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CHEMICAL-TECHNOLOGICAL CHARACTERISTICS AND BAKING APPLICABILITY OF PROTEIN PREPARATIONS OBTAINED FROM PEAS AND FABA BEANS USING AIR CLASSIFICATION METHOD

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Luguminous seeds have been recognized as a suitable source of protein for production of isolates and concentrates applicable in food and fodder industries [1, 2, 7]. Methods emploied for production of protein preparations include wet and dry procedures. The wet procedure permits to obtain isolates of high protein concentration and programmed physico-chemical properties. There are however many inconveniences such as a high energy input, hardly utilizable by-products and sewages. The protein preparations are therefore expensive and in some cases not competive in comparison with other protein products [1, 2, 7].

The dry procedure is simpler [1, 2, 7]. It limitates effectively formation of waste products. The protein preparations are however much less concentrated (concentration 2:1). A specific difficulty which hamper progress in production of such preparations is necessity of advanced communution of the material to the degree permitting separation of protein occuring in the subcellular protein bodies using air classification method. Recommended by many authors application of pin mills [1, 2, 9, 10, 11] offers only partial resolution of the problem. High effectiveness in desintegration of plant tissue is in the case of such mills counterbalanced by extensive energy consumption and high ammortization costs, because of short life of working elements exploited in the rather hard conditions.

Therefore we have concentrated in this study on the possibility of development of simplified method based on classical milling technology. Instead of pin mill the conventional roller mill has been applied. To increase yield of the finest fraction of flour the two step grinding procedure has been adopted. In succesive experiments the effect of pretreatment of seeds (germination, autoclaving) on yields of the preparations and their nutritional characteristics have been analysed. The baking applicability of the preparation obtained from pea has been studied as well.

MATERIALS AND METHOD

In the experiments seeds of pea (*Pisum sativum L.*)— varieties Kaliski and Karat and of faba bean (*Vicia faba L. var. minor*) variety Nadwiślański were used.

Pea and faba bean seeds after dehulling were ground in a laboratory roller mill Brabender Quadrumat Junior as it was described by Kiryluk [5]. Protein concentrates were obtained from the flours using a laboratory air classifier Alpine (Alpine Multi-Plex Labor-ZZ-Sichter MZR). Fraction of the particle size below 15 μm was collected with yield of ca 12%.

Dry matter and protein content (N × 6.25) were determined according to standarized procedures [3].

Homologues of raffinose were isolated from the material and analysed using thin layer chromatography method following procedure described by Tanaka et al. [8] with slight modification [4]. Phytate contents were determined according to Wheeler and Ferrel [12]. Phytates were isolated in course of two-steps extraction of samples. For iron determination the phenantrolin reaction was adapted [4].

Energy input in the process of comminution of seeds and grits was calculated on the basis of the measurements of electric energy expended during free run of the mill and after feeding it with the ground material [5].

RESULTS AND DISCUSSION

The theoretical yields of protein preparations obtainable from leguminuous seeds have been calculated on the basis of data presented by Pernollet [6]. They depend on protein contents in seeds and in protein bodies (Table 1). In the case of complete isolation of protein bodies present in seeds there is a possibility of obtaining the preparations with yields amounting to 25-33% for peas and to 34-39% for faba beans. The yields obtained practically are somewhat lower (Table 2).

As it has been demonstrated in Table 2 there were differences in yields of the preparations connected with the variant of the method employed. Vose et al. [11]

Table 1. Distribution of protein in peas and faba beans

Material	Protein content			Theoretical yield of protein preparation %
	seeds %	protein fraction		
		% dry matter	% total protein	
Pea	20-25	70	90	25-33
Faba bean	30-35	80	90	34-39

PERNOLLET (1978)

Table 2. Effect of method of seed comminution on yield and protein content of protein concentrates obtained using air classification method

Material	Pin mill*)			Roller mill		
	protein content %	% of total protein	yield %	protein content %	% of total protein	yield %
Pea	50-60	70-90	25	50-60	25-18	12-6
Faba bean	60-70	55-75	28	60-70	27-20	15-10

*) VOSE et al. (1976), TYLER et al. (1981, 1982)

and Tyler et al. [9, 10] used a pin mill for comminution of the material. The yields obtained by these authors amounted to 25 and 28% for peas and faba beans respectively, whereas the protein contents in the preparations amounted analogously to 50-60 and 60-70%. In our experiments the roller mill was used. The yields of the preparations were lower. They were related to the protein contents in the products. The yield of the preparation obtained from peas amounted to 12% for 50% protein content in preparation and decreased to 6% for protein content of 60%. Similarly the yield of preparation obtained from faba beans varied from 15 to 10% for protein contents changing from 60 to 70%.

The distribution of protein in the preparations and residue flours are presented in Table 3. The preparations containsed 52 and 61% of protein for peas and faba beans respectively while in the residue flours the protein contents amounted to 23,6 and 28,1%. There was a slight decrease in protein contents in the residue flours as compared with those determined for grits. The composition of the residue flours varied from that of control flours only in about 1,5% lower protein content.

Table 3. Distribution of protein in preparations and residue flours (%, dry matter)

Material	Grits %	Protein preparation		Residue flour	
		%	yield %	%	yield %
Pea	25.9	52.0	11.4	23.6	88.6
Faba bean	32.6	61.0	13.7	28.1	86.3

No pretreatment of seeds

Comparison of energy consumption in milling of seeds in the pin mill and roller mills are presented in Table 4. The results were expressed in kJ per kg of preparation. The energy consumption in course of pin-milling of legume seeds was estimated according to the yield of comminution and was estimated according to the yield of comminution and power declared by pin mill producer

Table 4. Energy consumption in milling of seeds

Material	Energy (kJ/kg preparation)			
	Pin mill*) n	Roller mill		
		Control	Autoclaved	Germ. — autocl.
Pea	550	430	310	410
Faba bean	500	390	260	340

*) TYLER, PANCHUK (1982)

(Alpine). The technology based on the use of roller mill needed lower energy inputs. Pretreatment of seeds caused further decrease of energy consumption in comminution process.

Germination and/or autoclaving of seeds were carried out to improve the nutritional properties of protein preparations. The effects of such pretreatment of seeds on composition and yields of the preparations are presented in Table 5 for the process exploiting a roller mill. Germination of pea seeds did not affect the yield of protein preparation. Combination of germination and autoclaving caused a slight decrease of the yield and protein concentration in the preparation. Both operations reduced the contents of raffinose homologues and phytates to 43 and 63% respectively as compared to those determined in control grits (Table 5, Fig. 1).

The results obtained for faba beans (Table 5, Fig. 2) were closely correlated with those found for pea seeds.

In Table 6 data characterizing the residue flours are presented. The reduction of the contents both of raffinose homologues and phytates was comparable with the effects found for the protein preparations.

Table 5. Effect of pretreatment of seeds on composition and yields of protein preparations

Material		Yield %	Protein content	Raffinose homologues	Phytates
			% of dry matter		
Pea	Control	11.4	51.9	4.8	4.5
	Germinated (48h)	11.4	48.7	2.5	4.0
	Autoclaved (15')	13.4	48.1	4.4	3.5
	Germinated-autoclaved	10.7	46.6	2.3	3.2
Faba bean	Control	13.7	58.8	5.4	5.1
	Germinated (48h)	13.6	53.4	4.1	4.6
	Autoclaved (15')	15.0	58.6	4.6	3.4
	Germinated-autoclaved	12.2	57.8	2.3	3.8

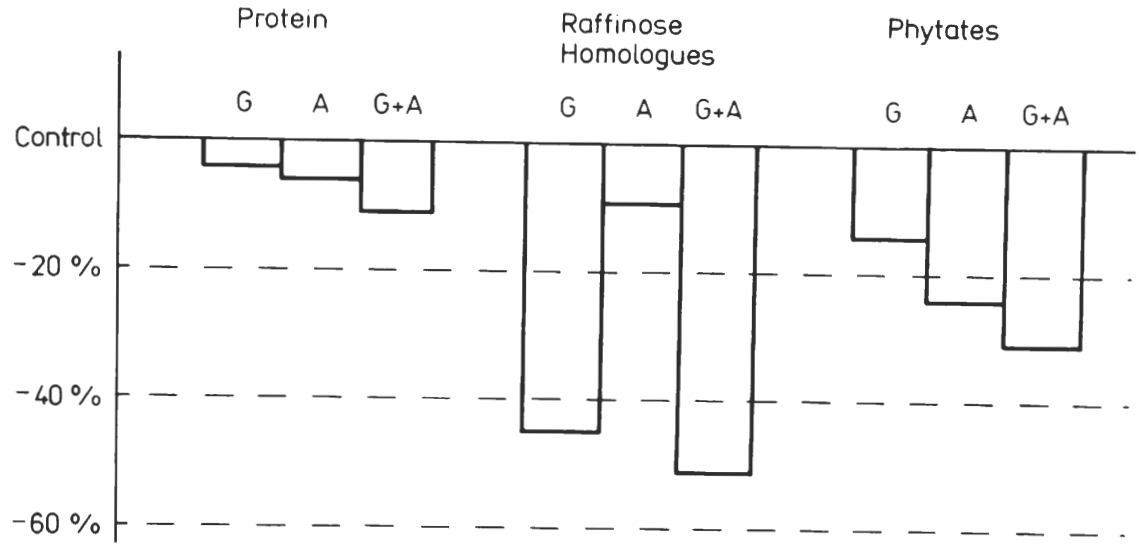

Fig. 1. Effect of pretreatment of seeds on decrease of protein content and some undesired constituents in preparations (pea)

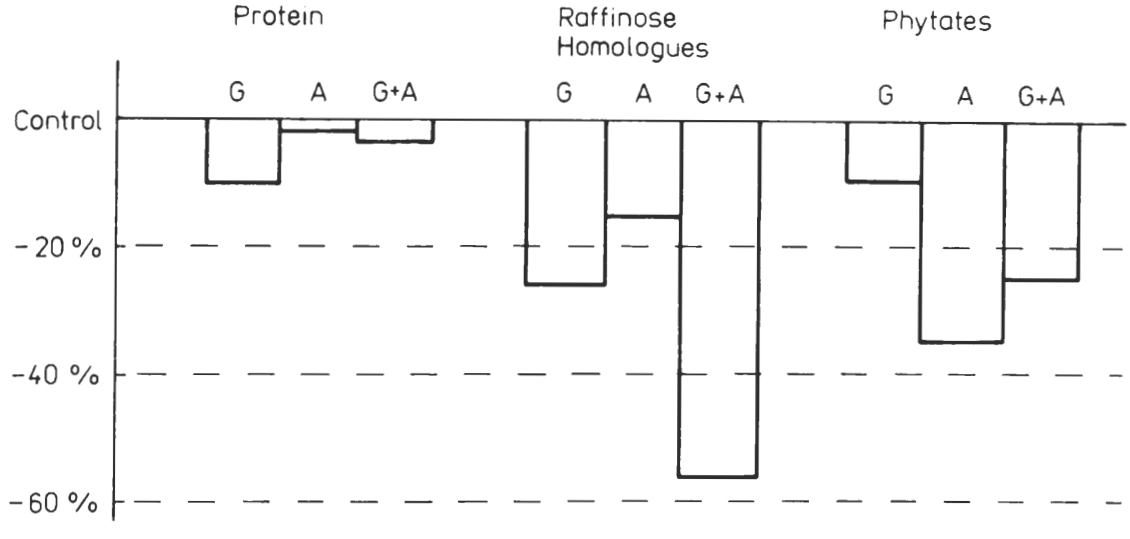

Fig. 2. Effect of pretreatment of seeds on decrease of protein content and some undesired constituents in preparations (faba bean)

In the successive experiments the applicability of protein preparation (in its undenatured form) obtained from pea seeds was characterized on the basis of examination of rheological properties of enriched wheat dough and laboratory baking tests. To the flours there was also added the phosphated starch preparation (2%) as a highly hydrophilic agent.

The farinograms (Fig. 3) demonstrated that the increasing additions of the protein preparation obtained from pea caused changes of visco-elastic properties of dough. In the case of simultaneous use of protein preparation and phosphated starch the changes were partly moderated. The water absorption of enriched doughs, determined for consistency of 500 Brabender units, was practically unchanged even in the dough containing 10% of the protein preparation. The addition of phosphated starch (2%) caused slight increase of water absorption of the dough. Much smaller effect if any was found for doughs containing

Table 6. Effect of pretreatment of seeds on composition and yields of residue flours

Material		Yield %	Protein content	Raffinose homologues	Phytates
			% of dry matter		
Pea	Control	88.6	23.6	4.9	2.7
	Germinated (48h)	88.6	22.6	3.1	1.8
	Autoclaved (15')	86.6	21.6	4.4	1.9
	Germinated-autoclaved	89.3	22.0	2.9	1.9
Faba bean	Control	86.3	28.1	4.0	3.1
	Germinated (48h)	86.4	28.2	3.9	2.8
	Autoclaved (15')	85.0	21.1	3.5	2.7
	Germinated-autoclaved	87.8	26.7	2.6	2.2

combination of the phosphated starch and protein preparation. A distinct decrease of bread volume caused by addition of protein preparation was observed. The use of phosphated starch prevented it, to some extent. The other organoleptic properties of enriched breads were evidently better when the combination of both the additives was applied instead of the protein preparation alone.

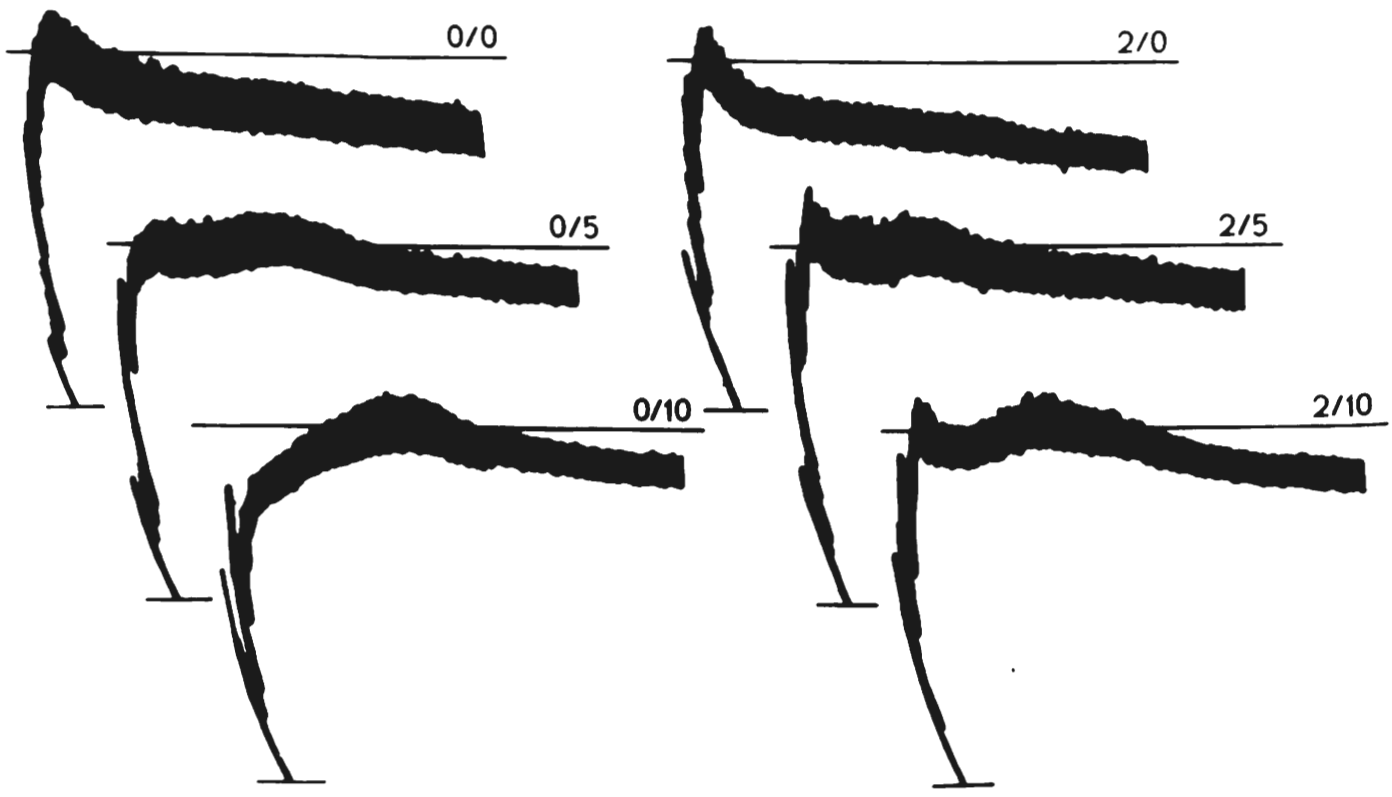

Fig. 3. The effect of the addition of pea protein preparation*) and phosphated starch**) on farinographic characteristics of the wheat dough***)

*) The protein preparation was added in the amounts of 5 and 10%. **) The phosphated starch was added in the amount of 2%; ***) Wheat variety Livilla

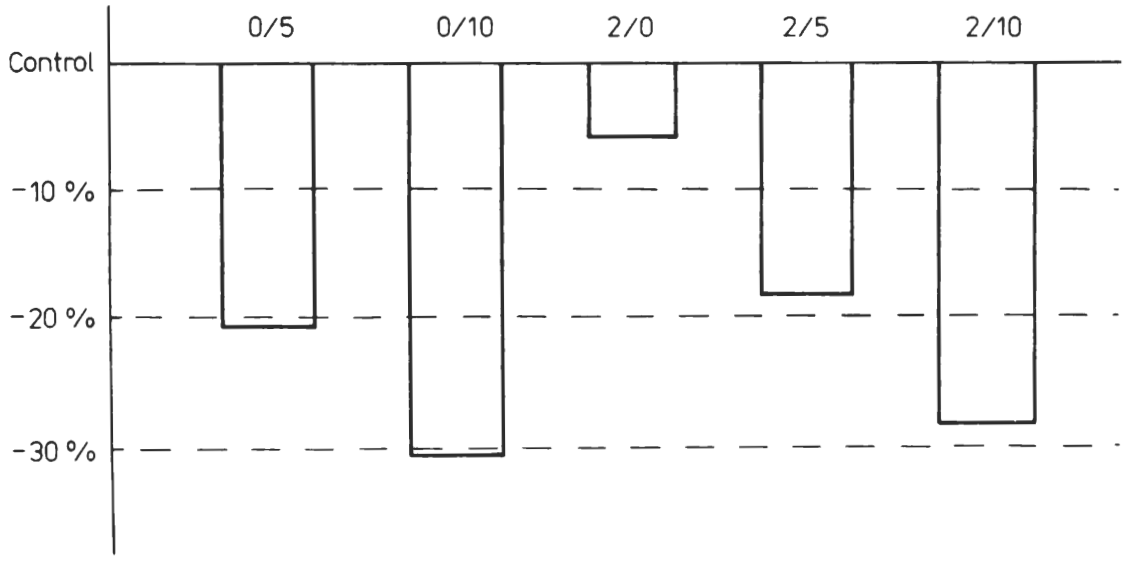

Fig. 4. The effect of the addition of pea protein preparation*) and phosphated starch**) on the decrease of wheat bread***) volumes

*) The protein preparation was added in the amounts of 5 and 10%; **) The phosphated starch was added in amount 2%; ***) Wheat variety Livilla

The experimental breads demonstrated no specific changes of taste and flavour that might be expected after addition of pea flour.

CONCLUSIONS

1. Usage of roller mill for comminution of leguminous seeds is effective in production of protein preparations.
2. Application of air classification method gives the preparations of protein contents up to 52 and 59%.
3. The residue flours preserve with only minimal variations the properties of initial material.
4. Pretreatment of seeds including germination and heat process (autoclaving), reduces contents of undesirable raffinose homologues and phytates in the protein preparations and residue flours respectively to about 1/2 and 2/3 of those determined for the controls.
5. The protein preparations may be applied in food processing in forms of denatured or unmodified products.
6. Usage of reasonable quantities of preparations in baking is possible. The technological properties of enriched wheat flour can be corrected by addition of phosphated starch.

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CHARAKTERYSTYKA CHEMICZNO-TECHNOLOGICZNA PREPARATÓW BIAŁKOWYCH OTRZYMANYCH Z NASION GROCHU I BOBIKU METODĄ PNEUMOSEPARACJI ORAZ MOŻLIWOŚĆ ICH ZASTOSOWANIA W PIEKARSTWIE

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Streszczenie

Badano możliwość użycia mlewnika walcowego do rozdrabniania nasion grochu i bobiku przeznaczonych do produkcji koncentratów białkowych metodą suchą (pneumoseparacja). Równolegle określono wpływ zabiegów wstępnych (kiełkowanie, autoklawowanie, kiełkowanie i autoklawowanie) na zawartość niektórych substancji niepożądanych (homologi rafinozy, fityniany) w mączkach wyjściowych, koncentratach białkowych oraz w mączkach pozostałych po pneumoseparacji.

Określono wpływ koncentratu niezdenaturowanego białka grochu, otrzymanego metodą pneumoseparacji, na właściwości funkcjonalne ciasta chlebowego oraz jakość chleba. Jako dodatek korygujący właściwości technologiczne doświadczalnych ciast wzbogaconych zastosowano preparat skrobi fosforanowej.

Stwierdzono, że zastosowanie mlewnika walcowego do przemiału nasion grochu i bobiku pozwala na wydzielenie metodą pneumoseparacji z uzyskanych mączek preparatu białkowego o zawartości odpowiednio ok. 52 i 59% białka, z wydajnością 11,4 i 13,7%. Mączki pozostałe po pneumoseparacji zachowywały pierwotne właściwości z nieznacznymi tylko zmianami.

Obróbka wstępna nasion (kiełkowanie, parowanie lub kiełkowanie i parowanie) powoduje obniżenie zawartości niepożądanych homologów rafinozy i fitynianów odpowiednio do ok. 1/2 i 2/3 ich zawartości w preparatach kontrolnych.

Zastosowanie otrzymanych preparatów jako dodatków do ciasta chlebowego jest możliwe. Efekt pewnego pogorszenia właściwości technologicznych ciast wzbogaconych może zostać częściowo skorygowany przez zastosowanie dodatku skrobi fosforanowej.