

UNIVERSITY OF AGRONOMIC SCIENCES AND VETERINARY MEDICINE BUCHAREST

FACULTTY OF BIOTECHNOLOGY

PhD THESIS

NEW BAKERY PRODUCT DEVELOPMENT WITH FUNCTIONAL POTENTIAL

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SUMMARY

Keywords: *functional foods, health-related labelling, functional ingredients, wheat flour, Cannabis sativa L., partially defatted hemp, Helianthus tuberosus L, Jerusalem artichokes, dietary fibres, minerals, inulin, health-related labelling, bread.*

The PhD thesis "Development of bakery products with functional potential" was drawn up by the PhD student Livia Dumitrașcu (Apostol), u der the scientific tutorship of Professor Dr Mona Elena Popa, within the Doctoral School by the University of Agricultural Sciences and Veterinary Medicine Bucharest.

The purpose of this thesis was to improve the feeding standard of the population by fortifying staple bakery goods, such as the white bread, reformulated by the addition of functional ingredients.

The scientific attempt to enhance the nutritional value of bakery products relied on the use of two sources of nutrients, i.e. Jerusalem artichokes **(***Helianthus tuberosus L)* tubers and partially defatted hemp (*Cannabis sativa* L) seeds, by-product from the cold pressing production of oil.

The doctorate thesis has 225 pages and nine chapters, 23 subchapters, 83 tables, 72 figures and 8 annexes. The list of references consists of 164 titles.

The paper consists of three parts, specific to a doctorate thesis:

- Part of documentation study of the investigated field and of the current stage of researches in this field, "*General considerations on the functional foods and analysis of the current stage of using various functional ingredients to produce functional foods*";
- Part two, experimental researches, "*Experimental researches to develop functional foods*";
- Part three, conclusions and contributions of the author to the development of the approached field, "*General conclusions, author's contributions, valorisation and dissemination of the research results*"

In the first part of the doctorate thesis, consisting of four chapters, the author did a documentation study and an analysis of the different aspects related to the importance of the functional foods in human feeding, consumer behaviour regarding the functional foods, the current stage of the market for functional foods, worldwide and in Romania, the functional role of the various ingredients in human diets, the use and feeding importance of the Jerusalem artichokes and hemp seeds in functional foods, European and national legislation regarding the functional foods.

Based on the documentary study and on the conclusions yielded from it, the author designed the research plan, which includes three large categories of experimental researches:

- Experimental researches to determine the composition of the raw materials used to make bakery products using the methods known for their efficiency to determine the complex compositions
  - ✓ Experimental researches to characterize physically-chemically the raw materials.
  - ✓ Experimental researches to characterize the raw materials in terms of biological contaminants.
  - ✓ Experimental researches to determine the content of biologically active compounds of the raw materials.
- Experimental researches regarding the fortification of the wheat flour with functional ingredients, i.e. Jerusalem artichokes tubers flour and partially defatted hemp seed flour; assessment of their influence on the nutritional composition and of the rheological traits of the wheat flour.
  - ✓ Production of wheat flour varieties enriched in compounds with functional role.
  - ✓ Complex characterization of the varieties of wheat flour enriched in compounds with functional role.
- Experimental researches for the production and characterization of new bakery products with functional potential, using Jerusalem artichokes tubers flour and partially defatted hemp seed flour as functional ingredients.
  - ✓ Experimental researches to determine the technology for the production of the newly-developed bakery products with addition of functional ingredients.
  - ✓ Analysis regarding the complex, physical and chemical, sensorial and microbiological characterization of the newly-developed bakery products with addition of functional ingredients.
  - ✓ Quantitative experimental analysis regarding the functional compounds added to the newly-developed bakery products in order to determine possible health claims.

The experimental researches used modern analytical methods and analytical equipment and instruments specific to bakery raw materials and finished products (determination of the rheological characteristics of the flour varieties using Mixolab method, gas chromatography to

determine the profile of essential fatty acids, the electronic nose, ^{1}H-RMN spectral technology to determine the essential fatty acids profile, etc.).

The raw materials evaluated for their potential use in the production of bakery goods with functional potential, were the white wheat flour, type 550, partially defatted hemp (*Cannabis sativa* L) seeds flour, by-product from the cold pressing production of oil and Jerusalem artichokes **(***Helianthus tuberosus L)* tubers flour.

The experimental results regarding the chemical composition of the Jerusalem artichokes tubers showed that inulin accounts for about 63% of the total constituents. The high proportion of inulin of this ingredient used in our experimental researches, confirms that the Jerusalem artichokes tubers have functional potential. The minerals content of the Jerusalem artichokes tubers is also rich, particularly that of potassium, calcium and magnesium.

The experimental analysis of the partially defatted hemp seeds flour shows that it has a high proportion of substances with high functional potential, such as the fibres, minerals and essential fatty acids, with an optimal ω-6 to ω-3 ratio, of 3:1.

In terms of the functional potential of both the Jerusalem artichokes tubers and of the partially defatted hemp seeds flour, the experimental results showed that we can issue labelling of "*rich in fibres*", "*source of calcium, potassium, magnesium and zinc"*, which provide, per 100 g product, more than 15% of the daily requirement. All these labels can be preceded by the term of "natural".

The wheat flour fortified with different proportions of Jerusalem artichokes tubers flour (5%, 10%, 15% and 20%) and of partially defatted hemp seeds flour (5%, 10%, 15% and 20%), as well as with a mixture of the two ingredients (5% Jerusalem artichokes tubers flour + 6%, 10% and 15% partially defatted hemp seeds flour), was analysed in terms of composition; the influence of these ingredients on the nutritional composition and rheological traits of the wheat flour were studied.

In terms of the functional potential, the experimental results show that all mixtures of wheat flour with additional Jerusalem artichokes tubers flour allow the labelling of "*source of zinc"*, "*source of fibres", "source of inulin",* and, for the sample with 20% Jerusalem artichokes tubers flour, the labelling of "*source of potassium"*.

In terms of health claims, all samples with Jerusalem artichokes tubers flour allow labelling regarding the inulin content: inulin has a beneficial influence on the mechanisms of the gastro-intestinal system, with laxative, diuretic, spermatogenic effects, with stomach and tonic effects.

The following labelling can be issued regarding the mixtures of wheat flour and partially defatted hemp seeds flour: "*source of fibres"* and "*source of zinc"*. The samples with 10%, 15% and 20% partially defatted hemp seeds flour can be labelled as "*source of magnesium"*. The high content of magnesium allows the health claim that it alleviates the major risk factors for stroke, blood hypertension and cholesterol. All samples of flour mixtures allow issuing the health claim of increased volume of the faeces bolus (EU Regulation 432/2012). As source of zinc, a health claim can be issued regarding its role in several metabolic processes involved in the growth and development of the human organism.

In terms of the functional potential of the mixtures of wheat flour with additional Jerusalem artichokes tubers flour and partially defatted hemp seeds flour, the experimental results have shown that they can be labelled as "*source of fibres", "source of inulin", "source of zinc"* and "*source of magnesium"*.

Baking trials and physical-chemical, biochemical and sensorial analyses have been done on the newly-obtained varieties of bread with additional Jerusalem artichokes tubers flour and partially defatted hemp seeds flour, in order to determine their quality.

The results of the physical-chemical parameters of quality of the analysed bread samples show that the ingredients from which these products have been made have a high nutritional quality, improving thus the nutritional quality of the main matrix (wheat flour).

Both the analysis of the physical-chemical parameters of quality, and the analysis of the sensorial characteristics of the experimental bread samples with additional Jerusalem artichokes tubers flour show that the bread sample made from the mixture of wheat flour and 5% Jerusalem artichokes tubers flour is acceptable in terms of the quality indicators according to SR 878/1996, being similar to the black bread.

The Jerusalem artichokes tubers flour provides an important supply of inulin and fibres, even for the experimental sample with just 5% of this ingredient, allowing the labelling of "*source of inulin"* and "*source of natural fibres"*.

Analysing the samples of bread made with additional partially defatted hemp seed flour, it was noticed that the bread samples made from wheat flour with additional %, 10% and 15% partially defatted hemp seed flour, had very good and good (the sample with 15% partially defatted

hemp seed flour) traits in terms of the quality parameters. The bread sample with 20% partially defatted hemp seed flour had poor sensorial traits, because of the altered, disturbing flavour.

Nutritionally, all the experimental bread samples meet the concept of "*source of fibres"* "*source of zinc"*, while the samples with more than 10% additional partially defatted hemp seed flour can be labelled as "*source of magnesium"*.

The analysis of the quality parameters of the bread samples with additional 5% Jerusalem artichokes tubers flour and various proportions of partially defatted hemp seed flour, according to the limits stipulated by SR 878/1996, shows that the bread made with a mixture of wheat flour with 5% Jerusalem artichokes tubers flour + 6% partially defatted hemp seed flour, is similar to the white bread made of wheat flour; the bread made with a mixture of wheat flour with 5% Jerusalem artichokes tubers flour + 10% partially defatted hemp seed flour, is similar to the black bread; the bread made with a mixture of wheat flour with 5% Jerusalem artichokes tubers flour + 15% partially defatted hemp seed flour doesn't fit within the limit stipulated by SR 878/1996 in terms of smell and taste. The statistical analysis performed with the t-Student test on the data from the sensorial evaluation confirmed the practical results for the studied samples.

In terms of the nutritional composition, the variants of bread produced from white wheat flour with additional Jerusalem artichokes tubers flour and partially defatted hemp seed flour are clearly better than the variants produced with each of the individual additional ingredients separately.

It is essential that the foods with functional potential presented in this paper become a sustainable offer, after going through other required stages such as thorough clinical studies and monitoring along the value chain, standardization and harmonization based on evidences, regulatory elements and joint industry-consumption action

Since these two functional ingredients had never been used before in researches in this field, we consider that the results of this paper will be useful for the bakery specialists.