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PRODUCTION OF BISCUITS WITH INULIN AND DETERMINATION OF THEIR CHARACTERISTICS

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Abstract

Inulin is highly studied and has already been accepted as a prebiotic. Due to its recognized prebiotic properties, it is increasingly used in the development of new food products. Often different types of biscuits do not have a prebiotic effect, but by adding ingredients such as inulin, their biological value can be increased.

In order to determine the characteristics of the biscuits with inulin two types of biscuits were produced: control (regular) biscuits and biscuits prepared with inulin. The raw materials used include: integral rye flour, buckwheat flour, oat flakes, flaxseed, sucrose, salt, sodium bicarbonate, cinnamon, sesame seed, water, olive oil and inulin. The biscuits production includes the following operations: measuring raw materials, mixing the powdery raw materials, adding water and oil, stirring, resting the dough in a refrigerator for 15 min., rolling out the dough and forming the biscuits, baking (150 ^{0}C, 10 min.), cooling at room temperature and packing. The prepared biscuits were chemically analyzed: moisture (routine reference method), ash (MKC EN ISO 2171:2011), protein (MKS EN ISO 20483-1:2011), fat (MKC EN ISO 6492:2012), crude fiber (MKC EN ISO 6865:2010), nitrogen-free extract (calculated by difference) and energy value (by calculation using Atwater factors). Also, the biscuits were sensory analyzed. Sensory analysis was conducted by applying the scoring method.

The addition of inulin increased the content of moisture (11.18%), proteins (11.35%) and nitrogen-free extract in the biscuits. (58.61%), and reduced the content of ash (1.84%), fat (14.69%) and crude fiber (2.35%). Inulin biscuits had a lower energy value and a received a higher average total sensory grade (14.19) in comparison with the regular biscuits (13.55).

From the results obtained it can be concluded that adding inulin to the biscuits influences by decreasing the energy value of the biscuits and improving the sensory characteristics.

***Key words**: Biscuits, Functional food, Inulin, Characteristics.*

1. Introduction

Biscuits are favorite food widely consumed mostly due to their pleasant taste, ready to eat, accessible cost, availability and longer shelf life [1]. 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 [2]. Because of increased demand for healthy, natural and functional products, attempts are being made to improve the nutritive value of biscuits and functionality by modifying their nutritive composition. Such effects are very often achieved by increase dietary fiber content and improve prebiotic characteristics of the final product [3].

Food manufacturers can use functional ingredients such as inulin to develop new biscuits that support

healthy blood glucose levels and increases the amount of dietary fiber, helping consumers increase their fiber intake. This is a welcome added benefit as the intake of fiber is well below the recommended rates nearly everywhere in the world [4].

Inulin, a fructan-type polysaccharide, consists of (2→1) linked β-d-fructosyl residues, usually with an (1↔2) β-d-glucose end group. The applications of inulin and its hydrolyzed form oligofructose are diverse [5]. The main sources of inulin that are used in the food industry are chicory and Jerusalem artichoke [6, 7].

Inulin is a functional food ingredient which offers a unique combination of nutritional properties and important technological benefits [8, 9]. Inulin is considered as a functional food ingredient since he affected the physiological and biochemical processes in rats and human beings, beneficially influencing the lipid metabolism, which results in better health and reduction in the risk of many diseases including cardiovascular diseases [6, 10, and 11]. Many scientists have discovered that inulin has a beneficial effect on the gastro-intestinal activity stimulating reproduction of beneficial bacteria [2, 12].

Because inulin and oligofructose are classified as soluble fibers they can be used as a: means of increasing dietary fiber, reducing the glucose content in the blood [13] or to replace sugars or fats [7, 14 - 17]. Depending on the: taste, texture, and other attributes desired, different mixtures are considered for inclusion in food products. Inulin-type prebiotics are used as functional food ingredients in beverages, yogurts, biscuits, and spreads; they are also used as dietary supplements [7, 18, and 19].

Taking into account the advantages of the application of inulin in biscuits/cookies technology [9, 13, 20 - 23], the objective of this study was to producing biscuits with inulin and to investigate their quality in terms of composition and sensory evaluation.

2. Materials and Methods

In this paper an analysis of biscuits with inulin was made (BSI). The biscuits with sucrose alone (BS) are the control type of biscuits [24], while biscuits BSI are with added inulin to the basic recipe composition. The biscuits with inulin (BSI) were obtained from the following raw materials: integral rye flour, buckwheat flour, oat flakes, flaxseed, sucrose, salt, sodium bicarbonate, cinnamon, sesame seed, water, olive oil and inulin. The biscuits were prepared in a confectioner's shop "Sweet Pleasures" in Veles, Republic of Macedonia. The base formulation for the development of biscuits was received from the confectionery shop, using recipe as described by Nakov *et al.,* [25] and Stamatovska *et al.,* [24].

Biscuits were analyzed for proximate composition including: moisture (cereal and cereal products - routine reference method), ash (MKC EN ISO 2171:2011), protein (MKS EN ISO 20483-1:2011), fat (MKC EN ISO 6492:2012), and crude fibers (MKC EN ISO 6865:2010). Nitrogen free extract (NFE) was calculated by difference [26]. Food energy value (kcal/100 g) was calculated using the Atwater factor: 4 × protein, 4 × carbohydrate (the carbohydrate was determined by difference [21]), 9 × fat [27]. The analysis were performed at laboratory for food analysis of the Faculty for Agricultural Sciences and Food in Skopje, Republic of Macedonia.

The produced biscuits were sensory evaluated using the scoring method [28] by 20 assessors (staff and students of the Faculty of Technology and Technical Sciences - Veles).The procedure of scoring was based on assessment of quality attributes chosen (appearance, structure and breaking, chewability, odor, taste, and overall acceptability). Each quality level expressed with the corresponding score (1 to 5 points) was precisely defined [22]. The individual parameters were corrected by correction factor (CF), whereby weighted points (WP) were obtained, the collection of which gives the total number of points for the sensory quality of the biscuits. Depending on the total number of points it was determined in which category the biscuits belong (Table 1, [28]).

Table 1. Category of sensor quality

Quality category	Sum WP
Excellent	19.1 - 20
Very good	16.1 - 19
Good	13.1 - 16
Frail	11.1 - 13
Not match	<11.1

3. Results and Discussion

The obtained results from the analysis of control biscuits (BS) [24] and biscuits in which is added inulin (BSI) are shown graphically (Figures 1 - 7).

Inulin, like other inulin-type fructans contain a great number of hydrophilic groups, which have the ability to water retention [9]. From the results presented in Figure 1 it can be seen that by adding inulin increases the moisture in the biscuits. Namely, the biscuits with inulin (BSI) are characterized by a higher amount of moisture (11.18%) compared to the control biscuits (BS) in which inulin has not been added (10.83%). Recently, in the biscuits with fructose, Nakov *et al.,* [13], noticed that the added inulin in the biscuits it results in increasing of the moisture content from 10.49% (basic biscuits, "Fructi") to 13.22% in biscuits enriched with inulin ("Fructi + Inulin").

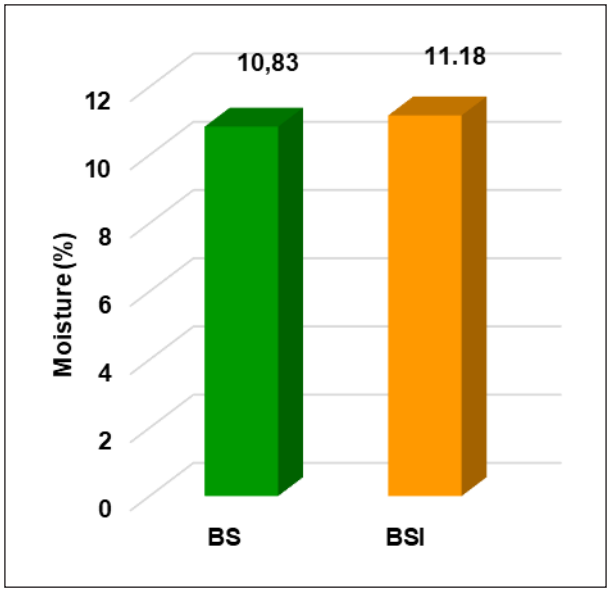

Figure 1. Moisture content of biscuits

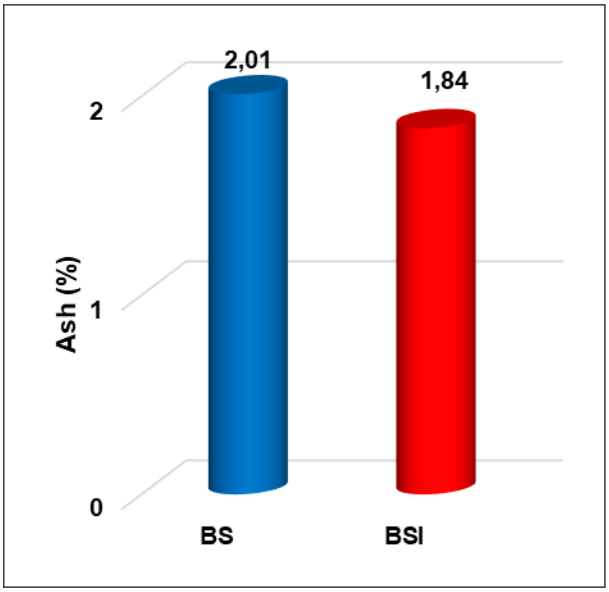

Figure 2. Ash content of biscuits

The fact that the added inulin in the flour for the biscuits/cookies leads to increase in the content of the moisture in the final product was found by other authors. Maghaydah *et al.,* [21], have received and studied gluten-free cookies with different amounts of added inulin (3%, 3.5%, 4% and 4.5%). While carrying out the chemical analysis they noticed different moisture contents, which depended on the amount of added inulin. Biscuits with the highest inulin content of (4.5%) contained the greatest amount of moisture (2.94%), whereas the biscuits with the least amount of added inulin (3%) contained the least moisture content (2.50%). A study conducted by Lourencetti *et al.,* [14], which aimed at developing formulations of cookies with partial replacement of fat by inulin, indicated that the amounts of added inulin in the biscuit it results in increasing of the moisture content. Similar results were found by Sharoba *et al.*, [11], of the gluten-free biscuits, in which inulin was added as a partial replacement of fat and sugar.

Ash is composed of inorganic matter generally present in biscuit. It includes iron, copper, potassium, sodium, and zinc [27]. Ash content in a food substance indicates inorganic remains after the organic matter has been burnt away [21]. The ash content values of two types of biscuits are given in Figure 2. The amount of ash in the control sample (BS biscuits) are higher (2.01%) compared to the amount of ash in the biscuits with inulin (BSI) (1.84%). These results are in agreement with those reported by Nakov *et al.,* [13]. The authors indicated a higher amount of ash in the biscuits "Fructi" (2.27%), compared to biscuits "Fructi + Inulin" (1.73%).

.The protein content is very important to check the quality of biscuit. It is key factor to determine the stability for different biscuit product [27]. The Figure 3 shows the results obtained for the protein content in the biscuits. From these results, it can be seen that BSI biscuits contain a higher amount of protein (11.35%) compared to BS biscuits (10.27%). The added inulin in the biscuits it results in increasing of the protein content.

Sharoba *et al.,* [11], used Jerusalem artichoke as a source of inulin in gluten-free biscuits formulation, and they found that in comparison with the control biscuits, biscuits containing inulin were characterized by the higher content of proteins and fiber, that increase with the increasing amount of inulin. Also, in the analyses by Nakov *et al.,* [13], a higher amount of protein was found in the biscuits with fructose in which inulin was added (22.32 mg/g), compared to biscuits with fructose in which inulin was not added (18.48 mg/g).

The values obtained for fat content in biscuits are given in Figure 4.

The BSI biscuits contain 14.69% fat which is less compared to BS biscuits (18.53%). The values obtained are lower than the values found by Nakov *et al.,* [13], for the content of fat in biscuits with fructose (19.48%, 23.42%). Sharoba *et al.,* [11], also investigated that the amount of fats of gluten-free biscuits decreased with added inulin in various amounts.

The biscuits with inulin also contain 2.35% crude fiber which is less compared to control sample biscuits (3.18%) (Figure 5).

The Figure 6 represents the nitrogen-free extract (NFE) contents of biscuits. According to the data shown in Figure 6, the biscuits BSI (58.61%) are distinguished by the higher nitrogen-free extract (NFE) content compared to BS biscuits (55.18%).

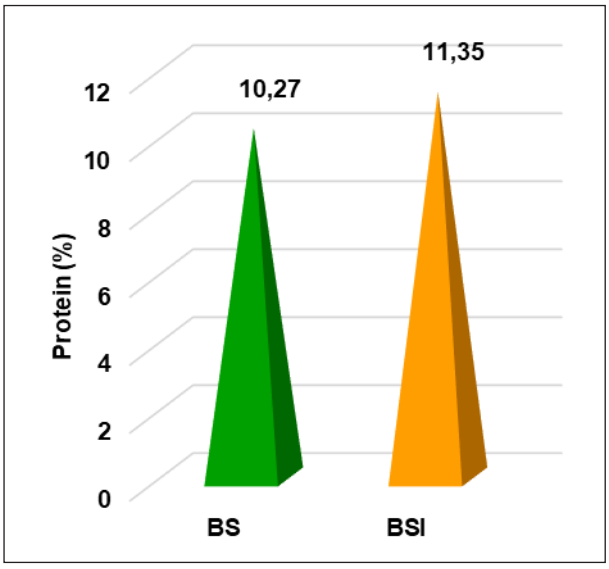

Figure 3. Protein content of biscuits

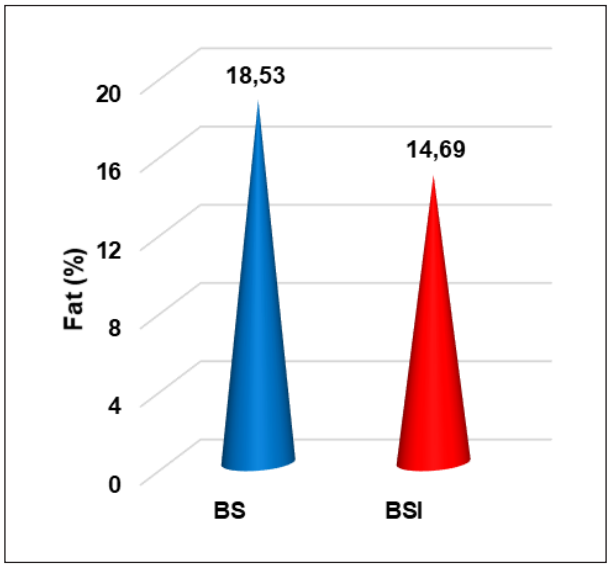

Figure 4. Fat content of biscuits

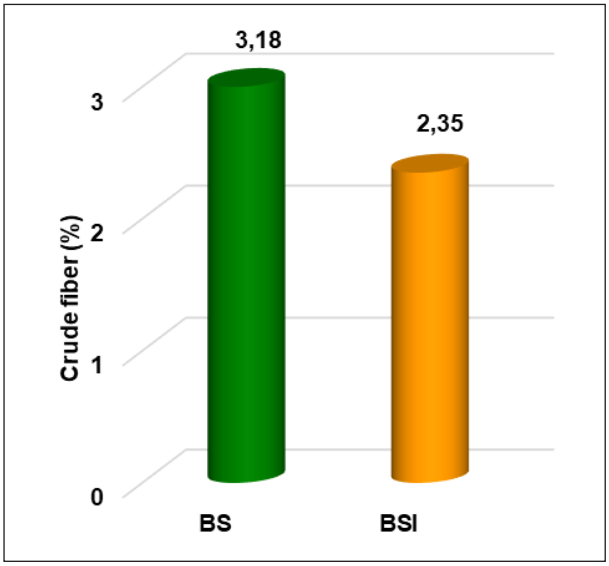

Figure 5. Crude fiber content of biscuits

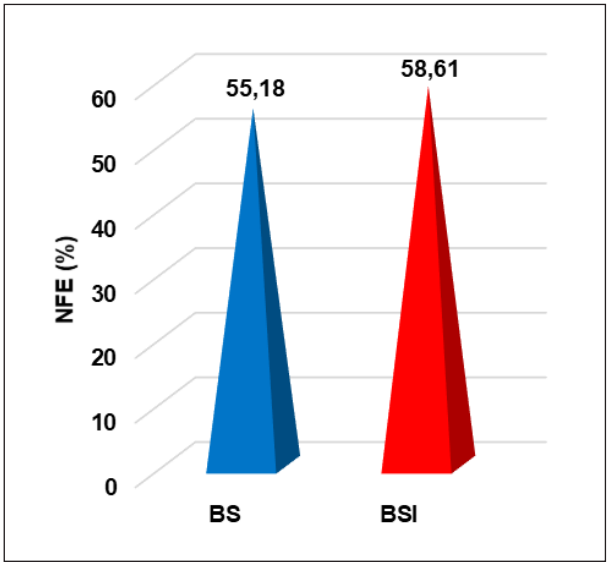

Figure 6. Nitrogen-free extract (NFE) content of biscuits

As a result of the aforementioned changes in the chemical analysis of biscuits associated with the use of the inulin, the caloric values, of biscuits produced using inulin were lower than the control (Figure 7). Adding inulin resulted in reductions from 441 Kcal/100 g (BS) to 421 Kcal/100 g (BSI).

Data on the sensory assessment of biscuits are presented in Table 2.

The higher number of points in terms of appearance (3.7) are assessed biscuits BS, and biscuits BSI are evaluated with 3.2 points. Regarding the other tested parameters: structure and breaking, odor, chewing and taste, with a higher number of points (2.45, 2.85, 2.25 и 3.44, respectively) are evaluated the biscuits in which inulin is added (BSI). According to the results from the performed calculations for total points shown in Table 2, with higher average overall score of 14.19 points are assessed biscuits with inulin (BSI).

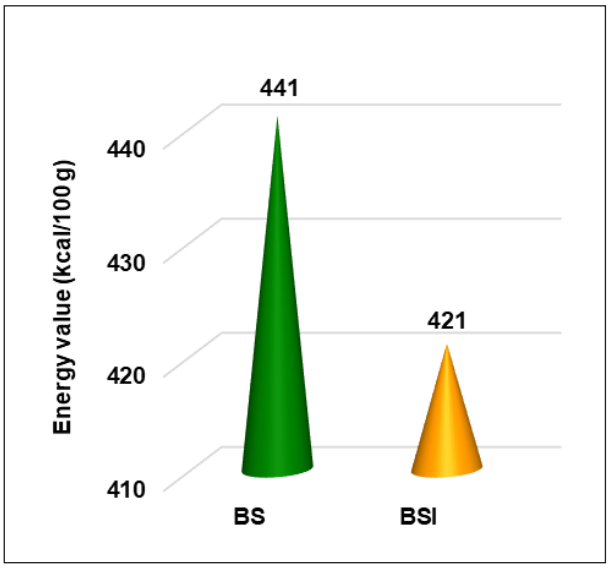

Figure 7. Energy value of biscuits

Table 2. Results of sensor analysis of biscuits

Sensory attributes / Type of biscuits (Sample code)	Appearance	Structure and breaking	Odor	Chewing	Taste	Total PB (overall acceptability)
Control biscuits (BS) [24]	3.70	2.15	2.65	1.99	3.06	13.55
Biscuits with inulin (BSI)	3.20	2.45	2.85	2.25	3.44	14.19

* Notes: The values in this table are calculated according to the average values from the results of the assessors.

Based on sensor evaluation (Table 2) is defined the category of sensor quality in which belong the obtained biscuits (Table 1). Biscuits BS (13.55 points) and BSI (14.19 points) belong to the group of products with good quality (13.1 - 16). The same was found by Nakov *et al.,* [22], in the sensory analysis of biscuits with inulin, with fructose as a sweetener.

The obtained data in tested by us biscuits (BS and BSI) differ from those reported in the literature. These differences are probably due to the different types of raw materials with different characteristics, which are used in preparing the biscuits as well as from the production technology itself [2, 11, 14, 16, and 23].

4. Conclusions

- From the data presented above we can conclude that the biscuits with inulin (BSI) are characterized by a higher amount of moisture, proteins and nitrogen-free extractive substances, and a smaller amount of ash, fat and crude fiber compared to control biscuits (BS). T

- Enriched biscuits with inulin were characterized by lower energy value and better sensory quality. On this basis, it can be concluded that inulin in the production of biscuits affects the tested parameters by reducing their energy value and improving the sensory characteristics.

- The findings of the present study may help in developing technology for utilization of inulin especially in the manufacturing of biscuits.

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