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SORBITOL ADDITION ON EXTRUSION PROCESS

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Summary. Sorbitol, available in form of the powder, is characterized by energy value the same as the value of saccharose, while its sweetness is equal to 60 % saccharose sweetness. From among the basic properties there should be mentioned the resistance to temperature of 200 deg C, melting point at 96.5 deg C and easy solubility in water. In the presented study sorbitol was added in proportions of 5, 10 and 15% to the feed mixtures being next extruded in a S – 60 single-worm extruder, at sections' temperatures: I – 145°C, II – 165°C, head – 160°C, shaft rotary speed 100 r.p.m. and die hole diameter 5 mm. The extruded product was tested for durability (Pfost type tests); shearing and compressive forces were determined in an Instron apparatus. The tests for the water stability of the extruded product were also carried out. On the basis of investigation results it was stated that the addition of sorbitol affected the hardness of the extruded product. Owing to water binding by sorbitol the extruded product was much softer at a little higher moisture content. These features seem to be useful at production of animal feeds.

Key words: extrusion cooking, sorbitol, feed quality

INTRODUCTION

Extrusion technique is often used in production of industrial feeds of good durability owing to the effect of high stresses (pressure up to 20 MPa) and temperature (above 100 deg C). As a result of high temperature and pressure the product is being sterilized (elimination of bacteria, viruses and moulds); there occur also tearing of fatty cells, inactivation of antinutritive factors and improving of protein digestibility [Mościcki 1999, Sobczak 2003, Sobczak and Zawiślak 2003).

To valuable raw materials in feed production – because of their high digestible protein contents – belong the ground soya bean seeds and meat meal; the last one, however, may be actually used only as an additive to feeds for dogs and cats. An excellent equivalent for meat meal is the fish meal, but because of high costs, the range of its application is rather limited. An interesting modification of typical dry feed mixtures are the soft feeds of higher moisture content, produced with addition of various dewatering (sugars, syrups etc.), antifungal substances and pH regulators [Grochowicz 2001].

The group of the moisture keeping-up substances comprises - among the others – sorbitol, glycerol and polydextrose. Sorbitol, most often applied in the food industry, is available in form of the powder, characterized by energy value the same as saccharose; its sweetness is equal to 60% saccharose sweetness. From among basic sorbitol properties there ought to be mentioned its resistance to the temperature of 200 deg C, its melting point at 96.5 deg C and good solubility in water [Swiechowski 1997, www.hortimex.com.pl].

OBJECT AND SCOPE OF THE RESEARCH

The presented studies were carried out to determine the effect of sorbitol addition on selected physical properties of extruded feeds. The investigations included:

- determination of basic physical parameters of raw materials,
- measuring of expanding degree for extruded materials,
- strength tests for extruded materials in an Instron apparatus,
- determination of kinetic durability for extruded feeds,
- determination of the water stability.

MATERIAL AND METHODS

Two kinds of feed mixtures were used as the raw material for experiments. The first one was based on the ground soya bean seeds and meat meal. Equal parts of both components were mixed with addition of 5, 10 and 15% sorbitol. The second kind of mixtures consisted of the ground maize grain, ground soya bean seeds and meat meal in equal proportions, with successive 5, 10 and 15% sorbitol addition (Tab. 1).

Table 1. Composition of particular feed mixtures (%)

Raw material	I	II	III	IV	V	VI	VII	VIII
Meat meal	50	47.5	45	42.5	33.3	31.65	30	28.33
Ground soya bean seeds	50	47.5	45	42.5	33.3	31.65	30	28.33
Ground maize grain	-	-	-	-	33.4	31.7	30	28.34
Sorbitol	-	5	10	15	-	5	10	15

Physical properties, kinetic durability and water stability were measured according to obligatory standards (measurement result was an arithmetic mean for three replications). Compression and shearing tests were done in the Instron 4301 apparatus with measuring head of 1 kN range. The results processed statistically with the use of Statistica software are presented in the chapter „Results”. Arrangement of the sample for testing is illustrated in Fig. 1. The knife of edge angle 45^{o} was used to shearing resistance tests.

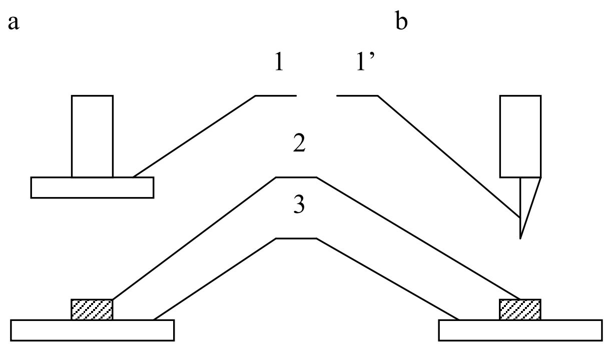

Fig. 1. Scheme of the sample arrangement during tests for compression (a) and shearing (b): 1 – compressing piston, 1' – shearing knife, 2 – tested sample, 3 – stationary plate of the apparatus

The process of extrusion was conducted in the S-60 single-worm extruder at variable temperature of sections: I – 145°C, II – 165°C, head – 160°C, extruder shaft velocity 100 r.p.m. and mouthpiece with the round holes of 5 mm diameter. Extruder and the mouthpiece are shown in Photo 1.

Photo 1. Extruder and its mouthpiece

RESULTS

The results of particular measurements, after statistical processing, are given in Tables 2–5 and in Figs. 2–7.

Table 2. Basic physical properties of the raw materials used to extrusion

Physical properties	Ground maize grain	Meat meal	Ground soya bean seeds
Discharge angle	43°	63°	45°
Angle of repose	33°	41°	33°
Bulk density, kg/m^3	778.68	460.8	677.04
Shaken bulk density, kg/m^3	804	1000	1206
Moisture content, %	9.1	6.9	6.3
Average particle size, mm	0.7	0.28	0.49

Before the extrusion process the mixtures were moistened to 30% m.c. in a paddle mixer with the use of a spraying nozzle. Moisture content of the extruded materials was measured after processing; the results are given in Fig. 2.

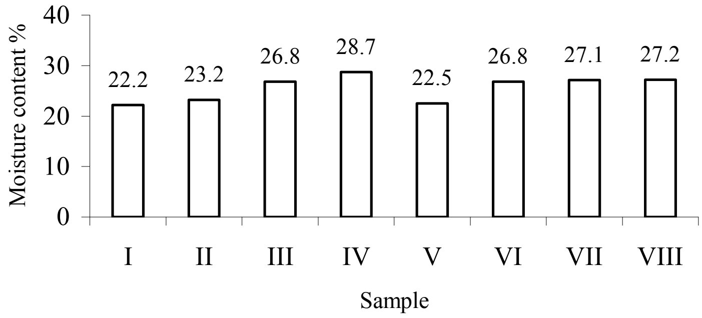

Fig. 2. Moisture content of the mixtures after extrusion.

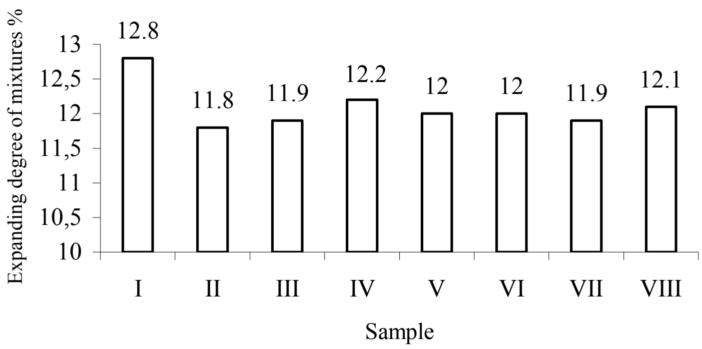

Fig. 3. Expanding degree of the mixtures after extrusion

Table 3. Statistical analysis of expanding degree for extruded feeds

	I	II	III	IV	V	VI	VII	VIII
Mean	0.6797	0.6247	0.6363	0.6270	0.6270	0.6143	0.6200	0.6251
Standard deviation	0.0183	0.0257	0.0224	0.0162	0.0188	0.0199	0.0201	0.0189
Coefficient of variability	2.6904	4.1134	3.5136	2.5870	2.9955	3.2467	3.4110	2.5600

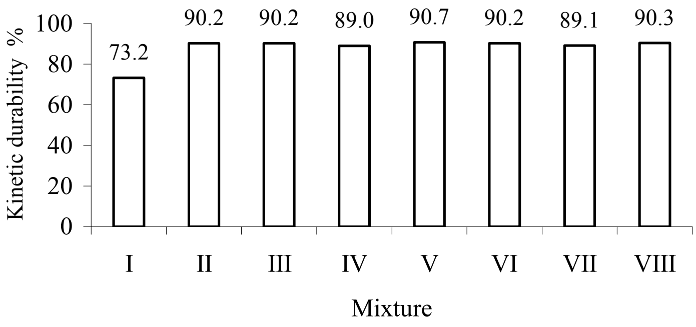

Fig. 4. Kinetic durability of extruded feed mixtures

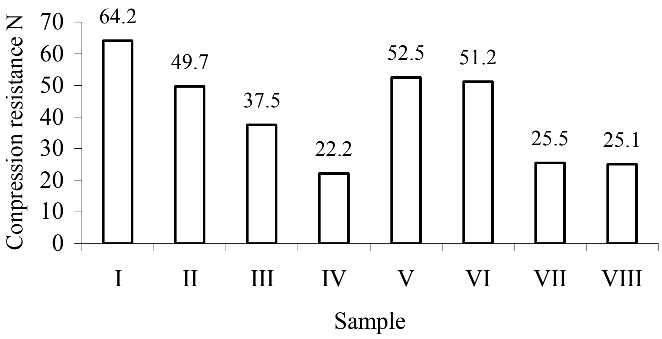

Fig. 5. Compression resistance of extruded feed mixtures

Table 4. A statistical analysis of compression resistance in the tested samples

Extruded mixture	Mean	No. of replica-tions	Standard deviation	Variance	Standard error.
I	64.173	15	8.608	74.094	2.223
II	49.673	15	8.059	64.948	2.081
III	37.513	15	8.259	68.214	2.133
IV	22.160	15	9.171	84.107	2.917
V	52.500	15	8.539	72.917	2.205
VI	51.160	15	10.431	108.805	2.693
VII	25.453	15	7.414	54.961	1.914
VIII	25.127	15	7.313	53.478	1.888

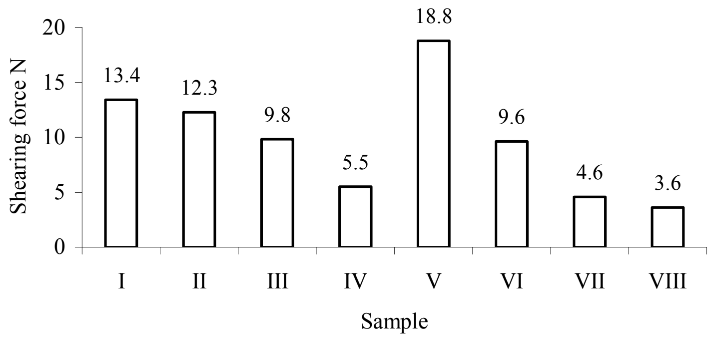

Fig. 6. Shearing force

Table 5. A statistical analysis of shearing force measured for the tested samples

Extruded mixture	Mean	No. of replica-tions	Standard deviation	Variance	Standard error.
I	13.400	15	3.521	12.396	0.909
II	12.260	15	2.489	6.195	0.643
III	9.813	15	1.761	3.101	0.455
IV	5.520	15	1.386	1.920	0.358
V	18.773	15	5.125	26.265	1.323
VI	9.613	15	1.749	3.060	0.452
VII	4.573	15	0.848	0.719	0.219
VIII	3.620	15	0.585	0.342	0.151

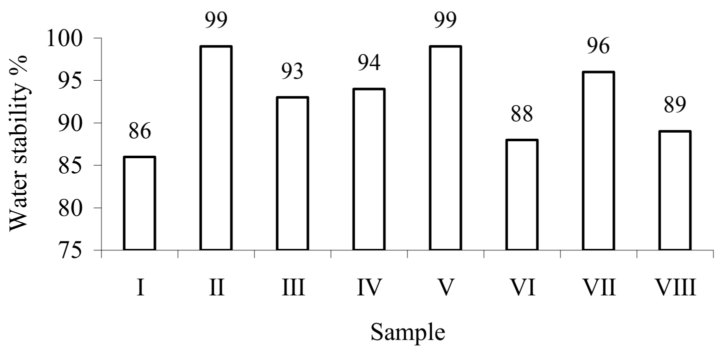

Fig. 7. Water stability

DISCUSSION

The expanding degree for particular extruded feed mixtures reached about 12%. No changes of this value were observed after addition of sorbitol in proportions of 5, 10, 15%, respectively. The extruded feed mixtures were characterized by high kinetic durability exceeding 90%; less durability, achieving about 70%, was shown only by the mixture I consisting of the meat meal and ground soya bean seeds. After supplementing feed mixtures with the sorbitol, their final moisture content increased by 1–5% for the raw material without ground maize grains, and by about 3% for those containing ground maize. An analysis of variance at the level $\alpha = 0.05$ confirmed the significance of differences in the values of both, compressive and shearing forces, as affected by sorbitol addition. The highest compression resistance and shearing force occurs in the sample without sorbitol addition.

CONCLUSIONS

On the basis of the obtained experimental results and their analysis the following conclusions may be derived:

1. Addition of sorbitol within the tested range did not affect the kinetic durability of the extruded material.
2. Along with increasing sorbitol addition to the mixture, the compression resistance and shearing force of the extruded material decreased (its hardness was being reduced).
3. Owing to the binding of water by sorbitol the extruded feed mixture became much softer and its moisture content slightly increased, which may be of advantage in production of feed mixtures for animals.

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