INTRODUCTION

The relation between food and health has had an increasing impact on food innovation, due to the popularity of the concept of functional food. The practise of using nutrition knowledge at the food product level to improve health of the consumer forms the general concept of functional foods. Many overweight people often have a craving for sweets and find it difficult to abstain from eating high calorie products. Therefore, new sweets need to developed, which have all the health-promoting properties of foods, but with taste and look like the conventional foods that are popular and regularly consumed by the public.

Biscuits are the most popular bakery products worldwide. Biscuits are ready to eat, cheap and conventional food. Different types of biscuits contain high contents of fat, sugar and calories, but they are low in fibre, vitamins, and minerals. Thus, they do not correspond to the rules of a healthy diet. Biscuits have a longer shelf life, good taste and are accepted as snacks in all age groups. Therefore, biscuits are considered as a good product for fortification and nutritional improvement. The main ingredient generally used for biscuits is high quality wheat flour with other ingredients, such as butter, margarine, sugar, eggs, milk and some plant species.

Legumes, fruits and other cereals have been widely recognized as important sources for fortification of wheat-based traditional bakery products, such as biscuits. Improvement of the nutritional quality of wheat-based biscuits through fortification with other materials of different plants has been investigated in several studies (Preedy et al., 2011).

There are several innovative ways to produce healthy and low calories biscuits. The fortification of biscuits with different kinds of nutrients is a common trend.

Protein fortification of biscuits is of current interest, because of increasing awareness of consumers towards health. Protein-fortified biscuits contain nutrients in concentrated forms. Protein-fortified biscuits can be prepared from composite flours, such as wheat flour fortified with soy, cottonseed, peanut, corn germ flour or mustard flour. Soybean is an excellent source of protein. It contains 35–45% of all essential amino acids required for proper growth and maintenance of the body. Rice bran is rich in soluble fibre like β-glucan, pectin, and gums. Biscuits made with substitution of soy flour and rice bran up to 15% each are nutritionally more superior to that of whole wheat flour biscuit (Mishra and Chandra, 2012).

Pigeon pea (Cajanus cajan L.) grain is also a potential source of protein. Biscuits of acceptable quality can be prepared by substituting wheat flour with up to 15% pigeon pea flour or up to 10% pigeon pea by-product flour (Tiwari et al., 2011). Biscuits containing 20% defatted mustard flour were found to be nutritionally rich, but scored lower for sensory quality than biscuits prepared from 15% defatted mustard flour (Tyagi et al., 2007).

The addition of dietary fibre to standard products changes the texture, flavour and taste of final products. The incorporation of a high amount of fibre in conventional foods often causes disruption of the wheat flour starch-gluten matrix and thus negatively affects dough properties.

The most common source of dietary fibre in bakery products has been bran from various cereals. Bran of wheat, rye,
oat and rice is commonly used for the production of whole-
meal products, including cookies, breads, muffins and ex-
truded snacks (Ktenioudaki and Gallagher, 2012).

One of the less investigated plant products is Jerusalem arti-
choke (Helianthus tuberosus L.). Jerusalem artichoke (Hel-
antus tuberosus L.) tubers are known to be a health-promot-
ing source. They contain inulin instead of starch as a carbo-
yhydrate reserve. Inulin and its degraded product oligofructose are the main compounds of interest in the food
industry as functional food ingredients and low-calorie food
materials. Many scientists have discovered that inulin has a
beneficial effect on the gastro-intestinal activity stimulating
reproduction of beneficial bacteria. Jerusalem artichoke
powder made from Jerusalem artichoke roots also is a valu-
able product, rich in inulin, as well as vitamins and minerals
(Praznik and Cieslik, 2000, Praznik et al., 2002, Cieslik et
al., 2005). Powder of dried Jerusalem artichoke tubers is
more convenient to store for a longer time and easier to use
in technological processes. Jerusalem artichoke powder has
lower moisture, protein, and fat content in comparison with
high quality wheat flour, but the dietary fibre, sugars, vita-
mins, and minerals amounts are higher (Gedrovica, 2012).
Powder of whole tubers of Jerusalem artichoke with high
amounts of inulin could potentially be applied as a substi-
tute of cereal flour in biscuits.

It has been suggested that cocoa shells can be a good source
of dietary fibre, with reported values ranging from 21.3% to
45.9% of total dietary fibre as non starch polysaccharides.
They also contain high amounts of fat (6.87%) and protein
(16.93%) (Redgwell et al., 2002).

The aim of the present investigation was to evaluate the ap-
lication of Jerusalem artichoke powder and cocoa bean
shells in butter biscuit production.

MATERIALS AND METHODS

Raw materials used for butter biscuits were: dried Jerusalem
artichoke powder, cocoa bean shell powder, commercial
high quality wheat flour, sugar, fresh chicken eggs, butter,
vanilla sugar, and baking powder (Table 1).

Dried Jerusalem artichoke powder, cocoa bean shell pow-
der, high quality wheat flour and other ingredients were
used as raw materials. Part of the high quality wheat flour
was replaced by Jerusalem artichoke powder at concentra-
tions of 10%, 20%, 30%, 40% and 50% of the total flour
amount and by cocoa bean shell powder at concentrations of
2.5%, 5.0%, 7.5%, 10% of the total flour amount. Butter
biscuits were baked in an electric oven at 210 °C for 15
minutes, and cooled for 30 minutes. After cooling till room
temperature, the samples were used for further studies. As con-
trol samples, biscuits were made of high quality wheat
flour, and other ingredients required by the recipe in the
same quantities.

The determined physical-chemical parameters and methods
used for analysis are summarized in Table 2.

The colour of biscuits with Jerusalem artichoke powder and
cocoa bean shell powder was determined using a Trismulus
colorimeter Color Tec PCM/PSM (Accuracy Microsensors,
Inc.). The CIE Lab colour value included is based on L*
(lightness – darkness), a* (redness-greenness) and b*
(yellowness-blueess). Colours were measured on the sur-
face of the biscuit slice by making at least ten readings in
three replicates for each biscuit type.

Hardness of biscuit was determined using a texture analyzer
TA.XT.plus (Stable MicroSystems Ltd.). The method is
based on compression test (Pre-Test speed and Test speed
were 1 mm sec⁻¹, post-test speed was 10 mm sec⁻¹) using a
HDP/3PB Three Point Bending Rig. The TA.XT.plus tex-
ture analyzer was equipped with a load cell of 50 kg. The
results were expressed as maximum force in Newtons. In
these tests Trigger force was 0.04903 N. The outcome was
determined from approximately ten readings of tree replica-
tions for each biscuit type.

The SPSS 14.0 for Windows and Microsoft Excel for Win-
dows 7.0 software were used for statistical analysis. Mean
arithmetic value and standard deviation were calculated for
the obtained results (Field, 2005).

RESULTS

The results of nutritional analyses are presented in Table 3
and Table 4. Incorporation of Jerusalem artichoke powder
(JAP) and cocoa beans shell (CBS) considerably improved
total fibre content of biscuits. In classical butter biscuits
made of high quality wheat flour the dietary fibre content
was less than 3 g 100 g⁻¹. Replacing high quality wheat
flour with Jerusalem artichoke powder, the amount of die-

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<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td>Ingredients</td>
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<tr>
<td>Wheat flour/blend of wheat and powder</td>
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<tr>
<td>Sugar</td>
</tr>
<tr>
<td>Eggs</td>
</tr>
<tr>
<td>Butter</td>
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<td>Baking powder</td>
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<th>Table 2</th>
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<tr>
<td>No</td>
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<td>2</td>
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<td>4</td>
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tary fibre increased significantly ($P < 0.05$). Replacing wheat flour with 30% of Jerusalem artichoke powder, the dietary fibre content in 100 g of butter biscuits was 3.55 g, and therefore, these biscuits can be called a "dietary fibre source".

In biscuits in which high quality flour was replaced with Jerusalem artichoke powder, the content of inulin increased significantly ($P < 0.05$). In butter biscuits there was no significant effect on moisture content ($P > 0.05$). An increased concentration of JAP in biscuits was associated with a lower fat and protein content, compared with the control sample.

Total fibre content was higher and moisture content, lower, in biscuits with CSB. The protein and fat content of control biscuits was slightly lower compared with samples with CSB, likely due to the high content of fat and protein in cocoa beans shells (Redgwell et al., 2002).

Changes of colour intensity ($L^*a^*b^*$) in samples with JAP and CBS is demonstrated in Figures 1 and 2. The levels of colour component $L^*$ show that samples with both powders were darker than control samples. The largest significant difference in samples with Jerusalem artichoke powder was in colour component $L^*$ value. All biscuits containing the

### Table 3

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Control biscuit</th>
<th>Biscuits containing 10% of JAP</th>
<th>Biscuits containing 20% of JAP</th>
<th>Biscuits containing 30% of JAP</th>
<th>Biscuits containing 40% of JAP</th>
<th>Biscuits containing 50% of JAP</th>
</tr>
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<tbody>
<tr>
<td>Moisture, %</td>
<td>1.21</td>
<td>1.08</td>
<td>1.12</td>
<td>1.24</td>
<td>1.23</td>
<td>1.26</td>
</tr>
<tr>
<td>Fats, g 100g$^{-1}$</td>
<td>31.02</td>
<td>29.4</td>
<td>29.4</td>
<td>28.8</td>
<td>28.97</td>
<td>28.75</td>
</tr>
<tr>
<td>Proteins, g 100$^{-1}$</td>
<td>6.81</td>
<td>5.94</td>
<td>5.89</td>
<td>5.76</td>
<td>5.51</td>
<td>5.45</td>
</tr>
<tr>
<td>Total dietary fibre, g 100$^{-1}$</td>
<td>2.41</td>
<td>3.16</td>
<td>3.36</td>
<td>3.55</td>
<td>3.77</td>
<td>3.98</td>
</tr>
<tr>
<td>Inulin, g 100$^{-1}$</td>
<td>0</td>
<td>2.70</td>
<td>5.36</td>
<td>8.02</td>
<td>10.6</td>
<td>13.18</td>
</tr>
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</table>

### Table 4

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Control biscuit</th>
<th>Biscuits containing 2.5% of CBS</th>
<th>Biscuits containing 5.0% of CBS</th>
<th>Biscuits containing 7.5% of CBS</th>
<th>Biscuits containing 10% of CBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture, %</td>
<td>2.02</td>
<td>1.99</td>
<td>1.86</td>
<td>1.62</td>
<td>1.41</td>
</tr>
<tr>
<td>Fats, g 100g$^{-1}$</td>
<td>24.32</td>
<td>25.46</td>
<td>26.20</td>
<td>26.83</td>
<td>27.64</td>
</tr>
<tr>
<td>Proteins, g 100$^{-1}$</td>
<td>5.24</td>
<td>5.29</td>
<td>5.32</td>
<td>5.38</td>
<td>5.46</td>
</tr>
<tr>
<td>Total dietary fibre, g 100$^{-1}$</td>
<td>2.9</td>
<td>3.16</td>
<td>3.58</td>
<td>3.94</td>
<td>4.22</td>
</tr>
</tbody>
</table>

JAP or CBS powder gave lower $L^*$ readings, indicating darker surface colour. In general, the $L^*$ value decreased with an increase in amounts of substitute added.

Hardness of butter biscuits with JAP decreased by 25.2–39.3% (Fig. 3). The hardness of biscuits with CBS increased with increased CBS powder amount in composite flour biscuits (Fig. 4). The increase of hardness of biscuits with CBS powder is mainly due to higher proportion of protein (Gallagher et al., 2005).

### DISCUSSION

The importance of dietary fibre in the human diet is widely accepted, and over many years extensive research has been undertaken on the enrichment of food products with fibre.
JAP and CBS powder additions in biscuit formulation had considerable effects on the physical-chemical properties of biscuits. In biscuits with Jerusalem artichoke and CBS powder, the nutritional value increased due to the content of dietary fibre increased. The study found that JAP and CBS can be successfully incorporated in biscuit dough. The study confirmed that traditional high fat and high sugar biscuits, which are not associated with healthy diets by most consumers, can be modified to produce a healthy alternative.

REFERENCES


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Fig. 4. Hardness of biscuits with cocoa beans shell

Cepumu uzturvērtības paaugstināšana

Rakstā apskatīts viens no variantiem, kā paaugstināt cepumu uzturvērtību, daļu kviešu mīlītu aizvietojot ar šķiedrvielām bagātu citu augu valsts materiālu. Pētījumā kā augu valsts materiāli ir izmantots topinambūra pulvers, aizvietojot 10, 20, 30, 40, 50% mīlu, un kā kākao mīz mīlu pulvers, aizvietojot 2.5, 5.0, 7.5, 10% mīlu smilšu cepumu standarta receptūrā. Iegūtie rezultāti parādīja, ka, pievienojot topinambūra pulveri un kākao mīzu pulveri, mainās cepumu esošais tauks un olbaltumvielu saturi, kā arī cietība un krāsa, kā arī paaugstinās šķiedrvielu daudzums, salīdzinot ar kontroli. Cepumu fizikāli kārtības izmaiņas nav būtiskas un abus minētos augu materiālus var izmantot jauna tipa cepumu izgatavošanai.