Scientific Papers. Series D. Animal Science. Vol. LXVI, No. 1, 2023
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

CURRENT TRENDS IN THE DEVELOPMENT OF VALUE-ADDED FOOD PRODUCTS BY EXPLOITING THE FUNCTIONAL POTENTIAL OF CHESTNUT FLOUR AND ROSEHIP POWDER

Ioana-Alina POP[1], Camelia MOLDOVAN[1], Loredana PLUSTEA[1], Daniela STOIN[1], Diana-Nicoleta RABA[2], Diana MOIGRADEAN[1], Delia-Gabriela DUMBRAVĂ[1], Mariana-Atena POIANĂ[1]

[1]University of Life Sciences "King Mihai I" from Timisoara, Faculty of Food Engineering, 119 Aradului Street, 300645, Timisoara, Romania
[2]University of Life Sciences "King Mihai I" from Timisoara, Faculty of Management and Rural Turism, 119 Aradului Street, 300645, Timisoara, Romania

Corresponding author email: marianapoiana@usab-tm.ro

Abstract
The scientific research done in the past few years has been conducted with the aim of discovering and developing new materials and technologies to develop foods that are healthier and more valuable nutrition-wise. The new generation of products should be in accordance with the environmental directives, sustainable, should do no harm, and should also ensure equitability of the market. Among the unconventional materials that caught our attention, chestnuts and rosehips are sustainable, underexploited resources that meet dietary and nutritional requirements. The aim of this paper is to gather comprehensive knowledge and get an overview of the use of chestnut flour and rosehip powder in different value-added food products, and to identify the possible gaps in the current knowledge. This work will help the further research in the field of valorization of chestnut and rosehip, and therefore, contribute to the development of innovative functional food formulations. Moreover, this matter is of importance because the generation of novel products would meet consumer expectations and will both help generate income to the food industry and provide a more sustainable use of resources.

Key words: *chestnut flour, functional foods, nutritional properties, rosehip powder, value-added food product.*

INTRODUCTION

Numerous uncertainties regarding the future of food and agriculture in all of its sectors (crops, animals, fisheries, and forests) have led to major issues and worries about sustainability and performance (Gonciarov et al., 2015). A lot of factors influence uncertainty, including population increase, dietary preferences, technological advancements, income distribution, the condition of natural resources, climate change, etc. (FAO, 2018). The world's population is constantly growing, while the Earth's ability to renew its resources is declining constantly. As a result, the bioresources needed for food production are also diminishing, and for this reason, new approaches are needed in order to feed the current and future global population.

At the same time, in the past years, the population has been showing interest in food and nutrition, not only as a way of eating a certain amount of food to survive, but rather as an instrument in disease prevention, bettering physical and mental well-being, and even to slow down the aging process.

This topic is important firstly because consumers need and expectations must be met, this resulting in a growth in capital for the food industry, and secondly, because new approaches are needed in the field in order to develop more sustainable food developing processes, to stop waste and to discover new materials that can enhance human food products, while keeping in mint the health and environmental aspects.

Foods with additional health benefits, beyond the regular nutritional qualities, are more appealing to consumers. As a result, functional foods are more in demand right now (Petcu et al., 2023). People's hectic lives today prevent them from adopting healthier eating habits, making them more vulnerable to conditions like diabetes, obesity, cardiovascular disease, and high blood pressure. As a result, consuming foods high in dietary fiber and

antioxidants will help reduce these health problems (Predescu et al., 2018). In recent years, demand in food products with added value has increased. Numerous studies, including those cited in this review, have demonstrated how scientists and researchers in the field of nutrition are looking for ways to enhance food products by fortifying and enriching them with various components and additives that are advantageous to human health (Goncearov et al., 2004).
As it has been proven through numerous investigations, chestnuts and chestnut by-products have been proven to have a great impact on health, sustainability, and waste management. Food products containing chestnuts and chestnut flour are valuable when it comes to nutritional and functional properties, as we can see from the results shown by different studies that were conducted by researchers around the world.
Innovative and fortified food products are absolutely necessary. Consumers have demonstrated that they are becoming increasingly interested in nutrition as well as food as a topic that goes beyond simply eating for survival. Therefore, it is obvious that the market requires an entirely novel category of edible goods.
Products that utilize unconventional materials are becoming a priority in research. The use of these materials for the development of food products has multiple benefits. In addition to the fact that the products created have an enriched nutritional value, certain population groups have opened a door to products that they could not have consumed before. People who have certain purposes regarding physical form, and who, for example, avoid consuming products that have a high sugar content, can find alternatives for sweet products that do not contain sugar. People with celiac diseases, who cannot enjoy traditional pastry and confectionery, can choose products based on flour that is not wheat, but coconut, or chestnut.
A healthy diet helps to avoid diseases, extend life, boost productivity, and foster circumstances for the body to properly adapt to its surroundings. Additionally, one of the best ways to boost the competitiveness of food industry manufacturers is to create a variety of specialized goods that are filled with food ingredients at a level that satisfies the physiological requirements of the body. Although the chestnut has recently come to light as a raw resource, its advantages are still not fully discovered. There is undoubtedly more to learn about this nutrient-dense fruit, and additional research on chestnuts and their qualities is required.
In line with the above considerations, our work will address several key points regarding the sustainable valorisation of chestnuts and rosehips, the nutritional aspects of chestnuts flour and rosehip powder, the impact of exploiting the nutritive and functional properties of chestnuts and rosehips on human health, as well as the currents trends registered in the use of chestnuts flour and rosehip powder to develop value-added food formulas.

CHESTNUTS AND CHESTNUT FLOUR

Southern Europe, Asia (China), and the Americas are home to the Fagaceae species *Castanea sativa* Mill. Chestnuts are a seasonal nut (fall) in Mediterranean nations, yet they are highly prized globally (Cruz et al., 2013). A significant species of trees with a priceless historical and cultural legacy, the European or sweet chestnut, is crucial to the financial and environmental context of mountainous regions. *Castanea crenata* Sieb. and Zucc. is common in Japan, *Castanea mollissima* Bl. is found in Korea and China, and *Castanea dentata* Borkh is present in North America (Cruz et al., 2013). Other species are also prevalent in these regions of the world.
Due to their starch, carbs, and low fat content, chestnuts can be employed as a significant source of nutritive energy (Vasconcelos et al., 2010). The majority compound is water, with humidity ranging from 40 to 64 g/100 g of fresh chestnut weight. Due to the high likelihood of mold growth and the large weight loss during storage, this high moisture content is a significant drawback for long-term preservation (Savu & Petcu, 2002). Chestnuts are primarily made up of carbohydrates (75-91%) on a dry basis, particularly starch (39-82%). The exact contents of amylose and amylopectin, which make up roughly 33% and 67% of the starch content, respectively, have been the subject of numerous investigations

(Pizzoferrato et al., 1999; Attanasio et al., 2004; Pereira-Lorenzo et al., 2006).
According to Pizzoferrato et al. (1999), starch can have a positive impact on intestinal functions due to the existence of short-chain fatty acids produced by the bacterial catabolism of dextrins obtained from amylopectin as well as by administering energy generated by the catabolism process of amylosis and amylopectin in glucose.
Chestnuts also contain fiber, which is a crucial ingredient. Dietary fiber has a good impact on health. Proteins vary between 3.9 to 10.9 g/100 g of dry mass, with a number of essential amino acids being recognized, such as arginine (Arg), phenylalanine (Phe) isoleucine (Ile), threonine (Thr), leucine (Leo), tryptophan (Trp) and valine (Val) and non-essential amino acids such as alanine (Ala), asparagine (Asn), aspartic acid (Asp), glutamine (Gln), glutamic acid (Glu), glycine (Gly), rhines (Serum) and tyrosine (Tyr). Mineral concentrations can vary between 1.0 to 8.0 g/100 g DM, and significant macroelements (K, P, Mg, Ca, S, and Na) are found. Potassium is the most significant member of this group. There have also been some intriguing micro-elements discovered, including Fe, Mn, Zn, Cu, B, and Se. The amount of minerals a person consumes is crucial to their health. Vitamins E and C are also present in chestnut fruits (Delgado et al., 2016).
Chestnuts are used to make chestnut flour after being peeled, picked manually or mechanically to remove any faded nuts, and subsequently crushed with a hammer or stone mill. This process takes many hours. Before usage and/or sale, chestnut flour (CF) can be kept for a number of months at room temperature or even for a number of years at 40°C. The flour's biochemical makeup is akin to that of other cereals. CF's major ingredient is starch, but it also contains proteins, lipids, minerals, and vitamins (B1, E, and C), all of which make it a great alternative for those who follow a diet free from gluten. The baking industry has seen a growth in the commercial utilization of CF, particularly in European nations. Cakes, biscuits, pasta, milky pudding items, bread, morning cereals, soups, and sauces could be made using chestnut flour (Mete & Dulger Altiner, 2017). Chestnut flour contains a lot of protein, a lot of sugar (20-32%), a lot of carbohydrates (50-60%), a lot of dietary fiber (4-10%), amino acids that are essential (4-7%), and very little fat (2-4%). In addition, it is abundant in potassium, magnesium, and phosphorus as well as vitamins B, C, and E (Sacchetti et al., 2004).
Chestnut flour is reported to have the following composition: 10.79% moisture, 47.80% starch, 21.51% sugar, 9.50% dietary fiber, 3.80% fat, 4.61% protein, and 1.99% ash in a study for the creation of gluten-free bread (Demirkesen et al., 2010).

ROSEHIP AND ROSEHIP POWDER

The rose plant's pseudo fruit is known as a rose hip (RH). According to Chubasik et al. (2008), various species of rosehips, particularly *Rosa canina* L., are regarded as significant sources of both polyphenols and vitamin C. The fact that RH's chemical composition varies based on the cultivar, growing area, climate, maturity, growing practice, and preservation circumstances is an intriguing aspect. Significant changes in RH's organic acids, phenolics, sugars, water-soluble vitamins, and minerals have been noted by numerous researchers (Ercisli, 2007). The presence of phenolics in Rosaceae fruits may in part be responsible for their physiological properties. Phenolics have a wide range of biochemical activity, some of which are anti-mutagenic, anti-carcinogenic, and antioxidant. The high ascorbic acid content of Rosaceae fruits might additionally have a role in their physiological actions. Numerous biochemical processes, such as antioxidant and anti-carcinogenic characteristics, are carried out by ascorbic acid. According to studies (Gao et al., 2000; Ercisli, 2007), the ascorbic acid content of RH ranged from 140 to 1100 mg/100 ml, with *Rosa canina* having the highest concentration at 880 mg/100 ml.
RH also includes pectin, carotenoids, tannins, tocopherol, bioflavonoids, sugars, organic acids, amino acids, and essential oils in addition to vitamin C. *Rosa canina* RH has a nitrogen level of 0.98%. Potassium and phosphorus values are 4860 ppm and 5467 ppm, respectively. RH has calcium and magnesium values of 2867 ppm and 1254 ppm,

respectively, while quantities of iron, copper, manganese, and zinc are 27, 56 and 30 ppm.

Vital fatty acids, which are long-chain, polyunsaturated fatty acids, are another vital component of rosehips. Linoleic and -linolenic acids are important fatty acids that control a variety of physiological processes, including blood viscosity, blood pressure, neuronal function, membrane fluidity, immunological, inflammatory, and many others. *Rosa canina* has 1.78% total fat. *Rosa canina* includes the following main fatty acids in the following proportions: lauric acid (4.88%), palmitic acid (16.4%), linoleic acid (16.0%), linolenic acid (40.5%), and nonadecylic acid (4.74%) (Ercisli, 2007).

Another vital component of rosehips that ought to be mentioned is the galactolipid. According to research, this bioactive molecule exhibits anticancer and anti-inflammatory properties with no reported toxicity (Larsen et al., 2003). More studies and investigations are necessary to properly grasp the potential benefits of *Rosa canina* for human health, despite the fact that the data in support of its use is quite encouraging.

Ascorbic acid, or vitamin C, is abundant in rosehips, which contain 426 milligrams of it in every 100 grams of fruit. According to the Institute of Medicine's 2000 recommendations, men should consume 90 mg of vitamin C daily, while women should consume 75 mg. RH also has a high lycopene content, with 6.8 mg per 100 g of wild RH.

THE HEALTH IMPACT OF USING CHESTNUT FLOUR AND ROSEHIP POWDER AS A FUNCTIONAL FOOD INGREDIENT

Chestnuts as a source of gluten free flour for celiac disease

One of the best-known use of gluten-free flours, such as chestnut flour, is for products that do not contain gluten and that are aimed for consumers with Celiac Disease. Celiac disease (gluten enteropathy), which is a lifelong intolerance to gluten from wheat and other grains that contain proteins comparable to gluten, for example barley, rye, and oats, is recognized as a proximal illness of the small intestine. Instead of using the flour from these cereals, products that use other fruit and vegetable flours should be developed in order to aid in the treatment of this illness through nutrition. People with celiac disease must adhere to a rigorous gluten-free diet that is frequently imbalanced and deficient in nutrients (Kupper, 2005; Chand & Mihas, 2006). Because gluten-free goods are likely to have lower nutritional content than their gluten-rich equivalents, consumers who are sensitive to gluten are searching for high-quality foods (Rocchetti et al., 2019).

The demand for gluten-free goods has rapidly increased in recent years, but celiac patients still need access to fresh, higher-quality goods. Making gluten-free products is difficult because gluten affects a number of crucial structural, rheological, and organoleptic characteristics of bread, snacks, and pasta. There isn't a direct alternative to gluten at the moment. Instead, gluten-free foods are made using a mixture of unfortified refined grain flour, a few hydrocolloids, and proteins. Alternative flours can be used to create acceptable gluten-free products while also enhancing their nutritional value and glycemic index (do Nascimento et al., 2014).

A lot of studies (Demirkesen et al., 2010; Aguilar et al., 2016; Koca et al., 2018; Torra et al., 2021) investigated the utilization and addition of chestnut flour to the composition of certain food products such as biscuits, cookies, bread, cakes, noodles, pasta, muffins, etc., and showed that the products that were developed, are a great alternative for traditional products, that can be consumed by celiac patients.

Chestnuts as a source of dietary fibers

A key ingredient in chestnuts is fiber. On a dry matter (DM) basis, neutral detergent fiber (NDF) makes up 2.7 to 28.9% of the fiber fractions, while acid detergent fiber (ADF) ranges from 0.5 to 4.5%, whereas acid detergent lignin (ADL) merely makes up 0.02 to 1.3% and cellulose makes up 0.5 to 3.6% (DeVries et al., 1999).

Dietary fibers are associated with positive health effects, including “stimulation of *Bifidobacterium* and *Lactobacillus* in the intestine, decrease in cholesterol levels, reduction of the risk of cardiovascular diseases, positive regulation of insulin response, increase in anticancer mechanisms and positive effects on the metabolism of blood lipids" (Prosky, 2000).

The process of fermentation of dietary fiber results in the production of short-chain fatty acids. These substances are crucial for ensuring the preservation of colonic integrity and metabolism. Additionally, according to Cook & Sellin (1998), they can be used as therapeutic agents to treat conditions like colitis, antibiotic-associated diarrhea, and colon cancer.

Chestnuts as a source of natural antioxidants

Chestnuts include vitamins such as vitamin E and C. Unsaturated fatty acids are protected against oxidation by vitamin E. From a nutritional standpoint, vitamin E has demonstrated a number of positive effects for human health, including reducing the negative effects of inflammatory diseases (such as rheumatoid arthritis or hepatitis) (Venkatraman & Chu, 1999), boosting the immune system and lowering the risk of cancer (Lee & Man-Fan, 2000), as well as a possible contribution to lowering the viral load in HIV-infected patients (Allard et al., 1998).

It is believed that vitamin C, the most significant hydrophilic antioxidant, is essential for protecting against illnesses and the degenerative processes brought on by oxidative stress (Retsky et al., 1993). Other organic acids, including citric, malic, quinic, fumaric, and oxalic acids, have also been found in chestnut fruits in addition to ascorbic acid.

It was found that several organic acids had high ranges, presumably as a result of the various extraction techniques used.

Due to their antioxidant action, organic acids may have a preventive impact against a variety of diseases (Carocho et al., 2013).

Inflammatory illnesses, ischemic diseases, cancer, hemochromatosis, emphysema, gastric ulcers, hypertension and preeclampsia, neurological conditions, alcoholism, smoking-related diseases, and others are among the human diseases that can be prevented by the antioxidants found in natural products (Uttara et al., 2009).

Health effect of rosehips consumption

Galactolipid in rosehips gives a unique anti-inflammatory effect. To maximize the preservation of phytochemicals, a standardized rosehip powder was developed. This powder has shown clinical advantages in illnesses like osteoarthritis, rheumatoid arthritis, and inflammatory bowel disease in addition to antioxidant and anti-inflammatory action.

Rosehips are high in vitamin C, as was previously mentioned. Vitamin C, also referred to as L-ascorbic acid, is an essential water-soluble vitamin. Humans are unable to produce vitamin C internally, unlike the majority of animals (Li & Schellhorn, 2007). Numerous biological processes depend on vitamin C, including the formation of collagen, L-carnitine, and norepinephrine. Alpha-tocopherol (vitamin E) and vitamin C have both been found to replenish other antioxidants in the body, making them both significant physiological antioxidants (Fan et al., 2014).

Vitamin C can modify the immune system's response (Carr & Frei, 1999; Jacob & Sotoudeh, 2002), restrict the development of carcinogens such nitrosamines in vivo, and possibly lessen oxidative damage (antioxidant function) that might cause cancer (Li & Schellhorn, 2007). According to the majority of case-control studies (Carr & Frei, 1999; Jacob & Sotoudeh, 2002), there is a negative correlation between dietary vitamin C intake and malignancies that affect the breast, lung, colon or rectum, stomach, oral cavity, larynx or throat, and esophagus. However, there is conflicting information regarding how much dietary vitamin C consumption affects cancer risk. Additionally, the majority of research trials indicate that taking extra vitamin C by itself or in combination with other nutrients has little advantage in terms of preventing cancer (Fan et al., 2014).

Additionally, cancer patients' plasma levels of vitamin C are lower than those of controls (Carr & Frei, 1999).

High-dose intravenous vitamin C therapy is frequently used to treat cancer. According to research done by Casciari et al. (2001), low dosages of ascorbate were cytoprotective but high levels enhanced cancer cell death. Padayatty et al. (2006) demonstrated that intravenous approaches produced plasma concentrations that were approximately 25 times greater than oral vitamin C therapy.

Rosehip aids in reducing the signs and symptoms of rheumatoid arthritis, osteoarthritis, and other conditions. The most prevalent type of arthritis is osteoarthritis. It is a long-term disorder where cartilage deteriorates. As a result of the bones rubbing against one another, stiffness, discomfort, and decreased joint motion result. Recent research has revealed that inflammatory mediators, such as prostaglandins, chemokines, and cytokines, are crucial for the development and maintenance of osteoarthritis (Berenbaum, 2013).

Numerous investigations have been carried out to assess the *in vitro* antioxidant capacities of rosehips and their derivatives. A 50% ethanol crude extract of RHP and its phenolic, ascorbic, and lipophilic fractions were studied by Gao et al. in 2000. The lipid peroxidation (2,2'-azobis (2,4-dimethylvaleronitrile: AMVN) and inhibition (2,2'-Azobis(2-amidino-propane) dihydrochloride: AAPH) tests) and Trolox-equivalent antioxidant capacity (TEAC) assays all revealed high antioxidant activity. According to the relationship between total antioxidant capacity and antioxidant concentration, the phenolic fraction significantly contributed to the antioxidant activity, but the lipophilic component was the most efficient.

In a 2010 study, Egea et al. evaluated the hydroxyl radical (OH•) and hydrogen peroxide (H_2O_2) abatement and total antioxidant capacity (TEAC) of *Rosa canina* RH and five other fruits. The fruits' total phenolic, ascorbic acid, and carotenoid contents were also examined. *Rosa canina* had a significantly higher phenolic and carotenoid content than the other fruits examined. *Rosa canina* RH had a high ascorbic acid concentration, which was indicative of its increased efficacy in the TEAC experiment and against H_2O_2 species. Just phenolics and carotenoids exhibited a minimal connection with the TEAC assay after a collection assessment between every antioxidant and every phytonutrient (Egea et al., 2010). The main ingredient in *Rosa canina*'s seeds, tiliroside, has been shown to have anti-obesity and anti-diabetic properties by promoting the oxidation of fatty acids in the skeletal muscle and liver (Ninomiya et al., 2007; Nagamoto et al., 2013).

CURRENT TRENDS IN EXPLOITING THE FUNCTIONAL POTENTIAL OF CHESTNUT FLOUR AND ROSEHIP POWDER

Studies concerning the utilization of chestnut flour (CF) as a replacement or in addition to traditional raw materials have shown that using CF not only makes the food product more acceptable from a taste point of view, but also fortifies it, and gives it functional properties. In a study (Inkaya et al., 2009) on the functional properties of CF and potential utilization in low-fat cookies, showed that CF is a material that is suitable for cookie production, that depending on the type of CF used, either had no deteriorative effect, or had an improving effect on various properties of the cookie. Dall'Asta et al. (2013) studied the effects of CF supplementation on the physicochemical properties of bread. The results of the study showed that, depending on the content of CF they were formulated with, breads could have a higher antioxidant capacity. Also, compared to regular wheat bread, the breads containing chestnut flour showed a higher amount of volatiles. Bread made with 20 g/100 g of CF showed a heterogenous crumb structure, a less dark color, lower hardness, resulting in a product that would meet consumer satisfaction (Dall'Asta et al., 2013).

Studies on the effect of chestnut flour supplementation on the physicochemical properties and oxidative stability of gluten-free biscuits during storage (Paciulli et al., 2016) were conducted on two lots of biscuits using different flour mixtures. Results indicated that increasing the percentage of CF lead to a color improvement, but excessive amounts of CF, led to a product that was too hard texture-wise. The stability of the color obtained by using CF was confirmed during shelf life, and so was the oxidative stability. The study also made with CF. New pasta products were developed by incorporating chestnut flour and bee pollen, with the intention of creating fortified pasta. The conclusion was that CF represents a promising ingredient for the development of functional, fresh and dried pasta formulas, because of the results. The pasta that was enriched with CF and bee pollen presented a higher amount of fiber, due to the partial replacement of wheat flour with CF. The fat content of the enriched pasta was also notably higher compared to the regular, wheat flour pasta, and, moreover, it was shown to have higher quality because of the higher percentage of unsaturated fatty acids in CF. The enriched pasta also showed a higher protein amount, with high quality proteins and essential amino acids (Brochard et al., 2021).

Bhatt & Jatav (2017) used water chestnut flour to develop and evaluate extruded puss products that were ready to eat. The final product with a content of 10% chestnut flour had an increased amount of essential minerals, starch and protein, compared to the traditional maize, rice flour extruded puff product. The developed product resulted in higher quality, having an overall high acceptability, good sensory qualities, and more nutritional elements. What was interesting in this study was the fact that the product that was developed, was said to be a good nutritional ready-to-eat food for low income groups in developing countries, and also for people with a higher interest in health. This aspect is very important nowadays, when all industries, including the food industry, are searching for ways to make products that can be available for all consumers, no matter their social status or place of living.

An investigation by Dulger & Mete (2020), showed the effect of chestnut flour addition on the nutritional and quality properties of noodles. As in previously mentioned studies, it was concluded that the higher the percentage of CF, the higher the total ash content and dietary fiber was, while the caloric value decreased, compared to the control sample. Thus, it is underlined that chestnut flour containing products can be used in diets, and can also be beneficial for health.

From a sensory point of view, the noodles containing chestnut flour were shown to be acceptable.

Another study shows that chestnut flour can also be used in meat products, such as sausages. Sirini et al. (2020), tested the effects of chestnut flour and probiotic microorganisms on the functionality of dry-cured meat sausages. The results of the study showed that incorporating CF and probiotics in traditional meat products could be a good alternative for adding value to said product. The improvements provided were tendencies to reproduce greater amounts of lactic acid, reducing the presence of residual nitrite, increasing dietary fiber and polyphenols. The ingredients that were incorporated, did not produce significant organoleptic changes, and the final product was acceptable in consumer's preferences.

The suitability of using Rosehip powder as a natural substitute for synthetic ascorbic acid in the bread-making process was examined in a study by Vartolomei & Turtoi (2021). By reducing the moisture, protein, and wet gluten content, raising the ash, fiber, and carbohydrate content, and adding vitamin C at levels corresponding to the amount of rosehip powder used, the replacement of wheat flour with rosehip powder altered the make-up of mixture flours. It also identified variations in bread physico-chemical properties and dough farinographic qualities.

The higher fiber content of all mixed flours led to greater water absorption as compared to the control specimen and flour improved with ascorbic acid.

The rosehip powder's vitamin C content, synthetic ascorbic acid, and the high fiber content of the combination flours all had an impact on the dough growth time, dough stability, and softening degree changes, which were all statistically significant. Furthermore, the inclusion of rosehip powder had a favorable impact on the farinographic quality number. In comparison to the control bread, the bread made from wheat flour and rosehip powder showed a positive evolution of physicochemical properties, including a noticeable increase in height, volume, specific volume, moisture, acidity, and porosity as well as a slight decrease in elasticity. These findings suggest that rosehip powder could take the role of manufactured ascorbic acid while baking bread (Vartolomei & Turtoi, 2021).

CONCLUSIONS

The population of our planet is rising, while the resources are decreasing. In order to feed the present and future generations, a new approach to human nutrition is needed. The development of novel food products that have added value in terms of nutritional and functional properties is the focus of the research in the field of food. The new generation of products should be in accordance with the environmental directives, sustainable, should do no harm, and should also ensure equitability of the market. The novelty products need to meet consumer needs and expectations while making sure that everyone, no matter the social status and the place they live, has access to said products. For novelty products, new materials, even unconventional ones, are needed. There are still plenty of resources that could be put to use in the creation of better products but have either not been exploited at all or not enough. The chestnut is one of these resources. A sustainable resource that has not been sufficiently exploited, could be the answer to many issues the planet faces: from food and nutrition, to waste reduction. The knowledge gathered from all the references cited below is proof that food and nutrition-wise, chestnuts and chestnut flour is an ingredient fit for the future. Further studies on the matter must be conducted, in order to fill the gaps in today's knowledge, and to explore thoroughly the effects this novel material might have, both on the food industry, and other industries as well.

REFERENCES

Aguilar, N., Albanell, E., Miñarro, B., & Capellas, M. (2016). Chestnut flour sourdough for gluten-free bread making. *European Food Research and Technology*, *242*, 1795–1802.

Allard, J. P., Aghdassi, E., Chau, J., Tam, C., Kovacs, C. M., Salit, I. E., & Walmsley, S. L. (1998). Effects of vitamin E and C supplementation on oxidative stress and viral load in HIV-infected subjects. *AIDS* (London, England), 12(13), 1653–1659.

Attanasio, G., Cinquanta, L., Albanese, D., & Matteo, M.D. (2004). Effects of drying temperatures on physicochemical properties of dried and rehydrated chestnuts (*Castanea sativa*). *Food Chemistry, 88,* 583–90.

Berenbaum, F. (2013). Osteoarthritis as an inflammatory disease (osteoarthritis is not osteoarthrosis!). *Osteoarthritis and Cartilage, 21,* 16–21.

Bhatt, D., & Jatav, A. (2017). Development and evaluation of ready-to-eat extruded puff product using water chestnut flour. *Journal of Environmental Science, Toxicology and Food Technology*, *11*, 21–26.

Brochard, M., Correia, P., Barroca, M.J., & Guiné, R.P.F. (2021). Development of a new pasta product by the incorporation of chestnut flour and bee pollen. *Applied Sciences*, *11*, 6617.

Carocho, M., Barros, L., Antonio, A. L., Barreira, J. C., Bento, A., Kaluska, I., & Ferreira, I. C. (2013). Analysis of organic acids in electron beam irradiated chestnuts (Castanea sativa Mill.): Effects of radiation dose and storage time. *Food and chemical toxicology: an international journal published for the British Industrial Biological Research Association*, 55, 348–352.

Carr, A.C., & Frei, B. (1999). Toward a new recommended dietary allowance for vitamin C based on antioxidant and health effects in humans. *The American Journal of Clinical Nutrition, 69,* 1086–1107.

Casciari, J.J., Riordan, N.H., Schmidt, T.L., Meng, X.L., Jackson, J.A., & Riordan, H.D. (2001). Cytotoxicity of ascorbate, lipoic acid, and other antioxidants in hollow fibre in vitro tumours. *British Journal of Cancer, 84,* 1544–1550.

Chand, N., & Mihas, A.A. (2006). Celiac Disease, *Journal of Clinical Gastroenterology*, *40*, 3–14.

Chrubasik, C., Roufogalis, B.D., Müller-Ladner, U., & Chrubasik, S. (2008). A systematic review on the *Rosa canina* effect and efficacy profiles. *Phytotherapy Research*, *22*, 725–733.

Cook, S.I., & Sellin, J.H. (1998). Review article: short chain fatty acids in health and disease. *Alimentary Pharmacology & Therapeutics, 12,* 499–507.

Cruz, B., Abraão, A., Lemos, A., & Nunes, F. M. (2013). Chemical composition and functional properties of native chestnut starch (Castanea sativa Mill). *Carbohydrate Polymers*, *94,* 594–602.

Dall'Asta, C., Cirlini, M., Morini, E., Rinaldi, M., Ganino, T., & Chiavaro, E. (2013). Effect of chestnut flour supplementation on physico-chemical properties and volatiles in breadmaking. *Lebensmittel-Wissenschaft und-Technologie*, *53*, 233–239.

Delgado, T, & Pereira, A.J. (2016). Bioactive compounds of chestnuts as health promoters. In Luis Rodrigues da Silva, Branca Maria Silva (Ed.), *Natural Bioactive compounds from fruits and vegetables as health promoters,* 132–154.

Demirkesen Mert, I., Mert, B., Sumnu, G., & Sahin, S. (2010). Utilization of chestnut flour in gluten-free bread formulations. *Journal of Food Engineering*, *101*, 329–336.

DeVries, J.W., Prosky, L., Li, B., & Cho, S. (1999). A historical perspective on defining dietary fiber. *Cereal Foods World, 44*, 367–9.

do Nascimento, A., Fiates, G., Anjos, A., & Teixeira, E. (2014). Availability, cost and nutritional composition of gluten-free products. *British Food Journal*, *116*, 1842–1852.

Dulger, D., & Mete, M. (2020). An investigation of the effect of chestnut flour additive on the nutritional and quality properties of noodle. *Gida. The Journal of Food, 45,* 1061–1072.

Egea, I., Sánchez-Bel, P., Romojaro, F., & Pretel, M.T. (2010). Six edible wild fruits as potential antioxidant additives or nutritional supplements. *Plants Foods for Human Nutrition, 65,* 121–129.

Ercisli, S. (2007). Chemical composition of fruits in some rose (Rosa spp.) species. *Food Chemistry*, *104,* 1379–1384.

Fan, C., Pacier, C., & Martirosyan, D. (2014). Rosehip (*Rosa canina* L): A functional food perspective. *Functional Foods in Health and Disease, 4*, 493–509.

FAO. (2018). *The future of food and agriculture – Alternative pathways to 2050*. Rome. 224 pp. Licence: CC BY-NC-SA 3.0 IGO.

Gao, X., Björk, L., Trajkovski, V., & Uggla, M. (2000). Evaluation of antioxidant activities of rosehip ethanol extracts in different test systems. *Journal of the Science of Food and Agriculture, 80*, 2021–2027.

Goncearov M., Petcu C., & Antoniu S. (2004). Hazard analysis critical control points - a modern concept regarding food quality and safety. *Scientific Papers: Veterinary Medicine*, 37, 868-872.

Gonciarov, M, Neagu, I., Ghimpeteanu, O.M., & Petcu, C.D. (2015). General principles and regulations on obtaining products from genetically modified organism, *Journal of Biotechnology*, 208, S72.

Hecht, S.S. (1997). Approaches to cancer prevention based on an understanding of N-nitrosamine carcinogenesis. *Proc Soc Exp Biol Med*, 216, 81–191.

Inkaya, A., Gocmen, D., Ozturk, S., & Koksel, H. (2009). Investigation on the functional properties of chestnut flours and their potential utilization in low-fat cookies. *Food Science and Biotechnology*, *18,* 1404–1410.

Institute of Medicine (US) Panel on Dietary Antioxidants and Related Compounds. (2000). *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. National Academies Press (US).

Itoh, N., Masuo, Y., Yoshida, Y., Cynshi, O., Jishage, K., & Niki, E. (2006). Gamma-Tocopherol attenuates MPTP-induced dopamine loss more efficiently than alpha-tocopherol in mouse brain. *Neuroscience letters, 403*, 136–140.

Jacob, R.A., & Sotoudeh, G. (2002). Vitamin C function and status in chronic disease. *Nutrition in Clinical Car*e, *5,* 66–74.

Koca, I., Yılmaz, V., & Tekgüler, B. (2018). A gluten-free food: Tarhana with chestnut. *Acta Horticulturae,* 1220, 195–202.

Kupper, C. (2005). Dietary guidelines and implementation for celiac disease. *Gastroenterology, 128,* 330.

Larsen, E., Kharazmi, A., Christensen, L.P., & Christensen, S.B. (2003). An antiinflammatory galactolipid from rose hip (*Rosa canina*) that inhibits chemotaxis of human peripheral blood neutrophils in vitro. *Journal of Natural Products,* 66, 994–995.

Lee, C. Y., & Man-Fan Wan, J. (2000). Vitamin E supplementation improves cell-mediated immunity and oxidative stress of Asian men and women. *The Journal of nutrition*, *130*, 2932–2937.

Li, Y., & Schellhorn, H.E. (2007). New developments and novel therapeutic perspectives for vitamin C. *The Journal of Nutrition,137*, 2171–2184.

Mete, M., & Dulger Altiner, D. (2017). Chestnut flour and applications of utilization. *International Journal of Food Engineering Research, 3,* 9–16.

Nagatomo, A., Nishida, N., Matsuura, Y., & Shibata, N. (2013). Rosehip extract inhibits lipid accumulation in white adipose tissue by suppressing the expression of peroxisome proliferator-activated receptor gamma. *Preventive Nutrition and Food Science,18,* 85–91.

Ninomiya, K., Matsuda, H., Kubo, M., Morikawa, T., Nishida, N., & Yoshikawa, M. (2007). Potent anti-obese principle from *Rosa canina*: structural requirements and mode of action of trans-tiliroside. *Bioorganic & medicinal chemistry letters*, *17*, 3059–3064.

Paciulli, M., Rinaldi, M., Cirlini, M., Scazzina, F., & Chiavaro, E. (2016). Chestnut flour addition in commercial gluten-free bread: A shelf-life study. *Lwt - Food Science and Technology, 70*, 88–95.

Padayatty, S. J., Riordan, H. D., Hewitt, S. M., Katz, A., Hoffer, L. J., & Levine, M. (2006). Intravenously administered vitamin C as cancer therapy: three *cases*. *CMAJ: Canadian Medical Association journal = journal de l'Association medicale canadienne*, *174*, 937–942.

Pereira-Lorenzo, S., Ramos-Cabrer, A., Díaz-Hernández, M.B., Ara, M., & Ríos-Mesa, D. (2006). Chemical composition of chestnut cultivars from Spain. *Scientia Horticulturae*, *107,* 306–314.

Petcu, C.D., Mihai, O.D., Tăpăloagă, D., Gheorghe-Irimia, R.A., Pogurschi, E.N., Militaru, M., Borda, C., & Ghimpețeanu, O.M. (2023). Effects of Plant-Based Antioxidants in Animal Diets and Meat Products: A Review. *Foods*, 12, 6, 1334.

Pizzoferrato, L., Rotilio, G., & Paci, M. (1999). Modification of Structure and Digestibility of Chestnut Starch upon Cooking: A Solid State 13 C CP MAS NMR and Enzymatic Degradation Study. *Journal of agricultural and food chemistry*, *47*, 4060–4063.

Predescu, C., Papuc, C., Petcu, C., Goran, G., & Rus, A.E. (2018). The effect of some polyphenols on minced pork during refrigeration compared with ascorbic acid. *Bull. UASVM Food Sci. Technol*., 75, 36–42.

Prosky, L. (2000). When is dietary fiber considered a functional food? *Biofactors, 12,* 289–97.

Retsky, K. L., Freeman, M. W., & Frei, B. (1993). Ascorbic acid oxidation product(s) protect human low density lipoprotein against atherogenic modification. Anti- rather than prooxidant activity of vitamin C in the presence of transition metal ions. *The Journal of biological chemistry*, 268, 1304–1309.

Rocchetti, G., Lucini, L., Rodriguez, J. M. L., Barba, F. J., & Giuberti, G. (2019). Gluten-free flours from cereals, pseudocereals and legumes: Phenolic fingerprints and in vitro antioxidant properties. *Food chemistry*, *271*, 157–164.

Sacchetti, G., Pinnavaia, G.G., Guidolin, E., & Dalla Rosa, M. (2004). Effects of extrusion temperature and feed composition on the functional, physical and sensory properties of chestnut and rice 299 flour-based snack-like products. *Food Research International*, *37,* 527–534.

Savu, C. & Petcu, C.D. (2002). *Hygiene and control of products of animal origin.* Bucharest, RO: Semne Publishing House.

Sirini, N., Roldán, A., Lucas-González, R., Fernández-López, J., ViudaMartos, M., Pérez-Álvarez, J.A., Frizzo, L.S, & Rosmini, M.R. (2020), Effect of chestnut flour and probiotic microorganism on the functionality of dry-cured meat sausages*, LWT - Food Science and Technology*, *134,* 110197.

Torra, M., Belorio, M., Ayuso, M., Carocho, M., Ferreira, I.C.F.R., Barros, L., & Gómez, M. (2021). Chickpea and Chestnut Flours as Non-Gluten Alternatives in Cookies. *Foods, 10,* 911.

Uttara, B., Singh, A. V., Zamboni, P., & Mahajan, R. T. (2009). Oxidative stress and neurodegenerative diseases: a review of upstream and downstream antioxidant therapeutic options. *Current neuropharmacology*, *7*, 65–74.

Vartolomei, N., & Turtoi, M. (2021). The Influence of the addition of rosehip powder to wheat flour on the dough farinographic properties and bread physico-chemical characteristics. *Applied Sciences, 11,* 12035.

Vasconcelos, M., Bennett, R., Quideau, S., Jacquet, R., Rosa, E., & Ferreira-Cardoso, J. (2010). Evaluating the potential of chestnut (*Castanea sativa* Mill.) fruit pericarp and integument as a source of tocopherols, pigments and polyphenols. *Industrial Crops and Products*, *31,* 301–311.

Venkatraman, J. T., & Chu, W. C. (1999). Effects of dietary omega-3 and omega-6 lipids and vitamin E on serum cytokines, lipid mediators and anti-DNA antibodies in a mouse model for rheumatoid arthritis. *Journal of the American College of Nutrition*, *18,* 602–613.