
Use of active compounds from hemp flour in bakery products

(SUMMARY OF Ph.D. THESIS)

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INTRODUCTION

In the last decade, the demand for foods that improve consumer health has begun to grow in many parts of the world in addition to rising health care costs, increased life expectancy and a growing desire for quality of life (DIPLOCK, 1999). Since ancient times, cereals and the products obtained from them have been a major component in the human diet.

Bread has a very important role in nutrition due to the balance in its composition in micronutrients and minerals (CRISTINA ROSELL, 2011). With the diversification of bread varieties, consumers have the opportunity to choose according to texture, taste and type, the varieties that meet their specific requirements. The specific characteristics are given both by the type of flour used, the composition of the dough and the auxiliary materials used, as well as by the manufacturing technology. Recent scientific research indicates that hemp seeds are a valuable source of nutrients, being recognized as one of nature's perfectly balanced foods.

Given the growing interest in fortified products and, at the same time, in the use of hemp seeds in human consumption, this study showed that by adding hemp seed flour to bread, it improves its nutritional properties. This process of fortifying the bread led to a high content of proteins and essential amino acids, lipids and unsaturated fatty acids, fiber and minerals, without significantly affecting the rheological properties of the finished product. When hemp seed flour was used as a source of nutrients in the manufacture of fortified bread, it added value in diversifying the range of assortments and obtaining new nutritional assortments.

1. The structure of the PhD thesis

The PhD thesis entitled "**The use of active compounds in hemp flour in bakery products**" comprises a total of 141 pages and has been structured in two parts: "**The current state of knowledge on active compounds in hemp used in bakery products**" includes a number of 43 pages and was divided into two chapters: "**General considerations on the strengthening of bakery products**" and "**General considerations on hemp**", which presents an extensive study in the literature on the importance of food fortification, consumer classes in need a special nutrition and products that are suitable for fortification and generalities regarding the hemp culture, the varieties approved in Romania, the chemical composition and the importance of using the hemp plant, especially its seeds and flour.

The second part of the thesis entitled "**Original contributions to the development of knowledge in the field of bakery products obtained from fortified flour with the addition of hemp flour**" totals 98 pages, being divided into four distinct chapters that present the purpose and objectives of the work, materials and methods used, the results and discussions of the doctoral thesis and last but not least the conclusions and recommendations regarding the studies performed and the fulfillment of the four proposed objectives of the thesis.

The thesis comprises a total of 26 figures, 44 tables and 229 bibliographic sources.

2. Aim and objectives of the research

2.1. The aim of the research

The aim of the paper was to identify the functionality of hemp flour in order to develop a product with high nutritional value with bioactive qualities to ensure a healthy food.

2.2. Research objectives

In order to achieve the goal proposed in the doctoral thesis, four major research directions were approached, established as objectives of this thesis:

- a) Physico-chemical characterization of F.G. and F.C. ;
- b) Extraction, identification and characterization of biologically active compounds from F.C. mixed with wheat in different proportions (5%, 10%, 15%, 20%);
- c) Obtaining and physical - chemical and microbiological characterization of a functional product with improved nutritional value;
- d) Psycho - sensory assessment of the product obtained from the addition of F.C. compared to the control sample;

3. Material and method

3.1. Introduction

The researches of physical-chemical, microbiological and rheological analyzes were performed both at the University of Agricultural Sciences and Veterinary Medicine Cluj - Napoca, within the Faculty of Food Science and Technology in the laboratories of Food Quality Control, Microbiology, Rheology, and within the University of Agricultural Sciences and Veterinary Medicine of Banat Timișoara, in the laboratories of Extraction - Evaporation, Physical - Chemical Analysis for feed and Nutrition - Chemical analysis.

The analysis of carbohydrates for both composite flours and bread samples were performed at the Research Institute of Chemistry "Raluca Rîpan", Cluj - Napoca.

Within the Pilot Station at the Faculty of Food Science and Technology Cluj - Napoca, the control bread tests were performed as well as those with the addition of F.C. in various additives (5%, 10%, 15%, 20%).

3.2. Materials and raw materials

The study material used to perform the experiments consists of the sample of F.G. type 550 - figure 3.1. and F.C. (Cannabis Sativa L.) from D.S. and Z. - figure 3.2.



Fig. 3.1. W.F. type 550
Source: (ORIGINAL PHOTO)

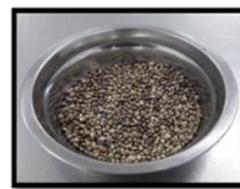


Fig. 3.2. Experimental hemp material a) D.S. variety b) Z. variety
Source: (ORIGINAL PHOTOS)

3.3. Methods used

In order to achieve the proposed objectives, four experimental designs were created, structured according to the four research directions.

3.3.1. Physico - chemical characterization of wheat flour and hemp flour

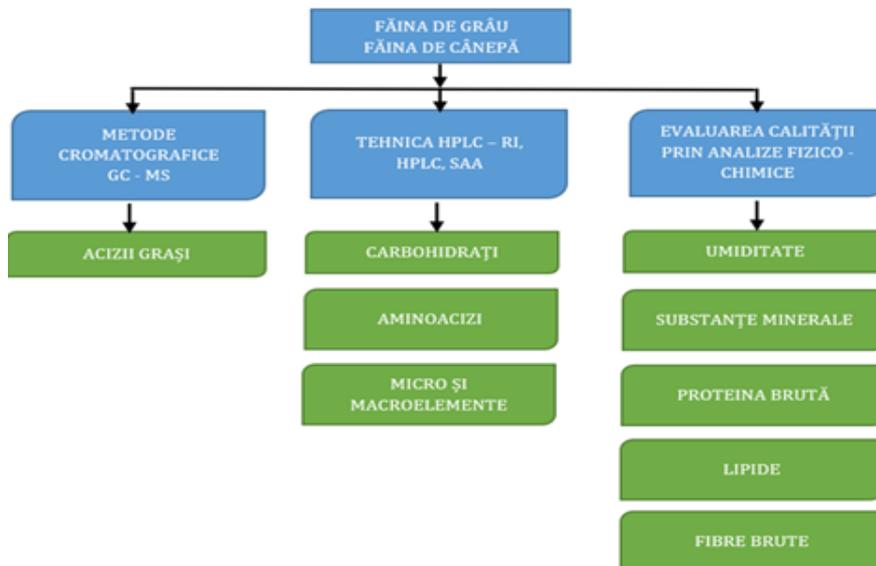


Fig. 3.3. Experimental protocol on the characterization of wheat flour and hemp flour (Cannabis Sativa L)

Source: (OWN PROTOCOL)

The objectives of this protocol are:

- Evaluation of the nutritional parameters of F.G. and F.C. (Cannabis Sativa L.) by applying various physico - chemical methods;
- Evaluation by spectrophotometric techniques and chromatographic techniques of micro/macroelements and individual amino acids from F.G. and F.C. (Cannabis Sativa L.);
- Analysis and identification of existing fatty acids in F.G. and F.C. (Cannabis Sativa L.), using the chromatographic method;

3.3.2. Extraction, identification and characterization of biologically active compounds from hemp flour mixed with wheat flour in different proportions (5%, 10%, 15%, 20%)

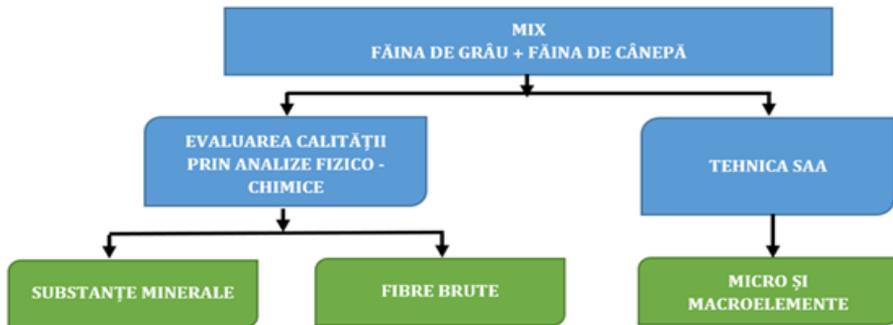


Fig. 3.4. Experimental protocol on flour mixes in different additives

Source: (OWN PROTOCOL)

The following objectives have been developed within this protocol:

- ✓ Analysis of mineral substances and crude fibers from mixtures in different additives;
- ✓ Identification of micro and macroelements using atomic mass spectrometry;

3.3.3. Obtaining and sensory, physico - chemical and microbiological characterization of a functional product with improved nutritional value

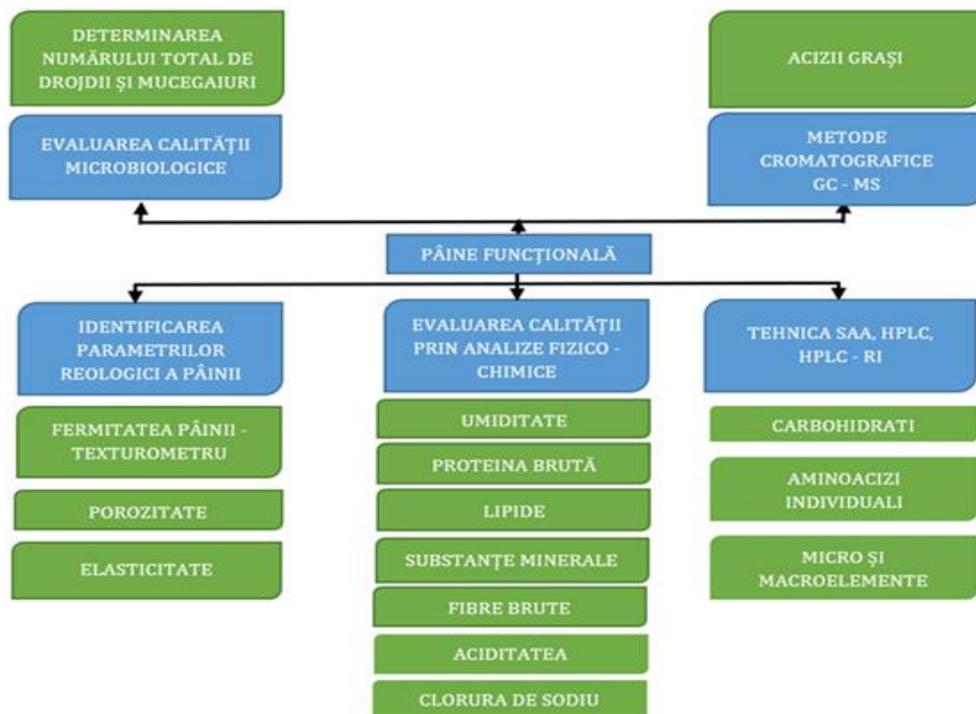


Fig. 3.5. Experimental research protocol on bread fortified with hemp flour (*Cannabis Sativa L.*)
Source: (OWN PROTOCOL)

Regarding this objective were elaborated in figure 3.3. the following experimental protocols:

- Integration in the baking process and optimization of the composite flour recipe in the baking process;
- Evaluation of the products obtained from a physical - chemical and microbiological point of view;
- Evaluation of the influence of F.C. in different proportions on the parameters by performing Fisher LSD statistical analyzes and Pearson correlations;
- Differentiation of samples with the help of statistical analysis;

3.3.4. Psycho-sensory assessment of the product obtained from the addition of hemp flour compared to the control sample

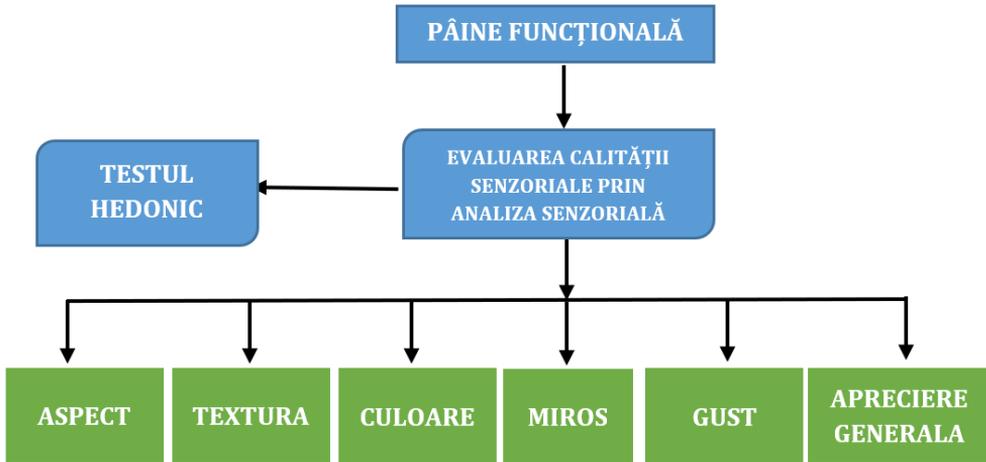


Fig. 3.6. Experimental protocol regarding the psycho-sensory analysis of the finished product
Source: (OWN PROTOCOL)

4. Results and discussions

4.1. Results and discussions on wheat and hemp flours

This subchapter presents the results regarding the samples represented by the raw material and the composite flours studied. Fisher's LSD statistical analyzes, supplemented by the Pearson Correlation, were applied.

The presented results show that the two varieties of hemp: Dacia Secuieni and Zenit have an increased nutritional value with a high content of proteins, fats, minerals, fibers, fatty acids and essential amino acids.

These values, being much lower than in the case of wheat flour, make hemp flour to be much higher quality. This is an important vector in the food industry, because it can be used in many food technologies (beer, sugar or bakery).

4.2. Results and discussions on the extraction, identification and characterization of biologically active compounds from hemp flour mixed with wheat flour in various proportions (5%, 10%, 15%, 20%)

A comparison between the two varieties shows that the results between them are similar, with a slight increase for Z-variety mixes. From a statistical point of view it appears that the mix between F.G. type 550 and F.C.Z. 20% show significant differences compared to the rest of the mixes, having a positive correlation. In the case of crude fiber content as in the case of higher resulting ash, it is recorded for Z. type mixes.

Significant differences for both varieties occur for mixes with the highest percentage of F.C. 20% compared to the other mix samples.

4.3. Results and discussions on the physico-chemical and microbiological characterization of a functional product with improved nutritional value

This process of fortifying the bread led to a high content of proteins and essential amino acids, lipids and unsaturated fatty acids, fiber and minerals, without significantly affecting the rheological properties of the finished product.

The results of this study showed the significance of using hemp seed flour in a product used daily.

4.4. Results and discussions regarding the evaluators' assessment from a psycho - sensory point of view of the product obtained from the addition of hemp flour compared to the control sample

The sensory evaluation of the bread was performed using the hedonic test according to ISO 13299:2016, the sensory characteristics being evaluated by a group of 30 trained evaluators aged between 19 and 25 years. Appearance, texture, color, smell, taste and general appreciation were the sensory attributes that were evaluated.

Regarding a comparison between the nine products obtained from the sample by F.G. 550 and F.C. from the two varieties it appears that the bread obtained from F.C. of the D.S. 5% was more appreciated, at a short distance from the one of the same variety with the addition of 15%, this fact is due to the fact that following the physico-chemical analyzes performed, the sample from the D.S. it is richer in protein and has a higher content of micro and macroelements (Cu, Cr, Pb, Zn, Fe, Mn, Ca, Mg, K, F), with a higher elasticity and consistency due to the increase in the percentage of F.C. added.

5. Conclusions and recommendations

5.1. Conclusions on the physico-chemical characterization of wheat flour and hemp flour

Given that in recent years the interest in the consumption of hemp seeds in the food industry has increased, it is of great interest to know the chemical composition of the varieties allowed from a legislative point of view.

The two varieties of hemp studied D.S. and Z., meet the THC level requirement (0.3% or 0.2% of the dry weight of the reproductive part of the flowering female plant).

Analyzes have shown that these varieties have an increased nutritional value, a high content of proteins, fats, minerals, fiber, fatty acids and essential amino acids.

All these values, much lower than those found in F.G., make the flour from grinding hemp seeds much higher quality.

The entire composition of hemp seeds, but emphasizing the large amount of fatty acids and essential amino acids, recommends the use of flour from hemp seeds due to the beneficial effects on the proper functioning of the human body.

F.C. It is an important vector in the food industry because it can be used in many different food technologies, such as beer, sugar or the bakery industry.

5.2. Conclusions on the extraction, identification and characterization of biologically active compounds from hemp flour mixed with wheat flour in different proportions (5%, 10%, 15%, 20%)

With regard to the second research objective entitled "Extraction, identification and characterization of biologically active compounds from hemp flour mixed with wheat flour in various proportions (5%, 10%, 15%, 20%)" identified the following issues:

For the physico-chemical analyzes performed: ash, crude fibers, respectively micro and macroelements, there is an increase of mixes from both varieties: D.S and Z., directly proportional to the addition of F.C. A comparison between the two varieties shows that the results between them are similar, with a slight increase for Z-variety mixes. From a statistical point of view it appears that the mix between F.G. type 550 and F.C.Z. 20% show significant differences compared to the rest of the mixes, having a positive correlation. In the case of crude fiber content as in the case of higher resulting ash, it is recorded for Z-type mixes. The highest percentage of fiber (6.8%) occurs in the case of the mix between F.G. type 550 and F.C.Z. 20% having a moderate to good correlation.

Significant differences for both varieties occur for mixes with the highest percentage of F.C. 20% compared to the other mix samples. Hemp is a large consumer of nutrients (N, P, K), it develops during the growing season a large vegetative mass accumulating between 70 and 75% of dry matter in the first vegetation period. As in the case of ash and crude fiber, mix variants with the addition of 20% of both varieties positively and significantly influence the mineral elements. In the case of both flour and mix mineral elements, it is observed that an important component is K, where its percentage is the highest. This is due to the increase in the percentage of F.C. added to the mix. From a statistical point of view, according to the Fisher LSD test, the results show significantly greater differences in the case of variants with a 20% addition of F.C. soi D.S. for Cu, Zn, Fe, Mn, K and P, respectively variety Z. for Cu, Cr, Ni, Zn, Mn, Ca, Mg, K, P.

5.3. Conclusions on the physico - chemical and microbiological characterization of a functional product with improved nutritional value

Functional foods through their production technology present an additional objective regarding the identification, quantification and finally the optimization of bioactive components with a functional role, as well as the monitoring of their efficiency in the final product. Given the growing interest in fortified products and, at the same time, in the use of hemp seeds in human consumption, this study showed that by adding hemp seed flour to bread, it improves its nutritional properties.

This process of fortifying the bread led to a high content of proteins and essential amino acids, lipids and unsaturated fatty acids, fiber and minerals, without significantly affecting the rheological properties of the finished product.

The results of this study showed the significance of using hemp seed flour in a product used daily. So, when hemp seed flour was used as a source of nutrients in the manufacture of fortified bread, it added value in diversifying the range of assortments and obtaining new nutritional assortments.

5.4. Assessment of the psycho-sensory evaluators of the product obtained from the addition of hemp flour compared to the control sample

The sensory evaluation of the bread was performed using the hedonic test according to ISO 13299: 2016. The sensory characteristics were evaluated by a group of 30 trained evaluators (17 female evaluators and 13 male evaluators) aged 19-25 years.

The degree of pleasure for the different types of bread was assessed on the basis of a 5-point hedonic scale (1 - "very unpleasant" and 5 - "very pleasant").

Appearance, texture, color, smell, taste and general appreciation were the sensory attributes that were evaluated. Psycho-sensory processing techniques are very useful in terms of optimization, monitoring and development of bakery products.

In conclusion, regarding a comparison between the nine products obtained from the sample by F.G. 550 and F.C. from the two varieties it appears that the bread obtained from F.C. of the D.S. 5% was more appreciated, a short distance from the same variety with the addition of 15%.

This is also due to the fact that following the physico - chemical analyzes performed, the sample of the D.S. it is richer in protein and has a higher content of micro and macroelements (Cu, Cr, Pb, Zn, Fe, Mn, Ca, Mg, K, F), with a higher elasticity and consistency due to the increase in the percentage of F.C. added.

6. Originality and innovative and future prospects

The original elements of the doctoral thesis entitled: "*The use of active compounds in hemp flour in bakery products*" consist of:

- Extraction, identification and characterization of biologically active compounds from F.C. mixed with F.G. in different proportions (5%, 10%, 15%, 20%);
- Use of F.C. of the two varieties: D.S. and Z. in order to diversify the range of bakery products;
- Achieving direct correlations between the quality parameters of composite flours and the quality characteristics (organoleptic, physico-chemical and microbiological) of the finished products;
- Traceability of structural changes of biologically active compounds;

Following the study carried out so far, new research directions can be deduced regarding the clarification of some insufficiently clarified aspects, or to amplify new approaches.

Based on the original aspects of this thesis, other major new research directions can be highlighted:

- Patenting of recipes for obtaining mixes from F.C. ;
- The use of mixes from F.C. in other sectors of the food industry and the development of new functional products of vegetable origin (sugar products, confectionery);
- Substitution of components of animal origin (animal protein meal) and their replacement with F.C., thus making sustainable products.

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