

Influence of Jerusalem Artichoke Powder on the Nutritional Value of Pastry Products

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Abstract—From year to year, the incidence of different diseases is increasing in humans, and the cause is inadequate intake of dietary fibre, vitamins, and minerals. One of the possibilities to take care of your health preventively is including in the diet products with increased dietary fibre, vitamin, and mineral content. Jerusalem artichoke powder (JAP) made from Jerusalem artichoke (*Helianthus tuberosus* L) roots is a valuable product. By adding it to pastry goods, we can obtain a fibre-rich food that could be healthier and an excellent alternative to the classical pastry products of this kind. Experiments were carried out at the Faculty of Food Technology of Latvia University of Agriculture (LLU). Results of experiments showed that addition of Jerusalem artichoke powder has significant impact on all the studied pastry products nutritional value ($p < 0.05$). With increasing concentration of Jerusalem artichoke powder in pastry products increase its nutritional value and decrease energy value.

Keywords—Biscuits, cakes, Jerusalem artichoke powder, nutritional and energy value

I. INTRODUCTION

PEOPLE become more and more aware of the importance of taking care of their health by using wholesome food that results in the need for new healthy products. One of the solutions is to enrich the favourite food with biologically active substances.

An important group of foodstuffs is baked goods of wheat flour of which people are willing to choose - sponge cakes, cakes, biscuits, etc. Cakes and biscuits are the most widespread pastry products with a high-energy value. By adding fiber-rich ingredients, the food value of the product increases. Scientists in the world have carried out lots of investigations on the possibilities to enrich the pastry products of wheat flour with seeds, fruit, vegetables etc. [1]

One of less investigated plant products is Jerusalem artichoke (*Helianthus tuberosus* L). Many scientists have discovered that it has a beneficial effect on the gastro-intestinal activity stimulating reproduction of beneficial bacteria. Jerusalem artichoke is recommended to use regularly for managing normal cholesterol level, improvement of vision, prevention of stress caused sequelae, and different diseases (intestinal tumours, liver diseases, obesity) as well as to use as an effective means against atherosclerosis, gout, arthritis, kidney stones, anemia [2], [3]. By drying Jerusalem artichoke, we obtain a dry powdered product the chemical composition of which is similar to that of raw Jerusalem artichoke tubers. It contains minerals, vitamins, proteins, dietary fibre, and more than 50% (of dry matter) of inulin [4].

Partial substitution of wheat flour with dried Jerusalem artichoke powder in pastry products – cakes and biscuits – is one of the possibilities to increase the nutritional value of pastry products.

The objective of this work was to investigate properties characterizing the nutritional value of pastry products enriched with dried Jerusalem artichoke powder.

II. MATERIALS AND METHODS

A. Experimental Design

Experiments were carried out at the Department of Food Technology, Latvia University of Agriculture in 2011. The object of the research: cakes, butter biscuits, and honey biscuits were baked according to the classical recipes and technologies of these products, and part of wheat flour in them was substituted with Jerusalem artichoke powder in concentrations – 10, 30, and 50 %. As control samples, pastry products were made of high quality wheat flour, and other ingredients required by the recipe in the same quantities.

B. Chemical Analysis

The determined chemical parameters and determination methods used of pastry products are summarized in Table 1.

C. Nutritional Analysis

Values used in calculation of energy are demonstrated in Table II.

D. Statistical Analysis

The results were processed by mathematical and statistical methods. Programme SPSS 14.0 for Windows and Microsoft Excel for Windows 7.0 processed the data mathematically. Mean arithmetic value and standard deviation were calculated for the obtained results. Data were interpreted by single factor and multifactor analysis of variance (ANOVA).

III. RESULTS AND DISCUSSION

In pastry products that were prepared by replacing 10%, 30%, and 50% of high quality wheat flour with Jerusalem artichoke powder, protein and fat content significantly changed ($p < 0.05$) in comparison with the control sample. Protein content gradually decrease in all experimental pastry products with increasing concentration of Jerusalem artichoke powder (Fig.1) and this can be explained by fact that Jerusalem artichoke powder contains 2.5 times less protein than high quality wheat flour.

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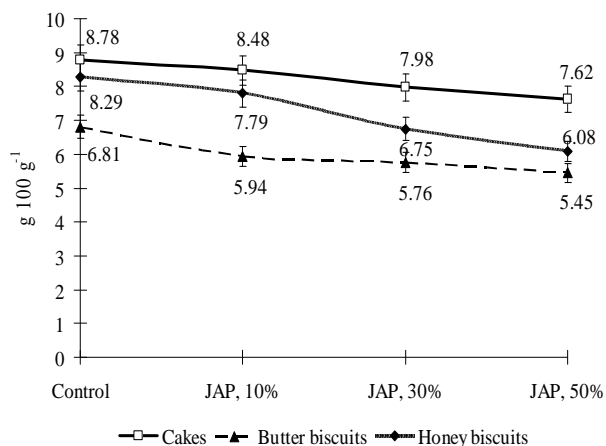


Fig. 1 Protein content in pastry products with Jerusalem artichoke powder

Fats content in pastry products with Jerusalem artichoke powder are shown in Figure 2. Decrease in fats content in all pastry products with Jerusalem artichoke powder can reduce product energy value, and it binds to the Jerusalem artichoke powder, which contain fat three times less than high quality wheat flour. In preparing of these products, the classic recipe has been altered, only the amount of wheat flour was replaced with Jerusalem artichoke powder.

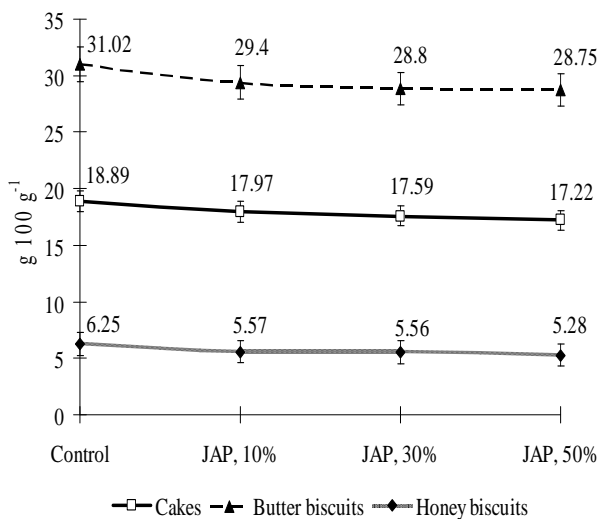


Fig. 2 Fats content in pastry products with Jerusalem artichoke powder

The recommended daily intake of inulin that people should daily take in is about 15–50 g [6], [2]. In pastry products in which high quality flour was replaced with Jerusalem artichoke powder, the content of inulin increased significantly ($p < 0.05$) (Fig. 3). More than half of the recommended daily intake of inulin is possible to take when person in their diet included 100 g of pastry products, in which are replaced 30% of high quality wheat flour with Jerusalem artichoke powder, than inulin content in cakes was 5.51 g, in butter biscuits 8.02 g, and in honey biscuits, it was 10.07 g 100 g⁻¹.

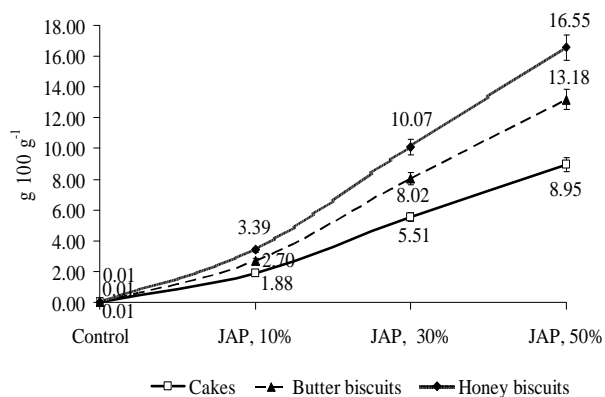


Fig. 3 Inulin content in pastry products with Jerusalem artichoke powder

The experimental results showed that in classical cakes and butter biscuits made of high quality wheat flour the dietary fibre content (except inulin) was less than 3 g 100g⁻¹, while in honey biscuits it was higher (Fig. 4). Replacing high quality wheat flour with Jerusalem artichoke powder, amount of dietary fibre increased significantly ($p < 0.05$) in pastry products. If the added amount of Jerusalem artichoke powder is 10%, total dietary fiber (excluding inulin) content of pastry products is growing by 32%. From health perspective it is desirable to use food products with high content of dietary fibres. Replacing wheat flour with 30% of Jerusalem artichoke powder, dietary fibre content in 100 g of cakes was 3.03 g, in butter biscuits – 3.55 g, but in honey biscuits – 5.14 g 100 g⁻¹; therefore, these pastry products may be called as “dietary fibre source” [7], [8]. If Jerusalem artichoke powder added in concentration 50%, the amount of total dietary fibres (excluding inulin) rises in the cakes to 3.75 g, in butter biscuits up to 3.98 g, and honey biscuits – up to 5.74 g 100 g⁻¹. Cakes and butter biscuits with 50% Jerusalem artichoke powder contains one fifth of the recommended daily intake of total dietary fibres, and honey biscuits – almost one-third.

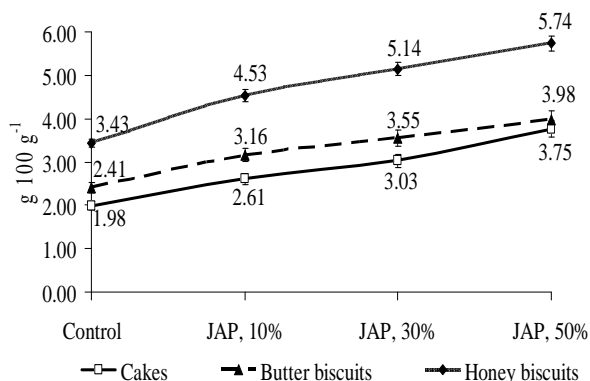


Fig. 4 Total dietary fibre content in pastry products with Jerusalem artichoke powder

By addition to recipes only one ingredient, it is possible to change the appearance of the product, sensory evaluation and nutritional value, including energy value.

In experiments investigated cakes, butter and honey biscuits are made by these pastry product classic recipes, they are only slightly modified: high quality wheat flour is partly replaced with Jerusalem artichoke powder. In results these changes have altered the product nutritional and energy value. When establishing content of protein, fats, inulin and total dietary fiber in experimental pastry products, it is possible to calculate the energy value, which is shown in Table 3.

The results show that the addition of Jerusalem artichoke powder, cakes energy value decreases. If the added amount of Jerusalem artichoke powder is 10%, the cakes energy value decreases by 4.7%, but if Jerusalem artichoke powder is 30%, then decreasing is by 5.9%, but if Jerusalem artichoke powder concentration is 50%, then a decrease is by 7.5%.

Butter biscuits energy value decreases by addition of Jerusalem artichoke powder. Reduction of energy value of butter biscuits with 10% Jerusalem artichoke powder is 3.2%, but twice as large (6.6%) – when added amount of Jerusalem artichoke powder is 30%, and energy value diminishing by adding Jerusalem artichoke powder in concentration 50%.

The results show that like other studied pastry products, energy value of honey biscuits decreases by addition of Jerusalem artichoke powder, and when its concentration is 10%, 30%, and 50% energy value reduced by 2%, 7.2% and 11.6%. Although the reduction of the energy value is not high, however improves the nutritional value of pastry products significantly: reduce fats and increase total dietary fiber content. In comparison with the control sample, cakes, butter biscuits, and honey biscuits with Jerusalem artichoke powder contain high level of inulin and other dietary fibres.

To confirm the increase in nutritional value of cake, butter and honey biscuits with 30% of Jerusalem artichoke powder were determined vitamin and mineral content that compared with control samples. Vitamin and mineral content of cakes is shown in Table 4.

The results show that the control sample of cakes containing 0.39 mg of thiamine and riboflavin 0.11 mg 100 g⁻¹, adding of Jerusalem artichoke powder increased amount of thiamine by 25.6%, and amount of riboflavin –by 54.5% in experimental cakes. In cakes with 30% Jerusalem artichoke powder increased amount of potassium (2.6 times) and magnesium (two times) most of all detected minerals in comparison with control sample. While the phosphorus and calcium increase, respectively by 47.6% and 33.3%, in comparison with the control sample. Iron content in cakes changed insignificantly by adding Jerusalem artichoke powder.

Vitamin and mineral content of butter biscuits is shown in Table 5.

Because proportion of flour in butter biscuits is 42%, the amount of added Jerusalem artichoke powder is higher in comparison with cakes, so in resulting them increases the amount of thiamine and riboflavin significantly ($p < 0.05$). The same in cakes the most increased potassium (it grew 3.2 times) and magnesium (two times) in comparison with control sample, and it should be noted that magnesium content in cakes and in butter biscuits is the same. While the phosphorus and calcium increase by 18.2% and 50.0%. Iron content of butter biscuits in contradistinction to cakes changed

significantly, and with addition of Jerusalem artichoke powder in concentration 30%, it increases 3.2 times.

Vitamin and mineral content of honey biscuits is shown in Table 6.

Among the all tree studied pastry products honey biscuits containing the most riboflavin, because proportion of flour in honey biscuits is 51%, also amount of Jerusalem artichoke powder is the highest in comparison with the cakes and butter biscuits. Amount of riboflavin in honey biscuits with 30% Jerusalem artichoke is 0.51 mg 100 g⁻¹, which is 2.2 times more than the control sample. Thiamine content of the honey biscuits is low (0.07 mg 100 g⁻¹), however it is noted that it is growing three times if is added Jerusalem artichoke powder.

By adding 30% Jerusalem artichoke powder in honey biscuits changes of minerals content was the same as in cakes and butter biscuits: increased content of potassium (3.7 times), magnesium (by 50%), calcium (double), iron (three times).

IV. CONCLUSION

The addition of dried Jerusalem artichoke powder to pastry products changes their chemical parameters, increases significantly their dietary fibre content, reduces energy value, and increases nutritional value.

In pastry products with Jerusalem artichoke powder, the nutritional value increased because the content of dietary fibre, vitamins and mineral substances increased and fat content decreased.

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TABLE I
DETERMINATION METHODS OF CAKES, BUTTER AND HONEY BISCUITS WITH
JERUSALEM ARTICHOKE POWDER

No	Indices	Method or standard used
1.	Proteins, g 100 g ⁻¹	Kjeldahl method, ASN 3108; ASN 3112; AACC 46-20; LVS EN ISO5983-1:2005
2.	Fats, g 100 g ⁻¹	Soxhlet method, AOAC 2003.06; ASN 3414
3.	Total dietary fiber, g 100 g ⁻¹	Uppsala method, AOAC 994.13, AACC 32-25
4.	Inulin, g 100 g ⁻¹	AOAC 999.03, AACC 32.32
5.	Thiamine, mg 100 ⁻¹	AOAC 986.27
6.	Riboflavin, mg 100 ⁻¹	AOAC 970.65
7.	Mg, mg 100 g ⁻¹	LVS EN ISO 6869: 2002
8.	K, mg 100 g ⁻¹	LVS EN ISO 6869: 2002
9.	P, mg 100 g ⁻¹	ISO 6491: 1998
10.	Ca, mg 100 g ⁻¹	ISO 6490/2: 1983
11.	Fe, mg 100 g ⁻¹	LVS EN ISO 6869: 2002

TABLE II
VALUES USED IN CALCULATION OF ENERGY [5]

Energy value, g-1	Coefficient, kcal	Coefficient, kJ
Proteins	4	17
Fats	9	38
Carbohydrates	4	17
Dietary fibre	0	0
Inulin [2]	1.5*	6.3*

TABLE VI
VITAMINS AND MINERAL SUBSTANCES IN HONEY BISCUITS, MG 100 G-1

Chemical indices	Control	Honey biscuits with JAP, 30%
Thiamine	0.07±0.01	0.22±0.01
Riboflavin	0.23±0.01	0.51±0.01
Mg	20.0±0.4	30.0±0.6
K	110.0±2.2	410.0±8.2
P	70.0±0.4	100.0±2.0
Ca	20.0±0.4	40.0±0.8
Fe	0.51±0.01	1.55±0.03

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TABLE IV
VITAMINS AND MINERAL IN CAKES, MG 100 G⁻¹

Chemical parameters	Control	Cake with JAP, 30%
Thiamine	0.39±0.01	0.49±0.01
Riboflavin	0.11±0.01	0.17±0.01
Mg	10.0±0.1	20.0±0.1
K	140.0±2.8	360.0±7.2
P	210.0±4.2	310.0±6.2
Ca	60.0±1.2	80.0±1.6
Fe	0.99±0.01	1.01±0.01

TABLE V
VITAMINS AND MINERAL SUBSTANCES IN BUTTER BISCUITS, MG 100 G⁻¹

Chemical parameters	Control	Butter biscuits with JAP, 30%
Thiamine	0.02±0.01	0.05±0.01
Riboflavin	0.19±0.01	0.40±0.01
Mg	10.0±0.1	20.0±0.1
K	90.0±1.8	290.0±5.8
P	110.0±2.2	160.0±3.2
Ca	20.0±0.4	30.0±0.6
Fe	0.58±0.01	1.87±0.01

TABLE III
ENERGETIC VALUE FOR PASTRY PRODUCTS WITH JERUSALEM ARTICHOKE
POWDER

Samples	Cakes		Butter biscuits		Honey biscuits	
	kcal· 100g ⁻¹	kJ· 100 g ⁻¹	kcal· 100g ⁻¹	kJ· 100 g ⁻¹	kcal· 100g ⁻¹	kJ· 100 g ⁻¹
Control	406.7	1723.5	540.6	2289.9	364.2	1546.3
JAP, 10%	387.4	1641.6	523.3	2216.4	356.9	1515.3
JAP, 30%	382.7	1621.8	504.8	2137.6	338.0	1434.5
JAP, 50%	376.0	1593.2	489.8	2073.6	321.9	1365.5