

## Naked oat cultivation in the Czech Republic

Jan Moudry<sup>1</sup>, Jan Moudry jr.\*<sup>1</sup>, Petr Konvalina<sup>1</sup>

<sup>1</sup>University of South Bohemia in Ceske Budejovice, Faculty of Agriculture, Studentska 13, Ceske Budejovice, 37005, Czech Republic

\*correspondence: [jmoudry@zf.jcu.cz](mailto:jmoudry@zf.jcu.cz); Presented by: [jmoudry@zf.jcu.cz](mailto:jmoudry@zf.jcu.cz)

### Abstract

The paper introduces briefly the history and current status of naked oat breeding and cultivation in the Czech Republic. The varieties of naked oat spring forms from the Czech provenance are world leaders in terms of yield and quality. Many European countries have expressed their interest in buying varieties, seed or production. Current varieties originate from an old variety called "Chinese". In Czechoslovakia during the 2nd World War, the collection of Canadian and Chinese oat varieties was built up and supplemented by a set of local landraces. In 1960, the "Krukanicky naked oat" variety was recognized, but its use was soon restricted because of the low yield. In 1988, in Krukanice, the excellent variety of naked oat "Adam" was cultivated and afterwards even better varieties such as "Abel", "Izak", "Saul" and others were cultivated. Current varieties of naked oat are characterized by a high number of grains in a panicle (42), large grains (proportion of grain over 1.8 mm sieve is 91-94 %) and relatively high Thousand-Grain Weight (27g). The average grain yield in comparative tests is 4.7 t/ha. The quality of grain is high not only because of a high content of nitrogenous substances (4.5-14.7 %) and fat in dry matter content (5.5-7.1 %), but also thanks to their composition. The share of solid glumes is only 0.3 %, and the beta glucan content is 5.0-5.8 %. These varieties are less additional-input-intensive, resistant to pathogens, and tolerate poor soil and site conditions. For these reasons, they are suitable for production systems with limited inputs (organic farming, low input systems) and environmentally sensitive areas.

### Introduction

The history of naked oat (*A. sativaspeciesnuda* L.) cultivation in Bohemia reaches back to times after the 2<sup>nd</sup> World War when the Cultivation Station in Krukanice near to Pilsen started to

cultivate this variety. The cultivation process was based on a collection of Canadian and Chinese oat varieties supplemented with a set of domestic oat landraces. In 1960, the “Krukanicky naked oat” variety cultivated from Flämingstreu x Canadian naked oat x Liberty varieties was recognized, but its use was soon restricted because of the low yield. The cultivation of naked oat intermittently continued also in nearby breeding station in Lužany. Here in 1972, the Nucleus naked oat variety was cultivated. In mid-80s, the Czechoslovakia mill-bakery industry had announced its interest in naked oat and asked year production of 10 – 20 000 tons. In 1988 an excellent variety named Adam was cultivated and in following years even better varieties – Abel, Izák, Saul, Otakar, Oliver, Kamil and the latest one named Tibor - were cultivated. The varieties cultivated in the Krukanice cultivation station (Selgen) are characterized by a good yield and quality. Naked oat has become a traditional commodity among producers and processors and now, it has been an interesting export article. Naked oat is used in food industry for oat flakes and other products (muesli sticks, bakery products, oat soups, protein isolates), but also for medical and cosmetic purposes. Oat significantly differs from other cereal plants thanks to its specific dietetic quality resulting from its chemical composition (Ahokas *et al.*, 2005, Givens *et al.*, 2004). Regular consumption of oat reduces danger of chronic diseases including cancer (Chatenoud *et al.*, 1998, Jacobs *et al.*, 1998) and heart troubles (Liu *et al.*, 1999). In the USA, oat products have become first products labeled as healthy products reducing the risk of cardiovascular diseases (Kalač, 2003).

## **Materials and Methods**

The data presented in the results are outputs from a long-term testing of the *Avena sativa spec. nuda* L. variety in the Central Institute for Supervising and Testing in Agriculture of the Czech Republic (UKZUZ), in the Cultivating Station Krukanice (SELGEN), in field experiments and in practice. The small-parcel field experiments with two to six naked oat varieties within the state experiments were started in 9 cultivation centres in three cycles under the same treatment intensity. The climate in the Czech Republic is characterized as a transiting zone between the Atlantic and Continental climate zones. The experimental stations are located in places at the elevation range from 345 to 647 m above sea level, with mean annual temperature in the range

of 6.3-8.1 °C and annual rainfall in the range of 537-738 mm. Eutric cambisol / sandy loam-medium are the prevailing soil types. The summary concerns 6 Czech naked oat varieties (Abel, Izak, Saul, Otakar, Oliver and Kamil). The work presents yield assessment results of the mentioned varieties from years 2003-2013. For the comparison of yield differences, 5 naked oat varieties and 5 husked oat varieties were chosen and the yield structure, yield parameter values of those varieties respectively, was evaluated. The quality assessment of naked and husked varieties was based on evaluation of technological and nutritional parameters of grain. At present, the experimental process has been reduced and the naked oat varieties have not already been listed in the catalogue of recommended varieties. The data in tables represent combined results from state testing and testing in the Krukanice cultivation station (SELGEN).

## Results

At present, the EU catalogue contains 25 naked oat varieties where four of them are winter type ones. In the Czech Republic to 2013, the Czech plant varieties database contained 7 varieties (Abel, Izak, Kamil, Oliver, Otakar, Saul, and Tibor) of this oat type. These varieties are described in the above mentioned EU catalogue as well.

**Table 1. Yield given by the Czech varieties related to the Izák variety (%)**

	Abel	Izák*	Saul	Otakar	Oliver	Kamil	Standard average t/ha
2003	96	100	101	-	-	-	4,33
2004	98	100	99	-	-	-	6,15
2005	94	100	103	-	-	-	4,78
2006	92	100	98	-	-	-	4,09
2007	95	100	105	-	-	-	4,03
2008	87	100	100	100	-	-	4,66
2009	89	100	90	100	105	101	4,75
2010	92	100	97	104	102	102	3,84
2011	-	100	97	103	104	103	5,62
2012	-	100	102	104	108	104	5,03
2013	-	100	98	100	101	100	5,38

\*Izák variety = standard (100 %)

Table 1 demonstrates yield growth achieved by naked oat varieties, although there are differences in single years. Oat yield predominantly depends on the grain number in a panicle,

because oat plants do produce a few fertile sprouts. The coefficient of productive sprouting is 1.1 - 1.2 in common growths. Oat plants are very apically dominant. When this dominance is reduced, we can expect increase of the sprouting coefficient, higher number of fertile stalks, stagnation of the number of grains in a panicle and Thousand-GrainWeight, panicle habitus change, higher number of spikelets in upper part of a panicle (at the expense of lower parts), decreased number of florets in spikelets, but also decrease of their reduction, decrease of the development processes variability (increased synchrony), more balanced concentration of grains in a panicle, increase of the uniformity of grains particularly in lower parts of a panicle (Moudrý, 2003a). The Number of grains in a panicle yield parameter is higher with the naked oat varieties (42.4) in comparison to the husked ones (38.2), see Table 2.

**Table 2. The comparison of yields and yield parameters of selected naked and husked oat varieties in years 2008 - 2011 (adjusted according to ÚKZUZ 2012)**

Parameter/ Variety	Atego	Raven	Scorpion	Max	Korok	Oliver*	Kamil*	Otakar*	Izak*	Saul*
No. of panicles (m <sup>2</sup> )	500	498	511	492	489	436	469	468	473	447
No. grains in a panicle (pcs)	40	39	34	40	40	47	39	42	42	42
HTZ (g)	36	36	42	37	38	27	29	27	27	27
Grain yield (t.ha <sup>-1</sup> )	6,93	6,78	7,11	7,02	7,11	4,92	4,82	4,81	4,72	4,52
*Naked oat varieties										

The difference in grain yield between the naked and husked varieties (Table 2) makes 2.23 t/ha when the naked variety yield reaches 68 % of the yield achieved with the husked varieties. As for the oat rice production, at the yield factor of 90 % for naked oat and 54 % for husked oat (average numbers from praxis over the period of 10 years), the production of oat rice (naked and peeled grains respectively), naked varieties give 0.5 t/ha (13.5 %) higher yield. In years

1999-2001, the yields of naked oat reach 74 % of the husked oat yields, but the yield of oat rice was higher by 23 % (Moudrý *et al.*, 2003b).

**Table 3. Grain quality of the Czech naked oat varieties in years 2008 - 2011(adjusted according to ÚKZUZ 2012)**

Parameter/ Variety	Oliver	Kamil	Otakar	Izak	Saul
Volume weight (kg.hl <sup>-1</sup> )	66	68	67	67	67
Solid glumes percentage (%)	0,2	0,1	0,2	0,4	0,3
Grains over 1,8 mm sieve percentage (%)	92	96	94	94	91
Nitrogenous substances content in dry matter (%)	13,7	14,2	14,0	14,3	14,3
Fibre content in dry matter (%)	2,1	1,9	2,3	2,3	2,2
Acidity number (mg KOH.g <sup>-1</sup> )	14	16	14	14	14
Fat content in dry matter (%)	5,7	7,5	7,0	7,1	5,6

The yield factor depends not only on the weight of glumes and its fixation strength to the grain and the efficiency of the peeling process, but also on the selection of suitable sieves for pre-preparation. The percentage of front grain (over the 1.8 x 22 mm sieve) is connected with grain size and the Thousand-Grain Weight number and is closely related to the yield factor. White *et al.* (1999) states, that the influence of the genotype on the oat rice (groats) yield makes 56 %. Burrows *et al.* (2001) compared the gross and net grain yield of naked and husked oat. The difference in the yield factor was lower than 0.5 % (P = 0.900). Our experiments have proved that naked oat varieties always give higher yields of oat rice (7-29 %). The Czech naked oat varieties are characterized by the Thousand-Grain Weight number of 27.4 g (new variety Tibor 29 g) and grains are bigger than peeled husked oat grains. Thus, when deciding the purchase of naked oat, it is advised to accept the share of grain over 15 x 22 mm sieve which increases

overall yield. As for husked oats, reducing the share under 1.8 x 22 mm sieve would result in an opposite effect (Moudrý 2003a).

The occurrence of husked grains, the share of fixed glumes in naked varieties respectively, is dependent on the genotype (the level of naked x husked varieties hybridization) and conditions (humidity, stand lodging). In last 15 years within the Czech variety collection, the share of naked oats with glumes has reduced from 1.0-1.9 % to 0.1-0.4 % (Table 3). When prevent husked oat grain contamination in operating conditions (purity of the seed, harvesting and product separation, etc.), it is possible to reduce grain handling (including processing of naked grains in hullers) and to reduce the risk of going rancid and bitter and to extend the storage period and to increase the seed germination.

### **Conclusion**

Oat, as the crop which is less demanding for additional inputs, resistant to the influences of site conditions and the influence of pathogens and with a number of other positive characteristics, may contribute to the sustainability of farming systems with fewer inputs and in environmentally sensitive areas. The comparison of spring naked oat varieties with hulled varieties shows that the naked varieties have better results in a number of parameters and this gives us the reason for further breeding and cultivation and increase their share in crop rotations.

### **Acknowledgments**

This work was supported by the research project No. NAZV QI111B154 of the National Agency for Agricultural Research of the Ministry of Agriculture of the Czech Republic.

### **References**

- Wight, C.P., G.R. Lazo, G. Gusmini, S.S. Miller, J. Mitchell Fetch, J-L. Jannink, N.A.Tinker (2014). Your submission to the AOWC and/or the Oat Newsletter. *International Journal of Circular References* 1:121-212.
- Ahokas, H., E. Heikkilä, M-L. Alho (2005). Variation in the ratio of oat (*Avena*) protein fractions of interest in coelic grain diets. *Genetic Resources and Crop Evolution* 52:813-819.

Burrows, V.D., S.J. Molnar, N.A. Tinkler, T. Marder, G. Butler, A. Lybaert (2001). Groat Yield of naked and covered oat. *Canadian Journal Of Plant Science* 81:727-729.

Givens, D.I., T.W. Davies, R.M. Laverick (2004): Effect of variety, nitrogen fertiliser and various agronomic factors on the nutritive value of husked and naked oats grain. *Animal feed science and technology* 113:169-181.

Chatenoud, L., A. Tavani, C. LaVecchia, D.R. Jacobs, E. Negri, F. Levi, S. Franceschi (1998). Whole grain food intake and cancer risk. *International Journal of Cancer* 77:24-28.

Jacobs, D.R., L. Marquart, J. Slavin, L.H. Kushi (1998). Whole-grain intake and cancer: an expanded review and meta-analysis. *Nutrition and Cancer* 30:85-96.

Kalač, P. (2003). *Funkční potraviny, Dona*, 130 p.

Liu, S.M., M.J. Stampfer, F.B. Hu, E. Giovannucci, E. Rimm, J.E. Manson, C.H. Hennekens, W.C. Willett (1999). Whole-grain consumption and risk of coronary heart disease: results from the Nurses' Health Study. *American Journal of Clinical Nutrition* 70:412-419.

Moudrý, J. (2003a). *Tvorba výnosu a kvality ovsa. Jihočeská univerzita v Českých Budějovicích*, 167 p.

Moudrý, J., J. Moudrý jr., Z. Štěrbá, J. Bárta (2003b). Comparison of yield and panicle productivity between hulled (*Avena sativa* L.) and naked (*A. nuda* L.) oats. *Biuletyn Instytutu Hodowli i Aklimatyzacji roślin*, 229:61-64.

White, E., A. McGarel, R. Browne (1999). What is Quality? In: *Oats Vive la différence, Second European Oats Conference Cambridge, 28-29 October 1999, Conference Proceedings*.