
SUMMARY OF Ph.D. THESIS

Researches on an innovative functional sweet product with bioactive blueberries compounds

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INTRODUCTION

A food can be defined as „functional”, if it can beneficially help one or more targeted functions in the body, by improving the health and well-being or by reducing the risk of developing diseases (EL SOHAIFY, 2012; HASLER, 2002). A “functional food” is a food former from natural ingredients, unmodified, a food to which a component has been added to bring benefits, a food in which one component has been replaced with another alternative component, that has favourable properties (HOWLETT, 2008). Currently they are considered to be foods with high nutritional value, having a number of potential health benefits, including cancer chemoprevention, stimulating or increasing immunity, reducing cholesterol levels (KALAITZANDONAKES, 2000).

At the beginning of the 21st century, the focus of nutritional science was to optimize the daily diet in terms of nutrients and non-nutrients, as well as other dietary food properties that favour health maintenance (DOYON and JOANNE LABRECQUE, 2008).

The term „functional foods” was first used in 1984 in Japan (BARBARA BIGLIARDI and GALATI, 2013).

In scientific literature „nutraceuticals” are often substituted with „functional foods.” The fact that nutritional science is expanding, can be confirmed by the increasing number of existing nutritional terms. (MARTIROSYAN and JAISHREE SINGH, 2015).

Functional sugary products can be defined as: „sugary products subject to the addition, elimination or replacement of standard ingredients, with an ingredient that fulfils a specific physiological function or offers a potential health benefit” (GIPSON and CHRISTINE M. WILLIAMS, 2000).

The purpose of creating a dietary „şerbet” with natural-functional ingredients was: to bring back into consumers’ attention a sugary product that was in some way forgotten „the şerbet”, and also because there was a noticeable increase in market demand for natural products, moreover for the functional ones.

Dietary products with innovative natural-functional ingredients and low caloric content were based on isomalt, maltitol, inulin and dried blueberries. Isomalt and maltitol are polyols that can replace the sugar and glucose in the classic product, and the functional ingredients used, respectively the dried blueberries, have high antioxidants and inulin comes with natural fibre intake.

Purpose of the thesis

The purpose of the research carried out within the doctoral thesis „Researches on an innovative functional sweet product with bioactive blueberries compounds”, aims to evaluate the positive impact, obtained by replacing sugar with sweeteners having a low glycemic index and by using the favorable action of natural bioactive blueberry compounds in obtaining a functional sugary product of „Şerbet” type.

General objectives

In order to reach the thesis aim, the following objectives have been proposed and realised:

1. A study of natural extracts from blueberries and highlights of several biologically active compounds;
2. The use of isomalt, maltitol and blueberries in the development of an innovative product that has dietary properties and natural-functional ingredients;
3. Evaluation of the physical-chemical parameters of the dietary product with natural-functions;
4. Statistical methods applied in the analysis and interpretation of the obtained results.

Structure of the thesis

The present doctoral thesis, with the title: „Researches on an innovative functional sweet product with bioactive blueberries compounds” is structured in two main parts. The first part presents the bibliographic study on the chosen theme and it includes: „Motivation for choosing the research theme and the importance of consuming food with high nutritional value, the general characterization of the raw materials used and laboratory products technology based on fondant.” Part II of the thesis, „The personal contribution” includes the purpose and objectives, materials and methods, results and discussions, conclusions and recommendations, originality elements and innovative contributions of the thesis. This paper contains a total number of 53 tables and 58 figures.

Part one: **THE CURRENT STAGE OF KNOWLEDGE** is structured in three chapters.

Chapter 1. Current aspects of nutrition, which justify the choice of theme, comprises two subchapters which include the information synthesized from the bibliographic study of: the importance of consuming foods with a high nutritional value; bioactive compounds (antioxidants, respectively vitamin C, total polyphenols, total flavonoids, total anthocyanins, aroma compounds).

Chapter 2. Raw materials used - general characterization, includes six subchapters, containing information about blueberries, isomalt, maltitol, inulin, and the raw materials used in the research of this doctoral thesis, respectively sugar and glucose for the control samples (classic „şerbet”).

Chapter 3. The laboratory products technology based on fondant, with a single subchapter.

The second part of the doctoral thesis, **PERSONAL CONTRIBUTION**, comprises five chapters.

Chapter 4. Purpose and objectives of the doctoral thesis were created in order to achieve this.

Chapter 5. Materials and methods, is structured in two sub-chapters. It presents all the raw materials and the materials that were used in this experiment, as well as all the methods applied to achieve the experiment's objectives purpose. These included on one hand an adaptation of the standard technological processes for obtaining classic „şerbet” in order to acquire a dietary product with natural-functional ingredients, and on the other hand in using specific analysis methods.

Chapter 6. Results and discussions regarding the determination of biochemical compounds of interest from blueberries fruit and blueberries powder, respectively classic „şerbet” (the control samples) and dietary „şerbet” with natural-functional ingredients, as well as the statistical interpretation of the results. The chapter is structured in 8 sub-chapters, each of them having multiple sub subchapters.

Chapter 7. Conclusions and recommendations. This chapter is structured in two subchapters such as: conclusions deducted upon the interpretation of results obtained from the thesis research and recommendations drawn from conclusions as well as favourable recommendations for the future.

Chapter 8. Originality and innovative contributions of the thesis.

PERSONAL CONTRIBUTION

Materials and methods

Raw materials used to produce the product:

- **Crystalline isomalt** under the form of granules, white, odourless, with sweet taste, slightly hygroscopic (acquired from company KUK Romania);
- **Maltitol** was purchased under the form of syrup (74.9% U.S.), white-yellow, with no smell, sweet taste(acquired from company KUK Romania);
- **Inulin**, in the present study is presented in powder form, 100% pure, extracted from chicory. Physically, the inulin is colourless and odourless, having a pleasant taste, slightly sweet, with moderate water solubility depending on the temperature (acquired from pharmaceutical producer AURICA Germany);

- The **blueberries** used are part of the *Ericaceae* family, the species *Vaccinium myrtillus* L., and were harvested from spontaneous (forest) flora, between July 15th and August 15th, 2015, from the Apuseni mountains, Horea commune, Alba county. We have used dried fruit and blueberries powder to make this diet product. The blueberries were pressed, and the remaining pulp went through the drying process. The drying took place in rooms equipped with fans and dehumidifiers, in trays on a single layer, at room temperature for a maximum of 2-3 weeks.

The equipment used to obtain the dietary „șerbet” with natural-functional ingredients were:

- specific equipment for obtaining fondant, such as the fondant machine in which the syrup was cooled down and beaten;
- laboratory tools: stainless steel vessels for boiling raw materials (isomalt, maltitol), that had the syrup as a result;
- Krüss refractometer, used to determine the syrup concentration;
- Baine-Marie pots for tempering the fondant;
- stainless steel vessels and spatulas for the process of incorporation and homogenization of the blueberries whole/powder; glass vessels for dosing and packaging the finished product.

Methods

In order to reach the thesis objectives, the methods applied intended on one hand, to adapt the classical technological process of making „șerbet” into obtaining a dietary product with natural-functional ingredients, that had the following main steps:

- ♦ preparation of raw and auxiliary materials;
- ♦ syrup preparation;
- ♦ obtaining the fondant, by cooling and beating the syrup;
- ♦ incorporation and homogenization of blueberries in the composition of dietary „șerbet”;
- ♦ dosing in the package.

On the other hand, specific methods of analysis were used: UV/Vis Spectrophotometry, High performance liquid chromatography (HPLC), Gas chromatography coupled with mass spectrometry (GC-MS), Brookfield CT 3 texturometer.

The research conducted within the thesis was carried out in:

- ♦ The Pilot Station for Sugar Products, in the Food Products Engineering department (IPA);
- ♦ The Spectrometry Laboratory from the Agro-Food Metabolomics Laboratory of the Institute of Life Sciences (ISV);

- ◆ The HPLC determinations laboratory from the Agro-Food Metabolomics Laboratory of the Institute of Life Sciences;
- ◆ Food Quality and Safety Testing Laboratory (LICSA);
- ◆ The Rheology Laboratory of the Food Products Engineering department;
- ◆ Microbiology Laboratory in the Department of Food Products Engineering.

Conclusions and recommendations

From the initial experimental protocol with 24 samples (different isomalt/maltitol proportion 70/30, 60/40, 50/50), following the analysis of the technological parameters, the sensory analysis and the rheological analysis, we opted for the V2 version (isomalt/maltitol proportion 60/40), to which we applied different proportions of blueberries (5%; 10%; 15%) and inulin (2%). Therefore, it resulted an experimental study scheme with 12 versions (six versions for the control samples and six versions of the dietary „șerbet” with natural-functional ingredients). As a result, the initial working protocol with 24 variants was reduced to 12 variants, which they became the research subject of this thesis.

Conclusions on nutrition assessment

➤ The main objective to obtain a product with a significantly lower energy value (228.83 kcal/100g; 221.16 kcal/100g; 214.15 kcal/100g; 228.83 kcal/100g; 221.16 kcal/100g; 214.15 kcal/100g), but also with a low glycemic index (18.76 IG/100g; 18.10 IG/100g; 17.49 IG/100g; 18.76 IG/100g; 18.10 IG/100g; 17.49 IG/100g), by replacing sugar and glucose with polyols (isomalt and maltitol) was reached (figure 1).

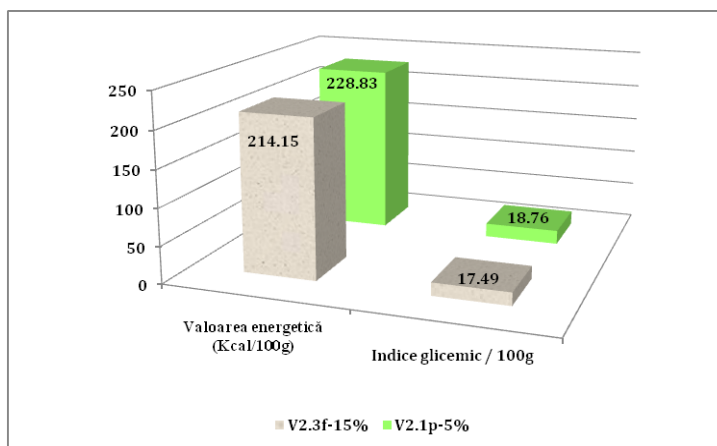


Fig. 1 Calculation of energy value, respectively calculation of glycemic index for the product variants with blueberries fruit V2.3f-15% and blueberries powder V2.1p-5%

➤ In addition to the low energy value, the product comprises bioactive compounds (vitamin C, total polyphenols, total flavonoid pigments, total anthocyanin pigments, flavour compounds) due to the presence of blueberries in the product (figure 2).

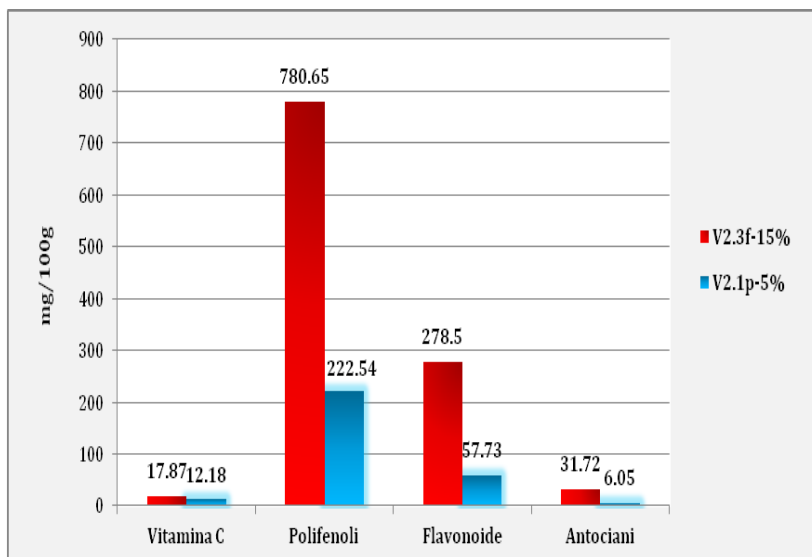


Fig. 2 Bioactive compounds content of the product variants with blueberries fruit V2.3f-15%, respectively with blueberries powder V2.1p-5%

➤ It can be noted that the fibre content has 2% inulin also from blueberries content in its composition.

➤ The product can be consumed by any person, even with a diabetic condition, in accordance with the recommended daily dose, because besides the advantages shown for polyols (low caloric energy, noncariogenic effect, chemical stability) they can produce a laxative effect.

➤ From a sensory point of view the appearance, color, homogeneity and taste, the product with blueberries powder is well appreciated.

Conclusions regarding the sensory evaluation

➤ Although from a nutritional perspective, the bioactive compounds are more significantly present in the product with dried blueberries fruit (figure 3), from a sensory point of view in terms of appearance, colour, homogeneity and taste, the product with blueberry powder is more appreciated (figure 4).

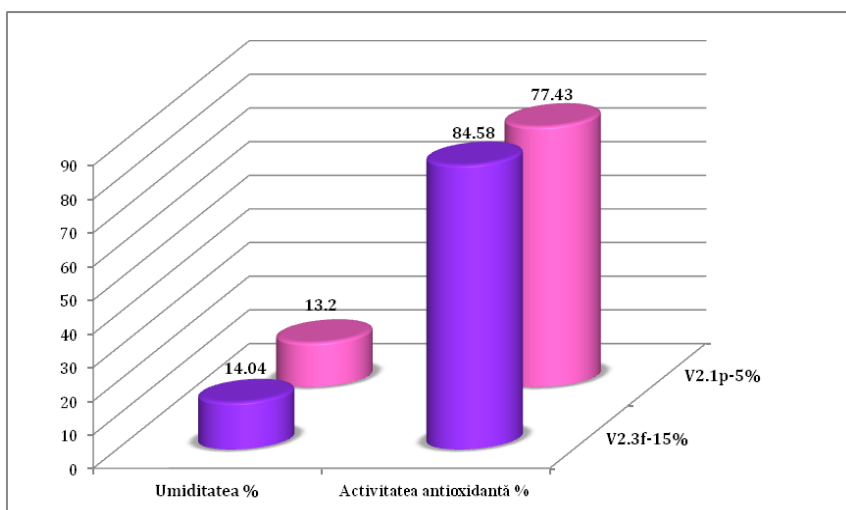


Fig. 3 Total antioxidant activity, respectively humidity of the product variants with blueberries fruit V2.3f-15% and blueberries powder V2.1p-5%

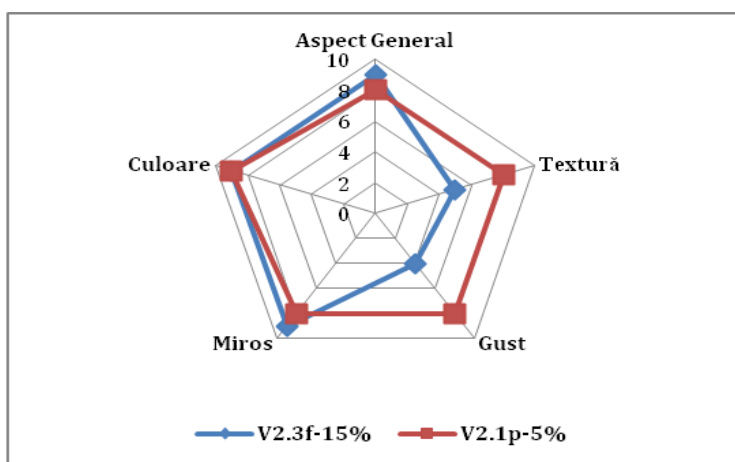


Fig. 4 Sensory evaluation for the dietary products with blueberries fruit V2.3f-15% and blueberries powder V2.1p-5%

➤ From the above considerations, we proposed the implementation in the production process of variants with blueberries fruit V2.3f-15% and a variant with blueberries powder V2.1p-10% for a high nutritional value, respectively better sensory appreciation. For these, have been realized technical specifications and the presentation of products.

➤ No artificial flavours and dyes are used, the product stands out by the rich taste and specific colour of blueberries.

Recommendations

In addition to the recommendations already drawn from conclusions (warming the product before consumption, and taking the recommended daily dose), we consider as opportune the following:

- An in-depth study of the interaction between sugars and bioactive compounds, respectively bioactive polyols-compounds, because the research results led to the hypothesis, perhaps not necessarily a content enhancement of the bioactive compounds in the use of polyols versus sugars, but more precisely by maintaining the content of bioactive compounds. The explanation behind this would be a greater chemical inertia of polyols in relation to sugars.
- A study on improving the rheological properties of the texture and adhesiveness of this product.

Originality and innovative contributions of the thesis

- Creating a new innovative product namely: dietary „șerbete” with natural-functional ingredients;
- The use of inulin together with blueberries for obtaining sugary products, represents a premiere in the research field, as the studied literature presents only usages concerning the enhance of fibre content in some food products such as: dairy products (yogurt), meat products (sausages), bakery products.
- The product we obtained can be produced on a larger scale, this fact being already confirmed by winning a grant, innovation cec type, in collaboration with a company from the economic environment;
- The innovative product, *dietary șerbete with natural functional ingredients*, is in the process of being patented.