Nutritional Changes of Common Oat (*Avena sativa* L.) and Naked Oat (*Avena nuda* L.) during Germination

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Abstract: Changes of basic nutrients (dry matter, ash, proteins, dietary fibre, fat, amino acids), vitamins (B_1, B_2, niacin, pantothenic acid, B_6, C, E and carotenoids), minerals and some trace elements (K, Ca, Mg, P, Zn, Fe, Cu and Mn) during germination of common oat (species Auron) and naked oat (species Abel) were followed. Absorption of water caused decrease of dry matter. Content of protein in dry matter increased due the storage starch decomposition in germinating grains. Methionine was found to be the limiting amino acid. After 8 days of germination the fat content was approximately by 7% and 40% lower and dietary fibre content by 212% and 142% higher in naked oat and common oat, respectively (in dry matter). Content of vitamin B_2, niacin, pantothenic acid, vitamin B_6, vitamin C and carotenoids increased by 429, 282, 188, 172, 447 and 478%, resp. in naked oat. The increase in common oat was even higher, but with regard to lower original levels in dry grain, naked oat represented better source of vitamins. No significant changes were found in vitamin B_1, vitamin E content showed slight decrease. Changes of minerals were more favourable in naked oat, increase of Ca, Mg, P, Zn, Fe and Cu between 23.7 and 60.7% of original value was observed. Contents of K and Mn were reduced in both tested oats.

Keywords: nutritional evaluation; germination; common oat; naked oat

INTRODUCTION

The practice of germination is traditionally widely used to improve the nutritional value of grains. Germinated legumes and cereal grains have been investigated for many years [1]. In comparison to the seeds, sprouts were recognized to have a better quality of protein, a higher content of polyunsaturated fatty acids, an increased bioavailability of essential minerals and a higher content of vitamins and dietary fibre. A large number of negatively valued components in the seed (e.g. phytic acid, trypsin-inhibitor, hemaglutinines, saponines, bloating substances) decline with increasing time of germination [2]. Compositional changes are affected by conditions of germination such as time and temperature, the presence or absence of light during the germination, composition of soaking and rinsing water as well as postgermination handling. The changes are more pronounced in sprouts than in sprout seed residues [1].

Existing documentation revealed the cardiovascular benefit of oat consumption due to lowering LDL cholesterol levels. Number of observational and human studies indicates that oat can impact such heart disease risk factor as diabetes, obesity and hypertension [3]. The increased interest of consumers in natural sources of nutritionally important factors and extension of crop diversity lead to the production and utilization of naked oat. Naked oat is higher in essential amino acids content than wheat or barley. It has lower content of dietary fibre and higher oil content than wheat, barley or common oat. Dietary fibre of naked oat contains soluble fibre beta-glucans that are considered to be important prebiotics.

The aim of this study was the evaluation of nutritional factor changes in common oat and naked oat during grain germination. The basic food components as well as minor nutrients were determined. The analyses included determination of dry matter, ash, proteins, dietary fibre, fat,

amino acids, minerals, and fat- and water- soluble vitamins.

EXPERIMENTAL

Material. The samples of dry and germinated common oat (variety Auron) and naked oat (variety Abel) used in present study were obtained from the Research Institute of Crop Production, Prague-Ruzyně (harvest 2003). The grains were subjected to soaking and swelling in tap water for 3 hours at laboratory temperature and the germination was carried out for 8 days at the temperature 20°C, artificial lighting and without humidity regulation. During the germination the grains were washed once a day. Samples were taken after 4, 6 and 8 days of germination. The germinated grains were homogenized and analyzed.

Methods. Dry matter was determined by gravimetric method (drying to constant weight at 105°C), ash by dry ashing (520°C) and fat after acidic hydrolysis. Enzymogravimetric method according to the AOAC method was used for dietary fibre determination and Kjeldahl method for protein determination. The various methods were used for vitamin determination: HPLC method for thiamin and tocopherols, microbiological assays for niacin, pantothenic acid and vitamin B_6. Vitamin C was analyzed by titrimetric method, carotenoids by spectrophotometric method and riboflavin by lumiflavin method. The content of amino acids was determined by ion-exchange HPLC. The flame AAS was used for mineral determination except phosphorus (spectrophotometric determination).

RESULTS AND DISCUSSION

Table 1 summarizes the results of basic nutrient composition of dry grain of naked oat Abel and common oat Auron and grains germinated for 4, 6 and 8 days. Absorption of water resulted in decrease of dry matter that is more pronounced in common oat. Dietary fibre content was higher in germinated grains than in dry grains, after 8 days of germination the levels reached 312% and 242% of original content for naked oat and common oat, resp. However because of higher original content of dietary fibre, common oat represents better source of fibre. Decrease of total lipids occurred in both naked oat and common oat. The relative content of protein in dry matter of sample increased due the storage starch decomposition in germinating grains. The amino acids pattern in the samples relates to the structural changes of nitrogen substances in germinated samples. Proportion of individual proteinogenic amino acids content was with exception of aspartic acid and lysine nearly constant. The chemical score of essential amino acids was calculated as a comparison of individual amino acid content in sample protein and the content of the same amino acid in egg white protein. The chemical score decreased during germination and was lower in germinating grain in comparison with dry grains. Methionine was found to be the limiting amino acid.

Vitamin contents (mg/100 g DM) in dry grains of naked oat and common oat are summarized in Table 2. Comparison of analyzed oats showed that naked oat, because of absence of hulls, is more concentrated source of vitamins. During 8 days of germination the content of vitamin B_2, niacin, pantothenic acid, vitamin B_6, vitamin C and carotenoids increased and amounted to 529, 382, 288, 272, 547 and 578% of original content in dry grain, resp. No significant changes were found in vitamin B_1, vitamin E content showed slight decrease (Figure 1). The trends correspond to the data published for grains and legumes (1, 4,

Table 1. Nutrient composition of dry and germinated oat grains

Analyte	Naked oat Abel				Common oat Auron			
	dry grain	germination (days)			dry grain	germination (days)		
		4	6	8		4	6	8
Dry matter (g/100 g)	96.8	43.5	32.2	27.1	95.9	28.7	20.1	20.5
Ash (g/100 g DM)	1.8	2.05	1.77	2.07	3.3	3.55	2.99	2.49
Fat (g/100 g DM)	9.6	7.8	9.0	8.9	8.4	6.5	5.0	5.1
Proteins (g/100 g DM)	11.6	14.5	15.0	13.6	11.9	15.1	13.0	12.6
Dietary fibre (g/100 g DM)	8.6	13.2	22.2	26.8	14.5	19.2	29.8	35.1

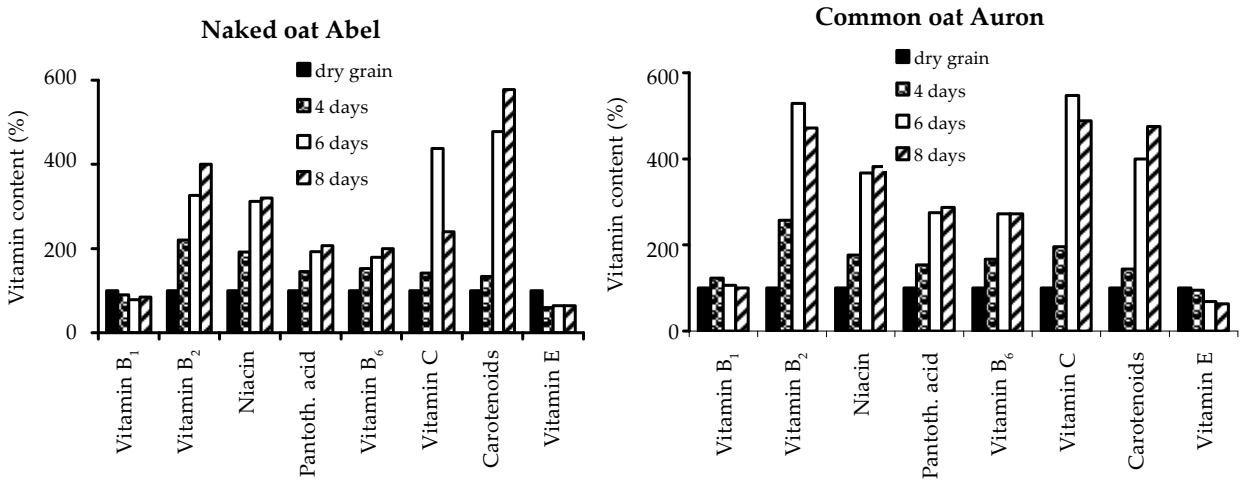

Figure 1. Vitamin changes during oat germination

Table 2. Vitamin content (mg/100 g DM) in dry grains of naked oat Abel and common oat Auron

	Viamin B_1	Vitamin B_2	Niacin	Pantoth. acid	Vitamin B_6	Vitamin C	Carotenoids	Vitamin E
Abel	0.51	0.15	1.25	0.95	0.19	0.1	0.18	1.66
Auron	0.30	0.07	0.68	0.57	0.18	0.1	0.16	1.32

5, 6). Though vitamin increase expressed in % of original content is lower during germination of naked oat, the content of vitamins in dry matter exceeded that in germinated common oat.

Cereal grains are generally excellent sources of phosphorus and potassium and fairly rich in calcium, magnesium and iron. In Table 3 mineral content of dry grains is summarized. During 8 days of germination of naked oat increase of Ca, Mg, P, Zn, Fe and Cu between 23.7 and 60.7% of original value was observed. K and Mn showed decrease of about 15% of original value. In germinated common oat only Ca, Zn and Fe content increased above original level (14.6–52.4%), in other minerals the decrease was observed (Figure 2). The final content of minerals in germinated grains is influenced by several factors such as quality of used water, time of germination and intensity of washing. The decrease of minerals might be attributed to the leaching into soaking and washing water. On the contrary the absorption of minerals from soaking water might occur. The fact that phytic acid, chelat-

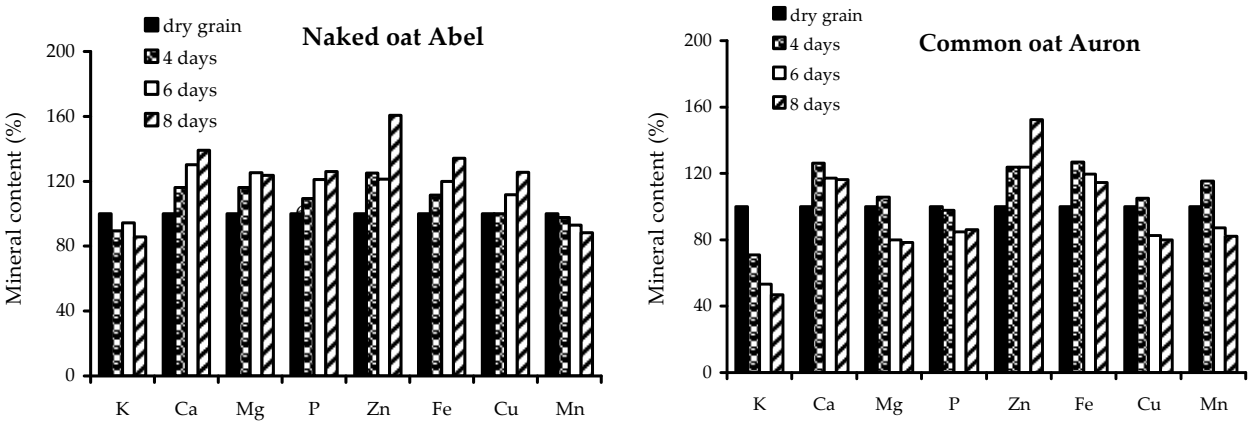

Figure 2. Mineral changes during oat germination

Table 3. Mineral content (mg/100 g DM) in dry grains of naked oat Abel and common oat Auron

	K	Ca	Mg	P	Zn	Fe	Cu	Mn
Abel	321	63	118	395	2.8	3.5	0.43	4.3
Auron	575	99	139	502	2.1	4.1	0.40	3.9

ing minerals, is hydrolyzed during germination process, contributes to the better availability of important dietary minerals (2, 7).

The results showed that during germination of both common and naked oats positive nutritional changes occur. Dietary fibre, protein, some vitamin and mineral levels are increased. Germinated naked oat with lower vitamin increase but higher original content represents better source of vitamins than germinated common oat. Mineral contents of germinated common and naked oats are comparable.

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