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PHYSICO-CHEMICAL PROPERTIES OF STARCH FROM POLISH GRASSPEA (*LATHYRUS SATIVUS* L.) VARIETIES

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ABSTRACT

The grasspea breeding programme in Poland resulted in development of 2 official varieties of Polish grasspea: small seed form-Derek and large seed form-Krab. The present study was to characterise basic physico-chemical properties of starch from these varieties.

Starch was examined by means of X-ray diffraction, thermal analysis and microscopy. Basic chemical components and pasting characteristics were also checked. It was found that both varieties contain approximately 48% of starch, of which 81% have diameter 12.5-43.4 micrometer. Percentage of amylose in the studied starch samples was 35%, fat was found in similar amounts as in the foreign varieties and protein in much higher quantity. Pastes of both starch types were highly stable.

Key words: grasspea, *Lathyrus sativus*, starch

INTRODUCTION

Grasspea (*Lathyrus sativus* L.) is used to feed animals (green parts) and people (seeds). It is extensively cultivated in Asia and Africa, and in Europe mostly in Spain, France and Italy [2]. In Poland it is present in the eastern part, often under the wrong names (podlaska, biała, ruska soczewica). The trials to reintroduce this plant in cultivation had been started by Agricultural University in Lublin. Then they were continued by the local company - Spójnia from Nochow. The result was the registration of 2 first polish grasspea varieties in COBORU: Derek- with small seeds and Krab- with larger ones [10]. Grasspea contains about 42-48% of starch in a dry matter [1,3] which should be considered a high amount.

The papers published in Poland on grasspea focus on its high nutritional value and possibility to use its seeds and green mass in food and feed production. There are however no thorough studies on characteristics of starch from polish grasspea varieties. Starch properties depend not only on botanical origin (species, variety), but also on cultivation, soil type, climate etc. [8]. This is why the aim of this work is to describe the basic physico-chemical properties of starch from polish grasspea varieties.

MATERIALS AND METHODS

Starch was isolated from 2 grasspea varieties - Derek and Krab, which were obtained from Plant Breeding and Seed Production Company 'Spójnia' in Nochow (Poland).

Ground grasspea seeds were milled in a laboratory mill RG 109. 100 ml of distilled water and 0.04 g of Neutrase (Novo Nordisk) proteolitic enzymic preparation were added to 40 g of the obtained flour. After neutralisation with 10% HCl solution, the flask was stirred in a water bath (45°C) overnight. Then the mixture was filtered through the milling sieve in order to remove bran, and centrifuged at 4000 rpm (centrifuge MPW 341) for 5 min. The upper- dirty part was removed and the rest was washed and re-centrifuged. Washing and centrifuging were repeated three times. The obtained starch was dried on the glass plates at room temperature. Dried starch was milled in a special mill for starch (Fritsh) and sieved through the mesh (0.12 mm).

Starch content in grasspea seeds was measured according to ICC standard method No. 122 (ICC Standards). Dry mass of starch was established by drying at 130°C for 1 hour. Protein determination in starch was done by Kjeldahl method using Büchi distillation unit B 324 (N x 6.25). Fat was measured after acidic hydrolysis of starch by Soxhlet method in Büchi Universal Extraction System B 811.

Seeds' size was checked on the sedimentation scale (Sartorius) according to the manual. 1.2692 g of starch (dry basis) was dispersed in distilled water, the measurement was done after 1 hour.

Starch phosphorus was measured according to [9]. Morrisson's method [11] was used for amylose determination, and modified Leach's [14] method for water binding capacity. 8.5% starch pastes were examined in rotary viscometer Rheotest 2, according to Gambuś and Nowotna [6]. Electron microscopy pictures were obtained with Jeol JSM 5200 equipment. Polycrystalline diffraction meter X'Pert Pro (Philips) with Cu 40/30 lamp was used to collect X-ray spectra (scanning time of each point was 2 seconds). Differential thermoanalysis was done in the air under static conditions in platinum crucibles. The rate of temperature increase was 5°C/min. Corrundum (ϕ=8 micrometers) was taken as the reference. The Paulik-Paulik-Erdey 1500Q Derivatograph (Hungary) was used.

RESULTS AND DISCUSSION

The amount of starch in seeds of Krab and Derek grasspea varieties was almost identical and equaled 48.4 and 48.2% respectively. The efficiency of starch isolation (the amount of starch obtained from 100 g of seeds) was 30.1% in case of Krab variety and 30.4 for Derek. Low efficiency of isolation was due to high amount of fibre in seed cover, which complicate starch extraction, as it was previously observed by Chavan [3].

Figures 1 and 2 represent electron microscopy images of starch isolated from Krab and Derek varieties. The granules visible on both photos have similar size and shape. They are either oval or irregularly round. Their surface is smooth with insignificant ruptures and small channels.

Fig. 1. Microphotography of starch isolated from Krab variety

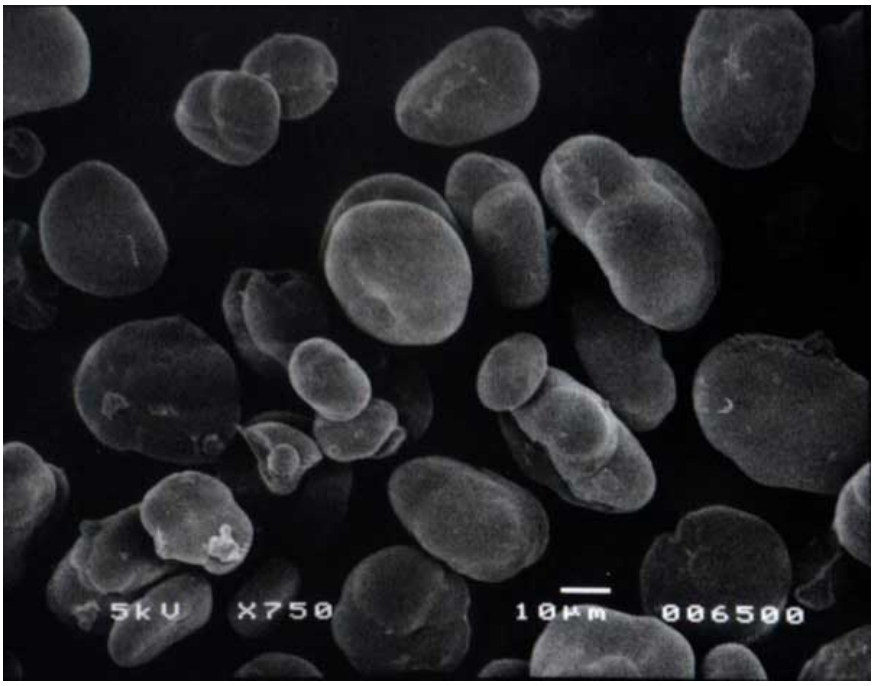
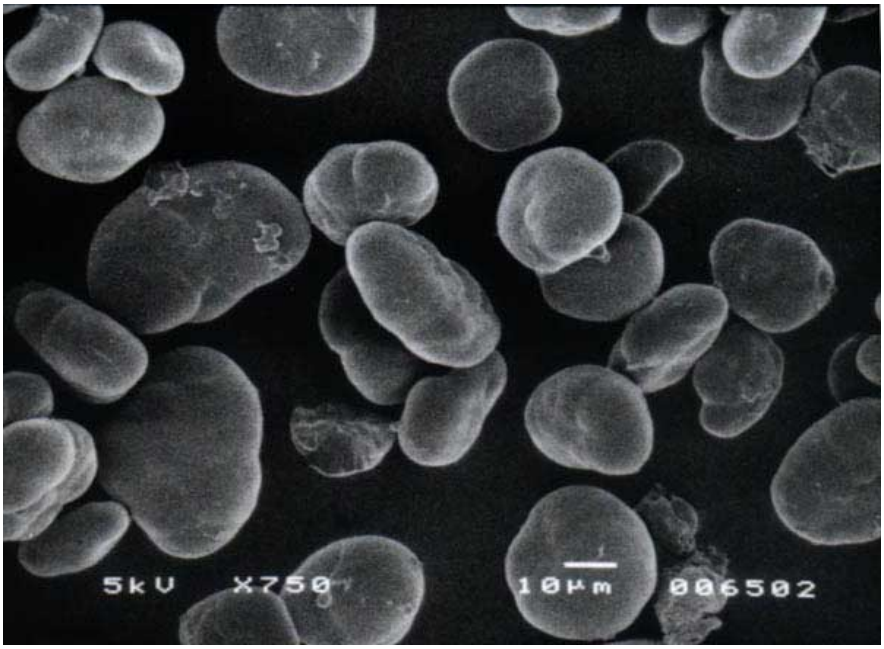


Fig. 2. Microphotography of starch isolated from Derek variety



The range of starch granules' size is shown in Table 1. According to Chavan et al. [3] the usual size of grasspea starch granules is between 6-33 micrometers for round and 17-35 micrometers (longer axis) for elliptic ones. Elliptic granules have an average diameter 16-26 micrometres. The present study revealed that 81.4% of all granules have the diameter in the range 12.5-30.7 micrometers and more than 90% between 12.5-43.4 micrometers. The percentage of large (above 43.4micrometers) and small (below 12.5 micrometers) granules is in case of starch isolated from both varieties almost the same and equals about 3%.

Grasspea starch, similarly to starches from other legumes is classified in crystallography as C type (Fig. 3) which could be described as a transitional type between A (cereal starch) and B (potato).

Table 1. Distribution of starch granule size in the studied samples

Range of granule size in micrometers	Percentage of granules in the specified range	
	Krab	Derek
>43.4	3.72	5.85
43.4>x>30.7	11.70	10.64
30.7>x>21.7	48.40	49.47
21.7>x>12.5	32.98	31.91
<12.5	3.20	2.13

Fig. 3. X-ray diffraction spectra of grasspea starch isolated from Krab and Derek varieties

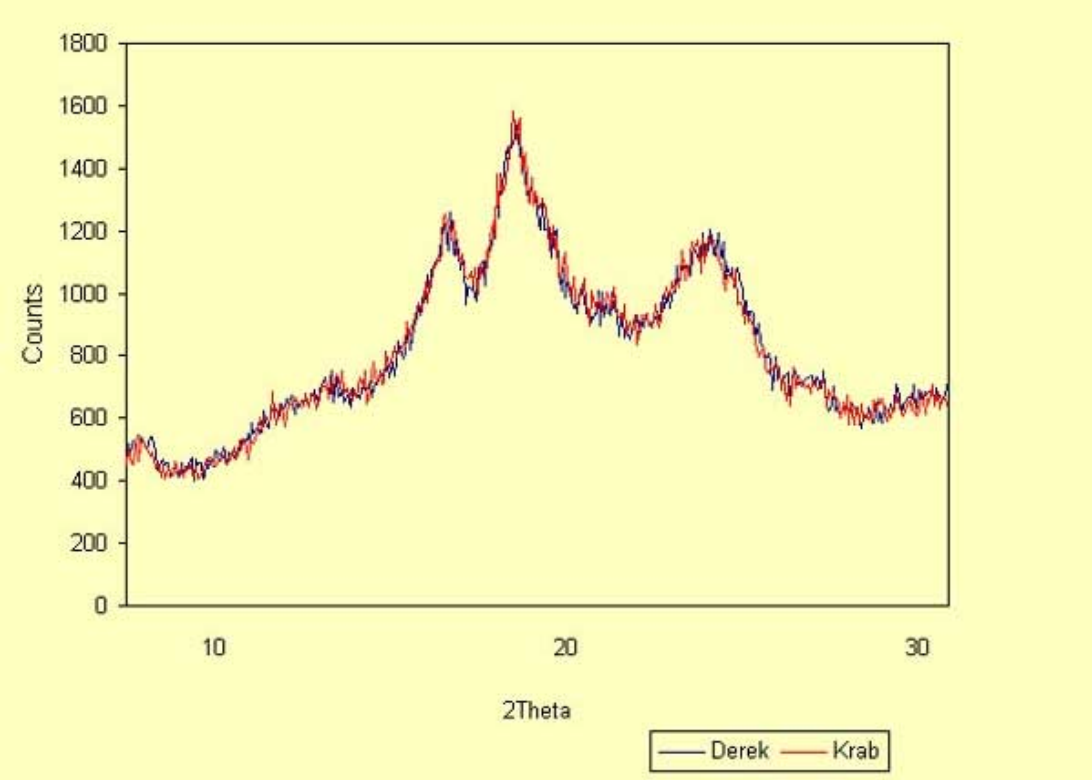
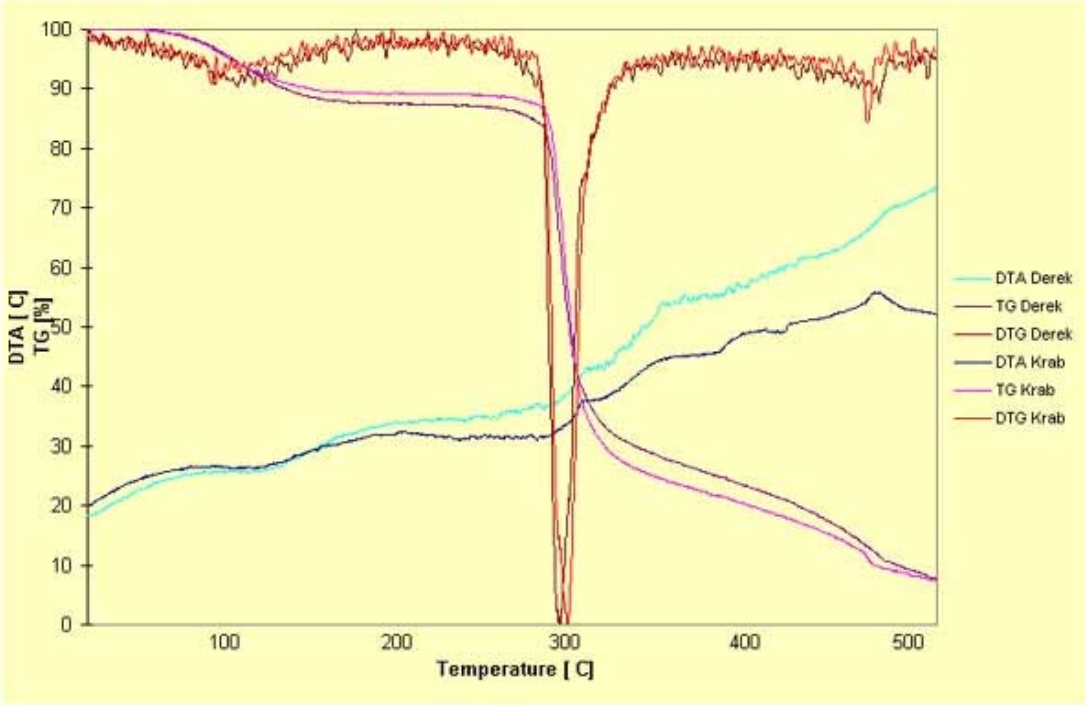


Figure 4 contains differential thermograms of the studied starches. The first loss of more than 10 % of mass takes place in both cases in the range 60-180°C and is linked with evaporation

of free and bound water. The main degradation of polysaccharides from Krab variety occurs at 280°C and speeds up significantly in the range 290-320°C. In case of Derek the initial degradation temperature is slightly lower and equals 260°C and the most of it takes place between 280-310°C. This difference could be due to higher amount of fat and protein in the starch of Krab variety. These compounds may form starch complexes which are more resistant to thermal decomposition than pure starch [4,5].

Fig. 4. Differential thermograms of grasspea starch isolated from Krab and Derek varieties



The amount of amylose in the studied samples was 35.2 (Derek) and 35.8% (Krab). Similar numbers were reported by Akalu et al.[1] -34% and Chavan et al. [3] -36%. Potato starch contains about 20% of amylose, cereal starches up to 30% [8]. The starches with higher content of amylose form pastes with lower viscosity. Moreover the helical chains of amylose can form inclusion complexes. This can suggest a potential use of grasspea starch in microencapsulation.

The level of fat present in starch of Krab and Derek varieties was 0.105% and 0.063% respectively. Chavan et al. [3] reported 0.12-0.5% fat in the starch samples examined by them. Krab variety was in this aspect comparable to foreign ones. It should be observed that large seed grasspea variety had almost 2 times more fat in starch than the small seed one. The similar tendency, however not in such extent, was found for protein amount. Starch isolated from Krab variety contained 0.47% and Derek 0.31% of this component. These numbers are higher than those reported by Chavan et al. [3] for starch isolated from Canadian grasspea varieties which usually contained 0.20-0.25% of protein. The amount of protein could be however influenced by the enzyme used in starch isolation.

Phosphorus amount in grasspea starch was found to be low and equalled 19.6 mg/100 g of dry mass for Krab and 17 mg /100 g of dry mass for Derek.

Table 2 contains the data about solubility and water binding capacity of the studied starch samples.

The lowest values of both indices were found at 30 and 70°C. The further increase of temperature caused almost 3 times better dissolving and 4 times higher water binding. Both these features, regardless of temperature, are almost equal for the studied samples. No previous reports on this characteristics were found for grasspea starch, however Schoch and Maywald [15] examining other Leguminosae starches stated that the increase of water binding and solubility could be observed beyond 80°C. These properties depend on variety, granule size, molecular weight of amylopectin and content of amylose, which stabilises the inner granule structure, reducing its swelling capacity [1, 16, 12].

Table 2. Solubility and water binding capacity of starch from Krab and Derek grasspea varieties

Variety	Solubility of starch depending on temperature [%]			
	30°C	70°C	85°C	90°C
Derek	1.93	7.62	20.32	24.12
Krab	2.00	8.24	20.71	24.18
	Water binding capacity [g of water/1g dry basis of starch]			
	30°C	70°C	85°>C	90°C
Derek	1.10	4.66	11.39	15.71
Krab	1.16	4.72	11.45	15.84

Pasting characteristics is summarised in Table 3.

Both starch solutions start to gelatinise at 72°C and the maximum viscosity is reached at 96°C. After incubation at this temperature, the viscosity slightly drops down, which is connected to previously described phenomenon of granule disintegration [1]. The reduction of viscosity after 20 min. of incubation at 96°C was however minor (0.9% for Krab and 1.6% for Derek as compared to maximum viscosity), which proves high stability of the pastes. During cooling the pastes, viscosity increases slightly (8.4-17.2 a.u.). At each point of pasting characteristics viscosity of starch from Krab variety is a little bit higher. This could be due to higher amount of fat and protein. Similar effects were found before for triticale starch [12], where fat and protein removal caused a decrease of viscosity, accompanied by decrease of pasting temperature and the increase of solubility which however were not observed in the present study.

Table 3. Pasting characteristics of 8.5% suspensions of grasspea starch isolated from Krab and Derek varieties

	Krab	Derek
Pasting temp. [°C]	72	72
Max. Viscosity [a.u.]	112.6	100.8
Temp. of max. Viscosity [°C]	96	96
Viscosity at 96°C [a.u.]	112	96.4
Viscosity after 20 min at 96°C [a.u.]	111.6	99.2

Viscosity at 50°C [a.u.]	117	114.2
Viscosity after 10 min. at 50°C [a.u.]	120	116.4

CONCLUSIONS

Polish grasspea varieties contain approximately 48% of starch. Its granules are round or oval, and their dimensions range from 12.5 to 43.4 micrometers (90% of granules). Amylose amount is about 35%. The obtained pastes are quite stable. Physico-chemical properties of starch from Polish large seed grasspea variety-Krab and small seed variety-Derek are similar to the previously reported for foreign varieties.

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