S U M M A R Y

of the doctoral thesis entitled:

THE STUDY OF THE POSSIBILITIES OF VALORIZATION NUTRACEUTICAL POTENTIAL OF SOME NEW FRUIT SPECIES, CULTIVATED IN ROMANIA

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The doctoral thesis entitled ***"Studying the possibilities of valorization nutraceutical potential of some new fruit species, cultivated in Romania"*** structured in 9 chapters, 30 tables, 119 figures, 3 appendices and a bibliography with 245 titles of specialized books, scientific articles and other sources of recent information.

The purpose of this work was to valorization fruit species in order to develop products with high nutraceutical value, new for consumers in Romania.

The study and experimental activity for the elaboration of the doctoral thesis were carried out within the Research Center for the study of quality food products, within the following laboratories: Integrated Fruit Growing Laboratory, Physico-Chemical Analysis Laboratory; Agrochemistry Laboratory, Post-Harvest Technologies Laboratory, University of Agronomic Sciences and Veterinary Medicine in Bucharest.

In order to achieve the purpose of the research, the following objectives were pursued:

Objective 1: Making innovative products from the three new fruit species (kiwi, asimina, jujube)

Objective 2: Determination of the biochemical composition of the raw material

Objective 3: Superior valorization of fruit through processing for increase in added value.

The work consists of two parts specific to a doctoral thesis: the first part, entitled "Bibliographic study", represents the documentary research and the current state of research, having data from the specialized literature, and the second part, entitled "Own research", includes the own experimental research, the results obtained and the conclusions of the work.

The first part of the thesis is structured on 5 chapters, the first chapter being entitled: **"The current state regarding the origin, systematic classification and morphological and agronomic particularities of new fruit species: kiwi, asimina, jujube"**.

Next 3 chapters, **Chapter II - "The current state of research on the importance of kiwi fruits and the possibilities of valorization worldwide"**; **Chapter III - "The current state of research on the importance of pawpaw fruits and the possibilities of valorization worldwide"**; and **Chapter IV - "The current state of research on the importance of jujube fruits and the possibilities of valorization worldwide"**, each comprise 3 subchapters that present aspects related to: the importance of fruits in human nutrition; nutritional properties of fruits; possibilities for harnessing fruit worldwide.

Kiwifruit, is considered a superfood and is widespread all over the world, due to its characteristic flavour, having a high nutritional value and high antioxidant and anti-inflammatory properties. Kiwifruits are some of the most nutrient-dense fruits, and compared to other commonly eaten fruits, they are particularly rich in vitamins C, E, and K, with a high fiber and iron content. Kiwifruits are mostly eaten fresh, but certain varieties lend themselves well to processing, such as alcoholic beverages (cider, liqueur, brandy) or natural juices, smoothies, candied, dehydrated and freeze-dried fruits, jam and marmalade, cakes or pastries, protein bars and chocolate.

Pawpaw is a nutritionally superior fruit, with a high content of vitamins, minerals and amino acids than other fruits, such as: apples, grapes and peaches, and can be considered an excellent source of potassium, calcium, phosphorus, iron and magnesium. It also has a high level of antioxidant compounds.

The antioxidant content is ten times higher than that of apples and bananas and is similar to strawberries and oranges. Research suggests that pawpaw fruits have a high potential to be added to various food products such as smoothies, smoothies, baby food, ice cream, candies, cakes, jam or jam), both for their increased nutritional benefits and for improving flavour. The intense aroma is similar to tropical fruits.

Jujubes have a high nutritional value due to the large number of macronutrients, micronutrients and bioactive compounds. The most important nutritional characteristics of jujubes are the content of soluble sugars (2-3 times the levels of other fruits), vitamin C (100 times more than other fruits), vitamin B, flavonoids, iron, potassium, calcium and zinc. The fiber content helps control calorie intake through the satiety effect.

Jujubes are a good source of healthy, essential fatty acids. They can be processed in various forms such as dehydrated, freeze-dried fruit, jam, nectar, fruit extract, powder, honey, bars, alcoholic beverages.

CHAPTER V, the last chapter of **Part I**, entitled: **"The current state of research on the preservation of the fruits studied"** included 3 subchapters regarding: freezing, freeze-drying and dehydration of fruits. A major goal of processing is to turn perishable fruits into stable products that can be stored for long periods, thus reducing losses and making them available at any time of the year, even out of season and in countries far from the place of production. In the food industry, several processing technologies are used for fruit preservation, but the main ones are: freezing and dehydration.

As a result of research, we found that for kiwifruits the best storage methods are freezing and dehydration, for pawpaw fruits – freezing, and for jujubes all 3 storage methods: freezing, freeze-drying and dehydration. Part II is made up of four chapters made up of own contributions made throughout the research period. The research was conducted between 2020 and 2023.

Therefore, **Chapter VI**, entitled **"Own contributions regarding the determination of the biochemical composition of the raw material"** includes the research carried out for the determination of the physicochemical analyses as well as for the analysis of the nutritional properties of the raw material used in the research.

This chapter includes the materials and methods used. In order to carry out the biochemical determinations, fruits from the three new fruit species from the Experimental Orchard of the Faculty of Horticulture, within the University of Agronomic Sciences and Veterinary Medicine in Bucharest, were used: kiwi (*Actinidia deliciosa*), pawpaw (*Asimina triloba* (L.) Dunal), jujube (*Ziziphus jujuba* Mill.); as well as white and purple sweet potato (*Ipomoea batatas*) from the Research and Development Station for Plant Cultivation on Sands in Dăbuleni.

The determination of the biochemical composition of the raw material consisted of:

- Determination of total dry matter content (S.U.T. %)
- Determination of soluble dry matter content (°Brix)
- Determination of fructose content
- Determination of glucose content
- Determination of total titratable acidity
- Determination of total polyphenol content
- Determination of antioxidant activity
- Determination of fiber content
- Determination of mineral element content
- Determination of protein content.

Following the biochemical analyses carried out, the following were found: Soluble dry matter: the lowest level was found in kiwi samples and highest in ripe purple sweet potato.

Total dry matter: Compared to frozen pawpaw fruits, the fruits of frozen kiwifruit have a higher SUT content, which indicates that kiwifruit loses its water content by freezing unlike pawpaw fruit.

Acidity (citric acid): compared to fresh fruits, in the case of freeze-dried kiwi samples, the concentration of citric acid is much higher than in the other samples, the Hayward variety having the highest citric acid content. From the results of the fresh samples, it resulted that kiwi fruits are the most acidic while the lowest levels of citric acid were found in the samples of fresh pawpaw and purple sweet potato. Jujubes having a low citric acid content.

Fructose: the lowest content was recorded in kiwifruit (KPH, KCB, KPB, KCH) and fresh white potato (BAP), while the highest content was recorded in the alcohol kiwifruit (KA) samples (this sample had honey added) and in the sweet potato samples (BMC and BAC).

Glucose: the lowest content was recorded in potato samples fresh white sweet and fresh kiwifruit of the Hayward and Bruno varieties, and the highest content was recorded in the samples of kiwi from alcohol and baked purple sweet potato and pawpaw both fresh and frozen.

Polyphenols: the highest content was determined in freeze-dried kiwi samples, followed by fresh purple potato, and the lowest gallic acid content in KA and KCH samples. In the case of the pawpaw samples, a higher content of gallic acid was found in the frozen sample than in the fresh sample. The determination of the total polyphenol content in the freeze-dried samples showed that in the case of kiwifruits, the bioactive compounds are maintained in considerable quantities, the freeze-drying process determining their concentration compared to the fresh product.

Antioxidant activity: on determining antioxidant activity the AP, CDP, CDD1 and CDD2 and BMP samples showed much higher antioxidant activity than the other samples. The highest percentage of inhibition of free radicals was also recorded in the same samples.

Fibre: the highest content of cellulose and lignin was found in the kiwi between 12-15% and the lowest content was found in the purple sweet potato sample - 3.198% compared to the white sweet potato.

Protein: the highest protein content was recorded in the kiwifruit sample and the lowest protein content was recorded in the pawpaw sample.

Mineral elements: kiwi fruits of the Bruno variety presented the high content of Potassium, the kiwifruit of the Hayward variety had the highest content of Calcium, the purple sweet potato had a high content of Phosphorus, Manganese and Iron, and the white sweet potato had the highest content of Zinc, Magnesium and Sodium.

All raw material analyses were performed in triplicate. The results represent the average of the three experiments.

The statistical analysis of the data was interpreted with the help of Microsoft Excel and IBM SPSS programs. In order to compare all the data obtained, the ANOVA test was used with the Duncan pot-hoc test and the significance threshold $p<0.05$ was used. The available statistical functions of the two programs helped to correlate the data.

Chapter VII, entitled **"Own contributions to innovative kiwifruit products"**, had the following specific objectives:

Objective 1: To obtain innovative kiwifruit products using fruit from organic farming, no added sugar, no additives, stabilizers or chemical correctors

Objective 2: Sensorial analysis of kiwifruit products

Objective 3: Analysis of biochemical and organoleptic parameters of ice cream kiwi

In order to make innovative products, we used two varieties of kiwifruit: Hayward (R2P3) and Bruno (R0P12). From kiwifruits we made 27 products, which were tasted by consumers, of different genders and ages. The products were positively appreciated by consumers and received scores between 76.46% (smoothie with kiwi and white sweet potato) and 98.8% (candy with kiwi from alcohol, chocolate and purple sweet potato).

As a result of the research, the following conclusions were found: kiwifruits can be used in many product recipes both fresh, frozen, freeze-dried or dehydrated. The kiwi ice-cream variants presented in the table differ significantly in what sugar content and acidity. These variations influence the taste, texture, and overall perception of the product. Choosing the optimal variant depends on consumers' preferences, whether they prefer a sweeter and denser product (such as variant 2) or a lighter and less sweet one (such as variant 3). Variant 5 offers an interesting balance between sweetness and acidity, thus appealing to consumers who appreciate a more complex taste. Consumer attitudes and beliefs play a crucial role in how to accept or reject new foods, being not only relevant, but sometimes even decisive.

Chapter VIII, entitled **"OWN CONTRIBUTIONS ON OBTAINING INNOVATIVE PRODUCTS FROM PAWPAW"** had the following specific objectives:

Objective 1: Obtaining innovative products from pawpaw fruits using organically grown fruits, no added sugar, no additives, stabilizers or chemical correctors.

Objective 2: Sensorial analysis of products obtained from pawpaw fruits

Objective 3: Analysis of biochemical and organoleptic parameters of pawpaw ice-cream.

This chapter presents its own contributions on obtaining innovative products from pawpaw. They have a unique taste and texture and are suitable for various products. It lends itself very well to many recipes, from this consideration we have investigated different methods of processing this fruit.

The fruit is rich in essential nutrients, and its use in various recipes adds significant nutritional value to the finished products. These products are proving to be an innovative alternative to traditional options. We can say that pawpaw can be easily used in various product recipes, but especially for waste. Pawpaw paste gives any dessert a creamy, smooth and homogeneous texture, attracting consumers looking for high quality products.

From pawpaw we made 32 products. The products offered to consumers for tasting obtained an appreciation score between 85.72% (cake with pawpaw, purple sweet potato and cinnamon) and 99.14% (cream for cakes with pawpaw and purple sweet potato).

As a result of the research, the following conclusions were found: combining pawpaw paste with purple or white sweet potato or jujube is a good choice, as it gives the final product a unique taste, variety and complexity to desserts. Given the high appreciations, desserts with pawpaw can be promoted as premium products, emphasizing the texture and special taste offered by this fruit, being an innovative product in romanian confectionery.

Chapter IX, **"OWN CONTRIBUTIONS REGARDING THE OBTAINING OF INNOVATIVE PRODUCTS FROM THE JUJUBE"** presents the own contributions regarding the obtaining of innovative products from the jujube, respecting the following specific objectives:

Objective 1: Obtaining innovative products from jujube using organically grown fruits, no added sugar, no additives, stabilizers or chemical correctors

Objective 2: Sensorial analysis of products obtained from jujube

Objective 3: Analysis of biochemical and organoleptic parameters of jujube ice-cream.

I chose jujube because I think they lend themselves very well in many recipes, thus researching many methods of incorporating this fruit into different combinations, being a good substitute for refined sugar

From jujube I made 28 products. The products offered to consumers for tasting obtained an appreciation score between 80.8% (pie with jujube powder and grated white sweet potato) and 99.43% (biscuits with jujube powder and chocolate).

As a result of the research, the following conclusions were found:

The results showed that consumers' preferences are influenced by all the parameters analysed. The aroma and taste of jujube are highly appreciated, both for consumption fresh, dehydrated, and in products even if jujube is not so well known among consumers. Through these product recipes and tastings, I believe that information on the high nutritional value of these fruits can be spread. Jujube lend themselves very well as a natural sweetener and are an excellent substitute for refined sugar.

The thesis continues with **Chapter X**, which includes **"Conclusions and recommendations"** regarding research directions.

As a result of the research, contained in chapters VII, VIII and IX, it emerges that the 3 specific objectives have been fulfilled, namely: obtaining innovative products using fruits from organic farming, without added sugar, without additives, stabilizers or chemical correctors, the sensory analysis of the products obtained from the fruits and the analysis of some biochemical and organoleptic parameters of kiwi, asimina and jujube ice cream.

I made 87 products that were tasted by consumers of different genders and ages during events organized by the Faculty of Horticulture and the University of Agronomic Sciences and Veterinary Medicine in Bucharest, such as: Bucharest Horticulture Days, Bucharest Horticultural Autumn, Bucharest Food Summit, workshops, tastings for international visits.

According to my research, I believe that:

- the sensory analysis of the products played an important role in the choice of the final recipes
- educating consumers about the benefits and features of the product can increase acceptance in the future
- it is important to receive feedback from consumers in order to better understand the preferences

and to be able to make adjustments to the finished product, packaging or product presentation

- replacing refined sugar with fruit in the form of pulp, puree or juice can significantly enrich the quality of digestion by providing an increased intake of fiber, vitamins, minerals.

The valorization of the results was achieved by participating in the gastronomic competition „Ecotrophelia Romania 2024", from Iasi, with the product "Pawpaw symphony" which won the "Food taste award". At the same time, a gelateria from Bucharest tested and put up for sale two variants of ice cream recipes, with asimina and with kiwi.

Recommendations (future research directions):

- establishing the shelf life/storage of each product
- biochemical determinations for all tested recipes
- increasing the number of products of each fruit species
- using pawpaw fruits only in fresh or frozen state
- storing freeze-dried kiwifruit in the freezer at a temperature of -18°C
- using jujube powder as a substitute for refined sugar.

At the end of the thesis, the "Bibliography" chapter is presented, in which all the consulted bibliographic sources and all the authors cited in this work, in number of 245, can be found.