
Oat grain composition and its nutrition benefice.

Vita Sterna\textsuperscript{a*}, Sanita Zute\textsuperscript{b}, Linda Brunava\textsuperscript{a}

\textsuperscript{a} Department of Agro-ecological Research, State Stende Cereals Breeding Institute, „Dizzemes”, Dizstende, Libagi parish, Talsi County, Latvia
\textsuperscript{b} Department of Cereal Breeding, State Stende Cereals Breeding Institute, „Dizzemes”, Dizstende, Libagi parish, Talsi County, Latvia

Abstract

A key component of well-being and healthy lifestyle is healthy food including functional food. Oat (Avena sativa L.) is a well known annual crop in temperate climates. It is recognised as a healthy food containing significant amounts of soluble dietetic fibre, β-glucans, fat-soluble vitamin E and polyunsaturated fatty acids in the world. There are luck investigations in the protein quality and fatty acids composition, but few investigations of dietetic fibre amount and composition till now. Therefore the aim of this study was to characterise the biochemical composition of husked and naked oat varieties and breeding lines to grown in Latvian condition. In the studied samples content of protein, fat, vitamin E (α-tocopherol), same as composition of amino acids, fatty acids and dietary fibre were determined. The obtained results showed a wide range of fat content among varieties, it varied from 4.9 to 10.5 g 100 g\textsuperscript{-1}. The content of α-tocopherol in oat grain was determined 4.5 – 12.3 mg kg\textsuperscript{-1}, the sum of essential amino acids 35-45gkg\textsuperscript{-1} and unsaturated fatty acids accounted 78–81.5% of total fatty acids content. Results of evaluation leads to conclusion that oat grain are rich with biologically significant substances and their consumption in human diet is beneficial for human well-being.

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Keywords: Human health; well-being; amino acids; vitamin E; dietetic fibre;

1. Introduction

In recent years, public attention is especially paid to inhabitants health and well-being, through the consumption of wholesome food. Grains, including oats (Avena sativa L.), have been recognized functional foods, because they provide beneficial effect on the health of the consumer and decrease the risk of various diseases. The valuable

\textsuperscript{*} Vita Sterna. Tel.: +37-126093348.
\textit{E-mail address:} vitasterna@inbox.lv
physiological and nutritional attributes of oat by β-glucans and other dietary fibre components, high tocopherol and natural antioxidant level have generated an increased demand for oats in human nutrition, mentioned by Zwer (2004). Vitamin E activity is provided by the tocopherols and tocotrienols, which together create tocols. Alpha-tocopherol is a major antioxidant component in crude oat unaltered when the lipid is refined, noted Zielinski et.al., 2001. Separate fatty acids (FA) also have different impact on human health. Many studies estimate the beneficial effects of polyunsaturated (PUFA) and monounsaturated fatty acids (MUFA), reported Chillard et al. (2000) and Gebauera et.al. (2005).

A potential in improving nutrition and health is the consumption of dietary fibre. Dietary fibres were shown to contribute to the prevention of heart disease, diabetes, some forms of cancer and the improvement of both short and long-term memory functions. The World Health Organization (WHO) recommends a dietary fibre intake of at least 25g per day. The average intake is only 12-18g in the USA and 15-20g in Europe, but 40-60 g in Africa. One consequence of this imbalance in dietary fibre intake is obesity.

The discussion on oat grain dietetic value and suitability to the production of functional foods is more frequently mentioned in scientific literature by Biel et al. (2009). Oats are a major component of infant foods due to their high nutritional profile, lack of allergenicity, palatable flavour, good shelf-life, stability and low cost. Food uses for oats include oat bran, oat meal, oat flour and oat flakes which are mainly used for breakfast cereals. Porridge, hot cereals, bread, biscuits, infant food, muesli and granola bars are a few examples of food products produced from oats. Oat flour is also used as a thickener in many infant foods, noted Ranhotra (1995).

The increase of feed lots and the development of improved oat varieties for feed value will also increase the demand for oats. For further breeding of oats, there is an urgent need to increase our knowledge on variation in content of fibre and bioactive components in European oats and also on the importance of growing conditions. Old and new types need to be characterized on a broader scale. In the future most likely it will be possible to produce European oats and foods from these cereals with specific health benefits.

The aim of our investigation was to analyze the composition of high yielding hulled and naked oat varieties and perspective breeding lines grains grown in Latvia and evaluate its nutritional benefice and functional properties.

2. Materials and methods

The research was conducted at the State Stende Cereal Breeding Institute. The material consisted of 5 oat genotypes – hulled oat varieties Laima and Lizete, naked oat variety Stendes Emilija (S-156) and naked oat breeding lines 33793, 34170, were taken 3 replicates of each variety or breeding line. Mean samples from all replications (0.5 kg) were taken for testing with Infratec Analyser 1241 (test weight, protein, starch, β-glucans, and lipid content). Determination of dietary fibre composition was made by enzymatic-gravimetric method using Fibertex filtration module. The content of amino acids, fatty acids and α-tocopherol were determined using high-performance liquid-chromatography methods (Sterna et al., 2014). The sum of essential amino acids was calculated as EAA = Thr + Val + Met + Ile + Leu + Phe + His + Lys (FAO/WHO).

The statistical analysis was performed using SPSS 17. Statistical significance was declared at p < 0.05.

3. Results and discussion

The results of analyzed protein, fat, starch, total dietary fibre, β-glucans and vitamin E in husked and naked oat grains grown in different conditions are shown in Table 1.
Table 1. Biochemical composition of oat grains.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Character</th>
<th>Husked oats</th>
<th>Naked oats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min</td>
<td>Max</td>
<td></td>
</tr>
<tr>
<td>Protein content, %</td>
<td>9.70</td>
<td>17.30</td>
<td>10.58±0.67</td>
</tr>
<tr>
<td>Fat content, %</td>
<td>5.20</td>
<td>12.40</td>
<td>5.15±0.19</td>
</tr>
<tr>
<td>Starch, %</td>
<td>27.30</td>
<td>50.01</td>
<td>48.08±0.29</td>
</tr>
<tr>
<td>Vitamin-E, mg kg⁻¹</td>
<td>4.50</td>
<td>12.30</td>
<td>7.80±2.36</td>
</tr>
<tr>
<td>Total dietary fibre, g kg⁻¹</td>
<td>13.66</td>
<td>30.17</td>
<td>17.63±1.52</td>
</tr>
<tr>
<td>Soluble dietary fibre, g kg⁻¹</td>
<td>11.53</td>
<td>20.07</td>
<td>14.32±1.89</td>
</tr>
<tr>
<td>β-glucans, g kg⁻¹</td>
<td>2.70</td>
<td>3.50</td>
<td>3.15±0.19</td>
</tr>
</tbody>
</table>

The results of investigation showed that content of protein in samples of oat grains depending of varieties ranged 9.70% to 17.30%, and the richest were grains of naked oat variety Stendes Emilia (S-156). The results of our investigation are similar with other research findings, where protein content for husked oat was reported 115.0 g kg⁻¹, for naked oat it was reported as 143.4 g kg⁻¹ Biel et al. (2009). Data of other investigations show that fat content of oat varied from 4.2 to 11.8 g 100 g⁻¹ Zhou (1999). Our findings shows that protein and fat content same as amount of vitamin E, are significantly higher in naked out grains (p<0.05). The richest in α-tocopherol are grains of naked oat variety S-156. The results of our investigation are similar with other research findings, where the total levels of tococols, phenolic acids, and avenantharamides varied by over 2-fold between cultivars, but less variation occurred in total sterols and total folates Shewry et.al. (2008). Oat genotypes bred in Latvia did not show a marked difference when compared with material of foreign origin.

Limited variation was also observed in the dietary fibre content and composition of the oat varieties. Total dietary fibre content in oat grain samples varied from 13.66 g 100 g⁻¹ to 30.17 g 100 g⁻¹ and was in agreement with data from scientific literature, where fibre for oat grains reported 20.0 to 38.0 g 100 g⁻¹. High level of soluble dietary fibre was determined in our investigation. Average soluble dietary fibre content in husked oat grain samples determined 14.32g100g⁻¹ and in naked oat grain samples 17.63 g 100 g⁻¹. Higher content of soluble dietary fibre has variety ‘Lizete’. Our results was in contradiction with data reported Biel et.al. (2009), where significantly lower value of crude fibre (P ≤ 0.01) were observed in the grains of naked oats compared with the husked oat grains.

The content of β-glucans of oat grain samples ranged 2.7 g100g⁻¹ to 3.5 g100g⁻¹ and it is lower in comparison with our previous results, where average content of β-glucan for naked oat varieties determined 4.99 g100g⁻¹ and 5.07 g100g⁻¹ Brunava et.al. (2014). In the literature, β-glucan content for oat reported 2 g100g⁻¹ to 8 g100g⁻¹ of oat groats and is seemingly influenced by genetic and environmental factors, mentioned by Welch et al. (1995).

Not all proteins have the same nutritional value, protein quality strongly depends on its amino acid composition and digestibility. Composition of amino acids in husked and naked oat grains are showed in Table 2.

Table 2. Composition of amino acids in husked and naked oat grains.

<table>
<thead>
<tr>
<th>Amino acid</th>
<th>Husked oats g kg⁻¹</th>
<th>Naked oats g kg⁻¹</th>
<th>Amino acid, g kg⁻¹</th>
<th>Husked oats g kg⁻¹</th>
<th>Naked oats g kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Val</td>
<td>6.01 ± 0.08</td>
<td>6.98 ± 0.77</td>
<td>Asp</td>
<td>8.36 ± 0.27</td>
<td>10.24 ± 0.32</td>
</tr>
<tr>
<td>Ile</td>
<td>4.41 ± 0.08</td>
<td>5.10 ± 0.68</td>
<td>Ser</td>
<td>5.26 ± 0.08</td>
<td>6.41 ± 0.08</td>
</tr>
<tr>
<td>Leu</td>
<td>9.17 ± 0.11</td>
<td>10.18 ± 0.11</td>
<td>Glu</td>
<td>24.21 ± 0.86</td>
<td>29.66 ± 0.95</td>
</tr>
<tr>
<td>Lys</td>
<td>3.79 ± 0.68</td>
<td>4.92 ± 0.08</td>
<td>Pro</td>
<td>7.08 ± 0.31</td>
<td>8.17 ± 0.11</td>
</tr>
<tr>
<td>Thr</td>
<td>4.30 ± 0.11</td>
<td>4.77 ± 0.53</td>
<td>Gly</td>
<td>5.83 ± 0.47</td>
<td>6.62 ± 0.12</td>
</tr>
<tr>
<td>Phes</td>
<td>5.56 ± 0.05</td>
<td>6.50 ± 0.05</td>
<td>Ala</td>
<td>5.43 ±0.09</td>
<td>6.31 ± 0.09</td>
</tr>
<tr>
<td>Met</td>
<td>1.73 ± 0.20</td>
<td>2.20 ± 0.20</td>
<td>Tyr</td>
<td>3.61 ± 0.12</td>
<td>4.34 ± 0.31</td>
</tr>
<tr>
<td>His</td>
<td>3.68 ± 0.12</td>
<td>4.27 ± 0.24</td>
<td>Arg</td>
<td>9.78 ± 0.18</td>
<td>10.88 ± 0.68</td>
</tr>
</tbody>
</table>

EAA* 38.65 45.60
The nutritional quality of dietary protein is related to the concentration of essential amino acids in the protein. The results of investigation show that sum of essential amino acids in oat grain samples depending of varieties were determined from 31.63 g kg\(^{-1}\) to 54.90 g kg\(^{-1}\). Higher amount of essential amino acids has variety ‘33793’. Concluded that naked out grain samples has higher sum of essential amino acids than husked out 45.60 g kg\(^{-1}\) and 38.65 g kg\(^{-1}\) respectively, and it is higher than mentioned in scientific literature 30.3 g kg\(^{-1}\) Manthey et al. (1999). FAO/WHO recommended intake of total indispensable amino acids is 83.5 mg on kg of body weight per day, it is 5.8 g per human with body weight 70kg. From this point of view recommended intake could be provided with 100-110g of naked oat grain.

The amino acid content in 100 g oat protein is calculated to predict biological value or the anticipated ability of the absorbed test protein to fulfill human amino acid requirements (WHO/FAO/UNU, 2007). The results of investigation shows that amino acids composition of hulled and naked oat varieties and breeding lines is close to optimal. Just lysine and methionine (only varieties Laima and 34170) are below FAO recommended reference standard. The composition of essential amino acids of oat varieties and breeding lines and comparison with World Health Organization requirements (Reference*) are shown in Fig. 1(a). The composition of fatty acids in oat varieties and breeding lines are shown in Fig. 1(b).

Obtained results showed in Fig 1(b) leads to conclusion that content of oleic acid was determined 36.2 – 40.4% and content of linoleic acid 38.4 – 41.6%. The sum of unsaturated fatty acids accounted 78 – 81.5% of total fatty acids. Data of other investigations show that content of oleic acid in oat grain varieties determined from 37.2 to 42.1% and content of linoleic acid 38.6 – 42.5% (Saastamoinen, 1989). The sum of saturated fatty acids varied from 18.2% to 19.6% of total fatty acids, where palmitic acid determined 15.5-17.4% of all fatty acids and it was not differed among varieties (p>0.05). Saastamoinen M. et al. (1989) had determined mean content of unsaturated fatty acids about 75%, content of palmitic acid 14 - 17% for oat varieties which was close to ours. The evaluation of ratios significant for human health showed that ratio PUFA/SFA of analysed oat samples varied from 2.2 to 2.4, ratio C18:0/C16:0 varied from 0.10 to 0.15, ratio C18:1/C18:0 shoved that more healthy are husked oat samples ‘Laima’ same as naked oat samples ‘S-156’.

Oats hold many opportunities for development as foods, industrial and pharmaceutical products, which all add value to the oat crop. In nutraceutical production, components are isolated and purified from grain and sold in medicinal forms not usually associated with food products. Tailoring the nutritional and functional components of the oat grain, will support many novel and potential uses of this crop.
4. Conclusion

All varieties of oat grain are rich with biologically significant substances. Oat lipids contain unsaturated fatty acids 78-85% of total, α-tocopherol 4.5-12.3 mg/kg-1. Amino acids composition of hulled and naked oat varieties and breeding lines is close to optimal, where sum of essential amino acids of husked and naked oat grains are 45.60 g/kg-1 and 38.65 g/kg-1 respectively. Average soluble dietary fibre content in husked oat grain samples determined 14.32 g/100g-1 and in naked oat grain samples 17.63 g/100g-1 and evaluated as high.

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