm 0.22$	0.24 ± 0.01	$-4.94^{b,c} \pm 0.46$	$0.78^a \pm 0.05$	$5.07^e \pm 0.05$
	Mh	$7.15^d \pm 0.16$	$0.29^e \pm 0.01$	$-5.47^{b,c} \pm 0.27$	$0.77^{a,b} \pm 0.04$	$5.51^{d,e} \pm 0.31$

Values denoted with small letters in columns do not differ statistically significantly at p = 0.05;

Cohesiveness measures the degree of difficulty in disarranging the original structure of a gel (Choi and Kerr 2003) and is related to the internal bonding forces that keep the product whole (Surówka 2002). Replacing 10 or 20% of starch with medium- or high-saccharified maltodextrin did not affect cohesiveness; the same was true for 30% addition of medium-saccharified hydrolysate (Tab. 2). By contrast, adding low-saccharified maltodextrin (regardless of its amount) or medium- and high-saccharified in the amount of 40 or 50% decreased the cohesiveness of gels, compared to starch gel with no additives, the decrease being the larger, the greater was the proportion of hydrolysate in the gel (Tab. 2).

Adhesiveness depended both on the degree of hydrolysis and on the proportion of maltodextrins in the systems. While 10% addition of low- or high-saccharified hydrolysate had no perceptible effect on this parameter, a bigger addition of maltodextrin increased its value, compared to the gel of starch alone. By contrast, gels of systems containing 10 or 20% of medium-saccharified maltodextrin exhibited a lower adhesiveness than the latter gel.

In contrast to hardness, cohesiveness and adhesiveness (which were as a rule influenced by the addition of maltodextrins), elasticity was affected only in four cases. Namely, gels containing 30 and 40% of medium-saccharified maltodextrin or 20 and 40% of high-saccharified hydrolysate had a reduced elasticity compared to the starch gel without any additives.

Based on two of the above primary characteristics of texture (i.e. hardness and cohesiveness), a secondary parameter – gumminess – was determined as a product of the two. Gumminess is defined as a force needed to bring a semi-solid product, through disintegration, to the consistency that makes it fit for swallowing (Surówka 2002). It may be claimed that hardness, exhibiting bigger changes than cohesiveness, contributed more to the gumminess of the gels. The results of instrumental texture profiling indicate that the textural properties of gels depend both on the amount and saccharification degree of the hydrolysate added to starch.

The colour of gels was determined in the CIELab space. The values of the L*, a* and b* components are shown in Table 3.

The value of L* (lightness) may range from 0 (for an object fully absorbing radiation) to 100 (for a perfect white object). The gels under study had the L* values in the range 44.69-71.15 (Tab. 3). Their lightness depended both on the degree of depolymerisation of maltodextrins added to starch and on their proportion in the gels, being the highest for gels containing low-saccharified maltodextrin. Replacing a part of starch with low- or high-saccharified hydrolysate resulted in a lighter colour of gels than that of the starch gel without additives. The L* value tended to rise with increasing proportion of low-saccharified maltodextrin in the system (Tab. 3). By contrast, the presence of medium-saccharified maltodextrin led to a darker colour of gels. It also had the strongest decreasing effect on

the value of this parameter among all the hydrolysates. The above results indicate that the lightness of gels depended both on the degree of starch depolymerisation and the proportion of maltodextrin in the system.

Table 3. Colour parameters of 10% water pastes of starch and starch-maltodextrin systems; Ml, Mm, Mh – low-, medium-, high-saccharified maltodextrin, respectively

Samples		Colour parameters				
		L	a*	b*	C	h°
Potato starch		57.35±0.07	−2.25±0.03	−10.80±0.11	11.03±0.11	1.49±0.21
Ml	10%	67.80±0.13	−2.88±0.03	−8.43±0.01	8.91±0.06	1.45±0.09
	20%	69.50±0.57	−2.93±0.04	−8.34±0.19	8.84±0.02	1.45±0.11
	30%	69.67±0.32	−3.04±0.06	−8.19±0.07	8.74±0.02	1.43±0.13
	40%	70.08±0.26	−3.18±0.02	−8.07±0.06	8.67±0.03	1.42±0.02
	50%	71.15±0.01	−3.14±0.02	−7.26±0.03	7.91±0.04	1.39±0.06
Mm	10%	56.41±0.53	−3.20±0.06	−10.47±0.10	10.95±0.16	1.48±0.06
	20%	56.12±0.36	−3.22±0.02	−9.50±0.01	10.03±0.02	1.46±0.02
	30%	53.15±1.17	−3.08±0.02	−8.98±0.26	9.49±0.27	1.45±0.11
	40%	46.43±1.69	−2.80±0.12	−8.85±0.26	9.28±0.21	1.47±0.16
	50%	44.69±1.15	−2.86±0.27	−10.08±1.03	10.48±1.22	1.49±0.19
Mh	10%	59.76±0.52	−3.07±0.02	−10.59±0.10	11.03±0.21	1.49±0.13
	20%	58.83±0.24	−3.19±0.09	−10.95±0.01	11.41±0.34	1.49±0.06
	30%	58.80±0.45	−3.40±0.06	−11.59±0.06	12.08±0.36	1.48±0.03
	40%	58.22±0.65	−3.46±0.01	−10.36±0.08	10.92±0.11	1.46±0.06
	50%	56.80±0.63	−3.56±0.03	−11.58±0.11	12.11±0.36	1.48±0.11

Starch-maltodextrin gels displayed lower values of colour parameter a* than the starch gel (Tab. 3). The a* value was the lower, the smaller was the proportion of maltodextrin in the system, with the exception of gels containing medium-saccharified maltodextrin for which this pattern got reversed at higher percentages of the hydrolysate in the system. The decreased values of parameter a* indicate that the colour of samples shifted towards green.

The negative values of parameter b* suggest that the colour of all gels under study did not comprise a yellow component. The use of maltodextrin, regardless of its amount or saccharification degree, caused the b* value of gel to increase, compared to the starch gel (Tab. 3). The change was the largest for systems containing low-saccharified maltodextrin. The latter gels exhibited also the greatest reduction in colour saturation (C) that tended to decrease with increasing proportion of maltodextrin in the system. Colour saturation was least affected by the

addition of high-saccharified hydrolysate. The hue angle (h°) ranged between 1.39 and 1.49. Such a small difference suggests that replacing a part of starch with maltodextrins does not cause a hue change that would be visible to the naked eye.

CONCLUSION

Replacing a part of starch, even as little as 10%, with maltodextrin results in lowered shear stresses for the whole study range of shear rates (1-300 s^{-1}). The flow strength of pastes decreases with the increasing proportion of maltodextrins in the system and the saccharification degree of maltodextrin has an effect on the thinning degree of starch paste. The presence of maltodextrins in the system with starch affects the textural parameters of gel by considerably lowering their values. The changes, however, are not proportional to the degree of maltodextrin saccharification. Moreover, the addition of maltodextrins influences the colour of gels, but the changes are not proportional to the degree of maltodextrin saccharification. To summarise, the addition of maltodextrin to starch-water systems can change the production process and the final product can have more valuable features.

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EFEKT DODATKU MALTODEKSTRYN O RÓŻNYM STOPNIU DEPOLIMERYZACJI NA WYBRANE WŁAŚCIWOŚCI TEKSTURY I PARAMETRY BARWY

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Streszczenie. Celem pracy była analiza wpływu dodatku maltodekstryn ziemniaczanych o różnym stopniu depolimeryzacji na wybrane właściwości teksturalne oraz parametry barwy układów skrobi ziemniaczanej, w których 10-50% skrobi zostało zastąpione hydrolizatami ziemniaczanymi o różnym stopniu scukrzenia. Materiał badawczy stanowiła handlowa skrobia ziemniaczana oraz handlowe ziemniaczane maltodekstryny – nisko scukrzona, średnio scukrzona i wysoko scukrzona. Do badań sporządzono 10% kleiki skrobi ziemniaczanej w wodzie oraz kleiki, w których kolejno 10, 20, 30, 40 i 50% skrobi zastąpiono hydrolizatem skrobiowym. Z tak otrzymanych kleików wyznaczono krzywe płynięcia w temperaturze 50°C, oznaczono barwę w układzie CIELab oraz wyznaczono profil tekstury. Do opisu krzywych płynięcia zastosowano model Herschel-Bulkley. Przeprowadzone analizy dowiodły, że zastąpienie skrobi już 10% maltodekstryny wpływa na zmianę właściwości żeli. Zmiany te jednak nie są proporcjonalne ani do stopnia scukrzenia maltodekstryn ani do procentowego udziału hydrolizatów w żelach. Wraz ze wzrostem udziału maltodekstryn w żelach obniża się lepkość pozorna, wzrasta ich rozrzedzenie, a także zmieniają się wartości parametrów tekstury. Również nawet 10% udział maltodekstryny w żelach, powoduje zmianę wartości parametrów barwy w układzie CIELab przy zastosowaniu iluminantu D_{65} i obserwatora 10°.

Słowa kluczowe: skrobia, maltodekstryny, parametry reologiczne, parametr barwy