Influence of Germination on the Carbohydrate Composition of Pea

PAVEL KADLEC[1], ALEXANDRA RUBECOVÁ[1], ZUZANA RÉBLOVÁ[2], HELENA ŠTARHOVÁ[1] and ZDENĚK BUBNÍK[1]

Institute of Chemical Technology – [1]Department of Carbohydrate Chemistry and Technology, [2]Department of Food Chemistry and Analysis, Prague, Czech Republic

Abstract

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Influence of germination on the carbohydrate composition of pea seeds was studied. After 4 days of germination the content of raffinose family oligosaccharides (RFO) in pea decreased to 17.5% of the original value and the ratio sucrose/RFO in cotyledons increased from 0.5 to 4.5.

Key words: pea seeds; germination; carbohydrates

The problem of high content of galactooligosaccharides and other antinutritional factors in legumes is one of the limiting factors for further increasing of legume consumption in human and animal nutrition. These saccharides consist respectively of one, two, three and four galactose units bound together and to sucrose in α-D-1,6-linkages. Owing to the absence of an enzyme (α-galactosidase) capable of hydrolyzing the α-1,6-galactosidic linkage, these oligosaccharides accumulate in the small intestine and undergo anaerobic fermentation with bacteria to volatile fatty acids and to production of flatus gases – hydrogen, methane and carbon dioxide. Fiber polysaccharides and indigestible starch have also been associated with flatulence. All these factors may produce diarrhea, flatus gas and their attendant discomfort.

Germination process is a way of processing how to reduce a large amount of galactooligosaccharides (raffinose family oligosaccharides – RFO). Evaluation of the effect of germination on the composition of various grain legumes, chiefly lentils and lupin seeds, is shown in some papers (CUADRA *et al.* 1994; GÓRECKI *et al.* 1997; MUZQUIZ *et al.* 1992; VIDAL-VALVERDE & FRIAS 1992; VIDAL-VALVERDE *et al.* 1992). The main objective of this work was to determine the pattern of soluble carbohydrates during germination of pea seeds.

MATERIAL AND METHODS

Plant Material: Samples of pea (*Pisum sativum* ssp. *sativum* L.), five cultivars (Grana, Merkur, Lantra, Primus, Profi), each cultivar from three breeding farms in the Czech Republic (Čáslav, Jaroměřice nad Rokytnou, Žatec), harvest 1997. Samples of pea were supplied by Central Institute for Supervising and Testing in Agriculture in Brno.

Germination Tests: Seeds were incubated in plates on moist filter paper at 20°C. Paper was moistened with distilled water, pH 7.0. Times of germination were 24, 48, 72 and 96 hs.

Determination of Dry Matter Content: Dry matter content [%] was determined after drying at 100°C to constant weight on HA 300 Moisture Balance (Precisa, Switzerland), reproducibility 0.02%.

Extraction and Assay of Soluble Carbohydrates: Approximately 2 g of ground sample was homogenised in 20 ml of ethanol : water (80 : 20, v/v), refluxed (boiled) for 60 min. After boiling the extract was diluted by demineralized water, filtered through a membrane filter 0.45 μm pore size and analysed by HPLC.

HPLC Determination: The identification and quantification of monosaccharides (glucose, fructose and galactose), sucrose and α-galactosides (RFO – raffinose, stachyose and verbascose) contents were carried out using HPLC chromatography as described by KVASNIČKA *et al.* (1996). Detection limits for individual saccharides were the following (in mg/100 ml): glucose 1.39, fructose 1.79, galactose 1.39, sucrose 0.60, raffinose 0.79, stachyose 0.78.

RESULTS AND DISCUSSION

Changes of soluble carbohydrates – monosaccharides, sucrose, RFO and total carbohydrates – during germination of pea are shown in Figs 1–5 always for the same

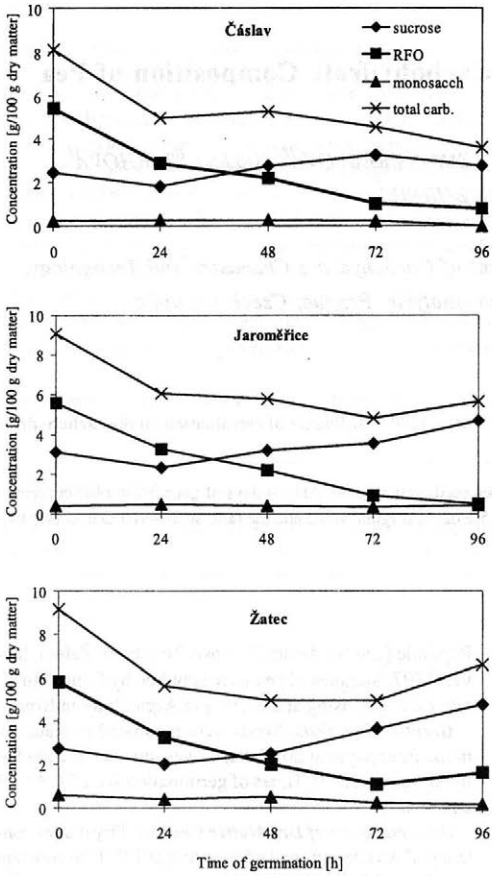

Fig. 1. Changes of soluble carbohydrates during germination of pea – cultivar Grana

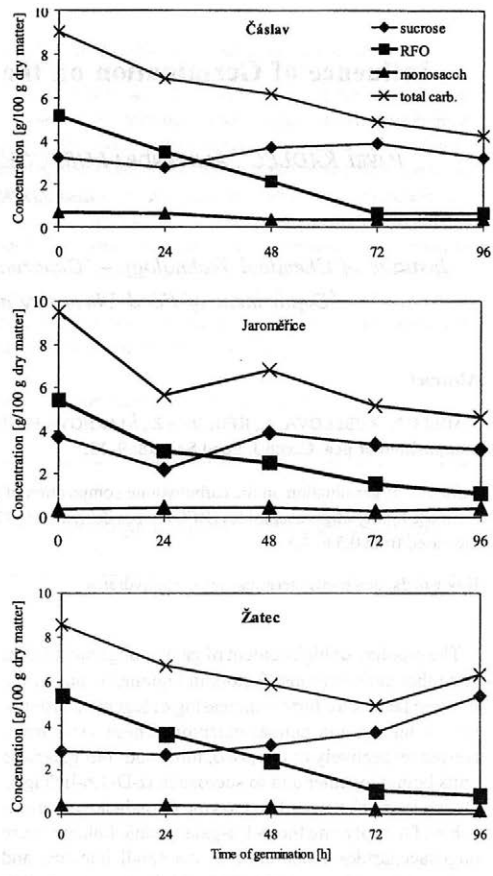

Fig. 2. Changes of soluble carbohydrates during germination of pea – cultivar Lantra

cultivar from three breeding farms (Čáslav, Jaroměřice, Žatec). The course of these changes is similar for all cultivars. The most important and the most useful change is confirmation of the significant decrease of RFO during the first three days of germination. Changes of RFO between 72 and 96 hrs of germination are minimal, only for cultivar Merkur from Čáslav and Žatec (Fig. 3) and all cultivars Primus (Fig. 4) the content of RFO after 96 h is a little higher than after 72 h. From this point of view, three days of germination are quite a sufficient time to decrease RFO. The content of monosaccharides is very low and changes of monosaccharides during germination are not significant for all cultivars. A general course of changes in sucrose content is the following: a decrease occurs, after 24 h germination followed by a regular increase up to 96 h. Only cultivars Lantra – Jaroměřice (Fig. 2) and Profi – Jaroměřice (Fig. 5) have the highest content of sucrose already after 48 h of germination and further prolongation corresponds to a negligible decrease in sucrose; Grana – Čáslav (Fig. 1), Lantra – Čáslav (Fig. 2) and Profi – Čáslav (Fig. 5) have the highest content of sucrose after 72 h of germination. Total content of soluble carbohydrates (sum of monosaccharides, sucrose and RFO) during germination of pea is decreasing. The lowest content of total carbohydrates after 72 h of germination was observed for the following cultivars: Grana – Žatec and Jaroměřice (Fig. 1), Lantra – Žatec (Fig. 2), Merkur – Čáslav and Žatec (Fig. 3), all cultivars Primus (Fig. 4) and Profi – Žatec (Fig. 5). It is caused by a regular increase in sucrose content after 72 h and 96 h.

In Table 1 are summarized the average values of soluble carbohydrates in pea during germination, calculated from all analysed 15 cultivars. The composition of single α-galactooligosaccharides in the group of RFO – raffinose, stachyose and verbascose – is demonstrated in Fig. 6. It is evident from this figure that all these α-galactooligosac-

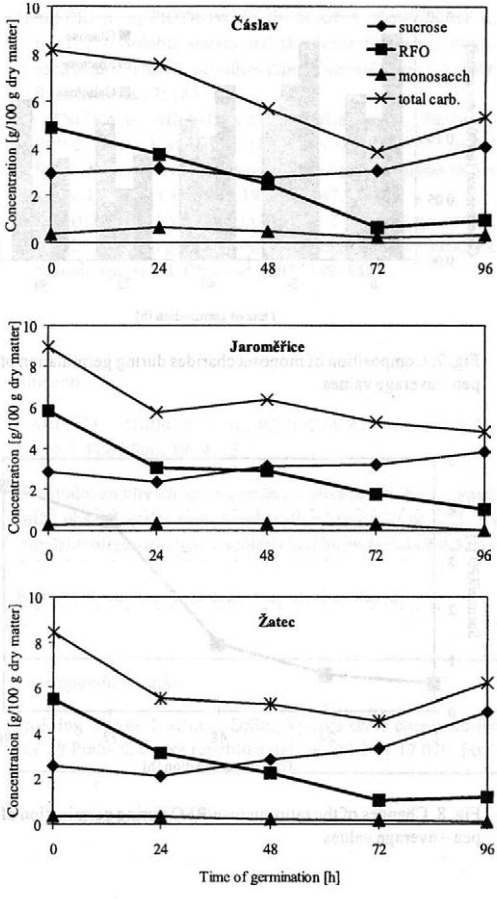

Fig. 3. Changes of soluble carbohydrates during germination of pea – cultivar Merkur

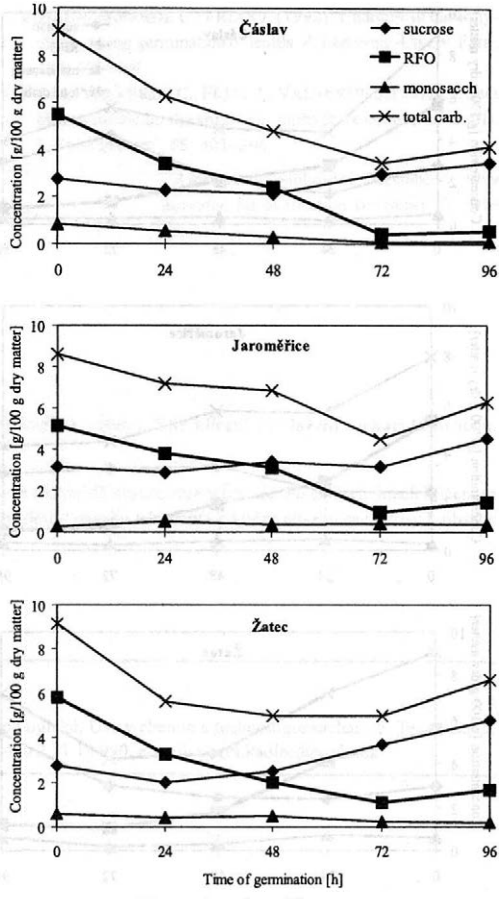

Fig. 4. Changes of soluble carbohydrates during germination of pea – cultivar Primus

charides already significantly decrease after 72 h. After 96 h germination only stachyose and verbascose were present, raffinose was no more determined. Composition of single monosaccharides – glucose, fructose and galactose – is shown in Fig. 7. The content of glucose and fructose regularly decreases after 24, 48 and 72 hrs. As for galactose, its content is not changed during germination.

For evaluation of required changes in the composition of carbohydrates the ratio between sucrose content and RFO content is a very objective value. This ratio was changed

Table 1. Composition of soluble carbohydrates (g/100 g dry matter) in pea during germination

Time of germination [h]	Dry matter [%]	Monosaccharides [g/100 g d.m.]	Sucrose [g/100 g d.m.]	RFO [g/100 g d.m.]	Decrease of RFO [%]
0	97.1	0.43	2.89	5.44	0.00
24	80.2	0.44	2.30	3.29	39.27
48	74.3	0.36	2.90	2.21	59.21
72	72.3	0.25	3.39	1.00	81.78
96	63.0	0.27	4.02	0.95	82.51

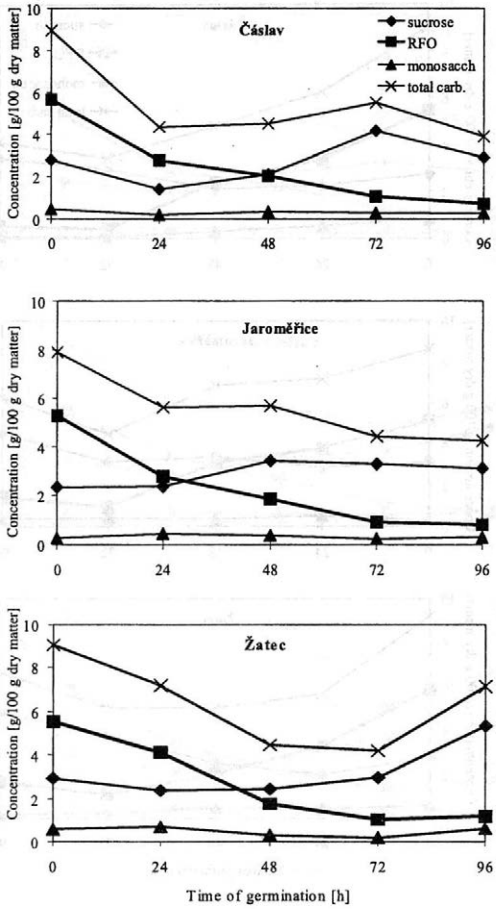

Fig. 5. Changes of soluble carbohydrates during germination of pea – cultivar Profi

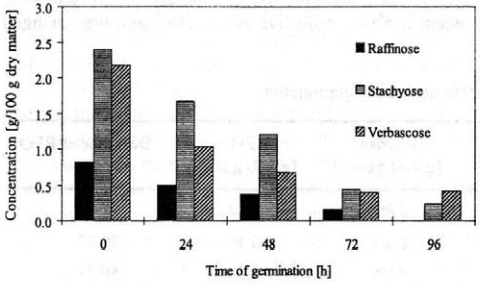

Fig. 6. Composition of RFO during germination of pea – average values

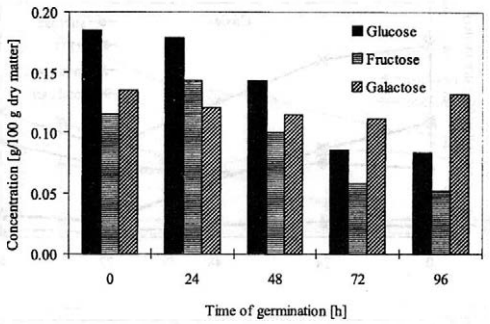

Fig. 7. Composition of monosaccharides during germination of pea – average values

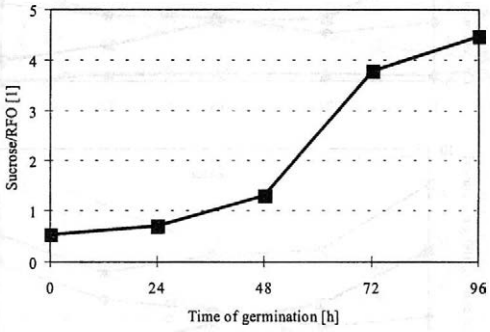

Fig. 8. Changes of the ratio sucrose/RFO during germination of pea – average values

from 0.5 to 4.5, changes of average values of this ratio in dependence on time of germination are shown in Fig. 8.

Conclusions

In agreement with papers concerning the effect of germination on the composition of various grain legumes, our results show that germination treatment decreases the content of RFO in pea to 17.5% of the original value and the ratio sucrose/RFO increases from 0.5 to 4.5. Three days of germination can be recommended to decrease a high content of α-galactooligosaccharides at both domestic and industrial scales to prepare good quality pea meal or fresh salads for human consumption.

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Souhrn

KADLEC P., RUBECOVÁ A., RÉBLOVÁ Z., ŠTARHOVÁ H., BUBNÍK Z. (2000): **Vliv klíčení na složení sacharidů hrachu**. Czech J. Food Sci., **18**: 9–13.

Byl studován vliv klíčení na změny v obsahu a složení rozpustných sacharidů obsažených v hrachu. Po čtyřech dnech klíčení se snížil obsah α-galaktooligosacharidů v hrachu až na 17,5 % původního obsahu a hodnota poměru obsahu sacharosy k obsahu α-galaktooligosacharidů v semenu hrachu se zvýšila z 0,5 na 4,5.

Klíčová slova: hrách; klíčení; rozpustné sacharidy

Corresponding author:

Prof. Ing. PAVEL KADLEC, DrSc., Vysoká škola chemicko-technologická, Ústav chemie a technologie sacharidů, Technická 5, 166 28 Praha 6, Česká republika, tel.: + 420 2 31 17 070, fax: + 420 2 31 19 990, e-mail: pavel.kadlec@vscht.cz