

BISCUITS WITH FLOUR OF LUCUMA, SPELT AND CAROB FOR PROPHYLACTIC AND DIETARY NUTRITION

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Abstract

The present study examines a recipe for biscuits with flour of lucuma, spelt and carob designed for prophylactic and dietary nutrition. Conducted literature research characterizes flours of lucuma, spelt and carob as expedient to be used in nutrients, designed for prophylactics and dietary nutrition. The presence of data for the conducted *in vivo* examinations gives us a reason to think that a combination of the products in a certain proportion is expedient for a product, intended for consumption from people with diabetes mellitus type 2, which is the main motivation for the present study.

Raw materials for biscuits were - whole meal spelt flour type 1750 - 356 g; lucuma flour - 356 g; carob flour - 71.2 g; and margarine "Bella" - 569.8 g. They were kneaded and shaped in round rings 6 mm thick and 17 g weight. The biscuits are baked for 8-10 minutes at 180 °C. The antioxidant activity of the ready biscuits is reported in four different by mechanism methods - methods: 2,2-diphenyl-1-picrylhydrazyl - DPPH, 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) - ABTS, fluorescence recovery after photobleaching - FRAP and cupric reducing antioxidant capacity -

CUPRAC. The quantity of soluble and insoluble dietary fiber is analyzed through BDS 11374:1986. Their microbiological indices - *Escherichia coli*, *Salmonella* spp., coagulase positive *Staphylococcus*, pathogen microorganisms, fungi, mesophilic aerobic bacteria and facultative anaerobic bacteria, are examined, according to the Bulgarian state standard. In the Department of endocrinology at multifunctional hospital for active healthcare "Caspela" Plovdiv Bulgaria, initial *in vivo* examinations are conducted and the glycemic control and the fatty profile of 15 people with diabetes mellitus type 2 with a very good control of the illness - blood sugar on empty stomach average 7.0 mmol/L and normal indices of the serum lipids. A control group from 8 healthy people is differentiated. The age range is from 43 to 81 years.

The basic physicochemical indices of the biscuits and of the powdered products of the recipe are specified. The soluble and insoluble dietary fibre content in the biscuits with flour of lucuma, spelt and carob is $16.43\% \pm 1.02$ and $3.15\% \pm 0.77$. The ready biscuits' presence of antioxidant activity is proved with the four methods used. The traced microbiological indices of the biscuits

for one month in refrigerating conditions, packed in copolymer foil designed for the food industry do not establish *Escherichia coli*, *Salmonella* spp.; coagulase positive *Staphylococcus*, pathogen microorganisms, mold, mesophyll aerobic and facultative anaerobic bacteria are below the admissible norms.

The data from the study indicates that the new product, biscuits with flour of lucuma and spelt, do not decay the glycemic control and the fatty profile of the examined people and they are with very good receptivity.

Key words: *Lucuma*, *Subtropical fruit*, *Biscuits*.

1. Introduction

Trends in healthy nutrition impose new products on the market which are unfamiliar and untypical for the region, but at the same time they are abundant in important micro- and macro- organisms which are necessary for the natural processes in the human organism.

Lucuma, known as "*Pouteria lucuma*" and "*Lucuma obovata*" is a subtropical fruit from the family of *Sapotaceae*. The exotic fruit is untypical and easily recognizable and the taste is sweet and is often compared to the taste of caramel [1]. In the last decade lucuma is successfully inculcated in the production of ice cream, juices, cakes, yoghurts, chocolates, infant's food and pies [2, 3]. Lucuma in powdered form is an excellent substituent of sugar and is used as a natural sweetener [2, 4]. Lucuma flour contains only 2 g natural fruit sugar on each 11 g of carbohydrates. Despite the fact that it is very sweet, lucuma has low glycemic index and could help for stabilizing blood sugar levels in the organism. In *Pinto et al.*, [5], publication it is described an *in vitro* examination of the exotic fruit's influence on patients with diabetes type 2 and hypertonia.

According to literature sources there is still no information of *in vitro* examinations with products containing flour of lucuma.

In a study of *Guerrero-Castillo et al.*, [6], lucuma in powder contains 57% to 87% carbohydrates, 2.3% fibre, 4% proteins, 1.1 to 2.4% fats, calcium, iron, phosphorus, magnesium. According to *Rojo et al.*, [7], the content of dietary fiber in lucuma the received flour as extremely healthy. The nutrient fibers accelerate food passage through the gastrointestinal tract, cleaning it from toxins and other unfavorable substances and protect from complicatedness in diverticulosis. Diabetics who include more fiber in their menu could lower the level of glucose. There are two types of fiber - soluble and insoluble. The soluble fiber control the cholesterol level

and the blood sugar in the organism. The insoluble fiber act as laxatives.

Spelt (*Triticum spelta*), also known in Bulgaria as dinkel wheat or hulled wheat, is a species of wheat. It was a main nutrient in parts of the near East and Europe from the Bronze age to the Middle Ages. Today it is known as healthy food because it contains a higher percent of proteins than wheat and a large content of fiber, minerals and vitamins [8]. It has almost two times more vitamin A and vitamins from the group B, fats, phosphorus and proteins. It contains gluten in large amounts but it is different from the one in the ordinary wheat, as for the proportion of gliadin/glutenin, as well as the protein matrix which is more easily absorbed from the digestive system [9].

Carob (*Ceratonia siliqua*) is an ever green plant from the family of cereals. The carob flour is an alkaline powder, an alternative of the cacao. It is made of dry, roast pods from the tree carob. It is usually used as a natural sweetener and it has sweet and unique taste. The carob flour has diverse healthy benefits, including its ability to stimulate the immune system, to prevent from cancer, to improve digestion, to lower the process of becoming older, to prevent from cardiovascular disease and diabetes. Health benefits of carob flour are mainly due to the content of vitamins and minerals, as calcium, zinc, potassium, phosphorus, vitamin K, riboflavin and vitamin E, as well as to natural antioxidants [10, 11].

The conducted literature research characterizes flours of lucuma, spelt and carob as expedient to be used in nutrients, designed for prophylactics and dietary nutrition. In the literature survey there is not data for their use in combination. The presence of data for the conducted *in vivo* examinations gives us a reason to think that a combination of the products in a certain proportion is expedient for a product, intended for consumption from people with diabetes mellitus type 2, which is the main motivation for the present study.

2. Materials and Methods

2.1 Materials

Commercial lucuma powder, produced in Peru, purchased in Bulgaria by "Internet café - BG", packed by "Zoya BG Organic Shop", and certified by ABG GmbH BG-BIO-16, was used in this study. We also used following materials: spelt flour - whole meal rye flour type 1750 ground on stone flour mill (producer: "Ecosem" from Bulgaria; Delivered by "Internet café - BG" - "Zoya bg Organic Shop"; carob flour - purchased in Bulgaria by "Internet café-BG" Ltd, packed by "Zoya bg Organic Shop", and margarine - „Bella with butter“ - purchased by the sales network.

The experiments are made with the most proper mix with different proportions of the three flours - lucuma, spelt and carob, as follow. The recipe for 1 kg of biscuits ready production is: whole meal spelt flour type 1750 - 356 g; lucuma flour - 356 g; carob flour - 71.2 g; margarine "Bella" - 569.8 g. After the kneading, the dough is shaped in round rings 6 mm thick and 17 g weight. The baking is done in laboratory furnace "Salva Modular" - Spain in temperature of 180 °C for 8 - 10 minutes until ready.

2.2 Methods

The physicochemical parameters, dietary fibers, antioxidant activity, microbiological load and *in vivo* experiment of biscuits with flour of lucuma, spelt and carob are determinate according to the following methods:

Sampling rules and test methods were according to Bulgarian state standard (BSS) 754:1980/Amendment 4:2003 [12].

Moisture content, (%) was established by express method by drying of 5 g flour for 24 h at 105 °C according to AOAC [13].

Fibre was determined according (BSS) EN ISO 11374:1986 [14].

Fat content, (%) was examined by Soxhlet method via solvent extraction with petroleum ether - (BSS) EN ISO 6997:1984 [15].

Carbohydrate were determined via (BSS) EN ISO 7169:1989 [16].

For protein determination direct Kjeldahl method analysis was used (determination of nitrogen content/nitrogen determination method) - Regulation (EC) №152/2009 [17].

The antioxidant activity was determined by four different in mechanism and passing conditions methods - DPPH, ABTS, FRAP и CUPRAC. The methods are described in detail in Wine Studies - 4th Edition of the International Conference Series on Wine Compounds [18].

2.2.1 Microbiological contamination

Following methods to prove the microbiological safety of the baked biscuits were used:

- Mesophilic aerobic and facultative anaerobic bacteria, according to (BSS) EN ISO 4833-2:2014 [19].
- Yeasts and fungi, according to (BSS) EN ISO 21527-2:2011 [20].
- *Escherichia coli*, according to (BSS) ISO 16649-2:2014 [21];
- *Salmonella* sp. bacteria, according to (BSS) EN ISO 6579:2003 [22];
- Coagulase-positive staphylococci, according to (BSS) EN ISO 6888-1:2005 [23].

3. Results and Discussion

Prepared biscuits are shown in Figure 1.

The main physicochemical indices of the powdered products in the recipe and of the ready biscuits are defined. The results are presented in Table 1.



Figure 1. Biscuits with flour of lucuma, spelt and carob

The products comprise considerably low content of proteins and fats. Minerals quantity with flour ash content and biscuits as a ready product is higher. Regardless of the low content of Carob flour, compared to the other two types of flour, its large influence on the increase of biscuits mineral content is eminent. Biscuits ash content - 3.79% is closer to carob flour ash content - 4.3% which explains the more saturated color of the end product. The reviewed carbohydrates content in the range from 64% to 82% for the examined products is high, as the fiber content is evident.

Table 1. Physicochemical indices of flour of lucuma, spelt and carob and ready product - biscuits

Sample	Parameters				
	Moisture content, %	Proteins, %	Ashes, %	Fats, %	Carbohydrates, %
Flour of lucuma	9.71	3.83	2.22	2.55	81.69
Flour of spelt	15.5	8	1.75	2	73.75
Flour of carob	4.8	9.5	4.3	0.5	80.9
Ready product - biscuits with flour mix	25.2	5.5	3.79	1.65	63.86

Analysis results for the content of soluble and insoluble fiber in the ready product are given in Table 2.

Table 2. Quantity dietary fiber in dietary biscuits with Lucuma flour

Product	Total dietary fibres	Insoluble dietary fibres	Soluble dietary fibres
Biscuits with lucuma flour	19.58 ± 0.99	16.43 ± 1.02	3.15 ± 0.77

These results prove their considerable presence which statement according to the European legislation is referable to products containing more than 3g at a 100 g for a product [24]. The received results give us a reason to consider the end product as favorable for consumption from people suffering from diabetes type 2, overweight and prophylectics.

25 mL 70% ethanol extract from 1 g of sample is received for defining the ready product's (biscuits with flour of lucuma, spelt and carob) antioxidant activity. The antioxidants presence is examined through four different in mechanism and activity methods, namely: 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,2'-azobis (3) -ethylbenzothiazoline-6 (ABTS), ferric reducing antioxidant power (FRAP), and cupric reducing antioxidant capacity (CUPRAC). It is clear from Figure 1 that the antioxidant activity of the ready products is confirmed through the four examined methods.

The microbiological contamination of the biscuits with flour of lucuma, spelt and carob is reviewed during their stay in refrigerating conditions - temperature 5 - 7 °C, packed in copolymer barrier foil designed for food industry for a period of 1 month. The ready product's microbiological condition for one-month preservation is interesting because of the high initial moisture content - 25.2% which would be a precondition for the product's microbiological damage. The results from the laboratory experiments are given in Table 3.

Table 3. Microbiological contamination and moisture content of a ready product - biscuits with flour of lucuma, spelt and carob

Sample/ Day	Total number of mesophyll aerobic and facultative anaerobic bacteria, CFU/g	<i>Escherichia coli</i> , CFU/g	<i>Staphylococcus aureus</i> , CFU/g	<i>Salmonella</i> spp./25 g	Yeast, CFU/g	Molds, CFU/g	Moisture content, %
1 day	20	< 10	< 100	Not established	< 10	< 10	25.2
20 day	50	< 10	< 100	Not established	< 10	< 10	26.1
30 day	2 x 10 ²	< 10	< 100	Not established	< 10	< 10	26.8

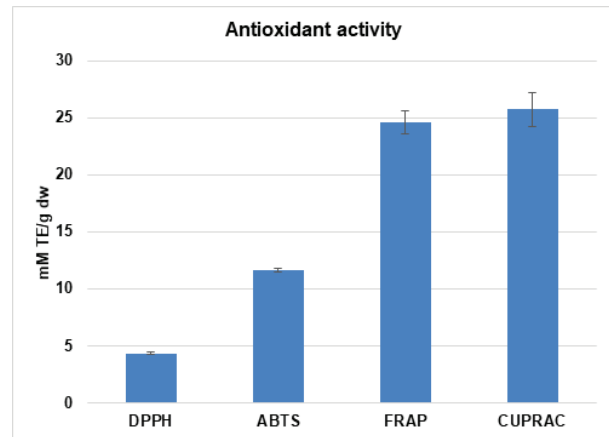


Figure 1. Antioxidant activity of a ready product - biscuits with flour of lucuma, spelt and carob

The result analysis indicates that in refrigerating conditions the moisture content remains almost unchanged, or it is rising with only 1%. There was not established presence of: *Escherichia coli*, *Salmonella* spp., coagulase positive *Staphylococcus*, pathogen microorganisms, molds, mesophyll aerobic, and facultative anaerobic bacteria. This gives us a reason to consider that the product is ready for consumption by the users in the experimental conditions we have completed.

In the department of endocrinology at Multifunctional Hospital for Active Healthcare „Caspela“ from Plovdiv - Bulgaria, initial *in vivo* examination for people with diabetes type 2 is conducted. There are included 15 diabetes sufferers with a very good control of the illness - blood sugar on empty stomach average 7.0 mmol/l and normal indices of the serum lipids. A control group from 8 healthy people is differentiated. The age rang was from 43 to 81 years. On breakfast all people consume only 4 from the tested biscuits. The following indices: blood sugar, total cholesterol, LDL-cholesterol, triglycerides are tested on empty

stomach two hours' after the consumption of the new product. A questioner card is made, including data of prescription and diabetes treatment, data from the physical examination and the patients' opinion about the subjective perception of the tested biscuits with lucuma.

In reference to the blood sugar, it is observed, in the prevailing number of the people with diabetes mellitus and in the healthy ones /controls/, an increase over the admissible level of 7.8 mmol/L on the second hour. In the diabetes group, only three patients indicate glycaemia increase to 8.5 mmol/L, as this correlates with the higher initial blood sugar (on empty stomach). The results about the serum lipids are interesting. There is not registered an abnormal level of cholesterol, LDL-cholesterol and HDL-cholesterol two-hours after the consumption of biscuits. For 4 patients with diabetes mellitus it is observed a statistically insignificant increase of the serum triglycerides to 1.9 mmol/L (upper referent level 1.7 mmol/L).

In reference to the taste receptors, all the people apprehend the tested biscuits very well.

In conclusion, the medical team, led by Assoc. Prof. Dr. PhD. Stefka Vladeva, Head of Department of Endocrinology and Metabolic Diseases at Multifunctional Hospital for Active Healthcare, „Caspela” from Plovdiv - Bulgaria, summarized that the research reported data indicate that the biscuits with flour of lucuma do not decay the glycemic control and the fat profile of people with diabetes mellitus type 2 and are perceived as very good in taste. Observation over more people and the more thorough analysis of the results, could propel the biscuits including in regular or interim breakfast to patients with diabetes type 2.

4. Conclusions

- A recipe for biscuits with flour of lucuma, spelt and carob is created for the first time. The dietary fibre content in the end product - biscuits with flour of lucuma, spelt and carob, is considerably large and it acquires the European legislation requirements.
- The ready biscuits' presence of antioxidant activity is confirmed by the four examined methods - DPPH, ABTS, FRAP и CUPRAC.
- Traced microbiological indices of the biscuits for one month in refrigerating conditions, packed in copolymer foil designed for the food industry do not contain: *Escherichia coli*, *Salmonella* spp., while coagulase positive *Staphylococcus*, pathogen microorganisms, moulds, mesophyll aerobic, and facultative anaerobic bacteria are below the admissible norms.
- The presented data from the preliminary *in vivo* research indicate that the biscuits do not decay the

glycemic control and the fatty profile of people with mellitus type 2 and are perceived as very good in taste.

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