PUMPKIN USED IN OBTAINING GLUTEN FREE BAKERY PRODUCTS

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Abstract

The incidence of metabolic diseases among the active population has an upward trend, which requires the diversification of the assortment range of gluten free products. The developed an innovative technology for obtaining gluten-free products with organic pumpkin pulp meets the required of a consumers segment, with gluten intolerance. Pumpkin is an ingredient used in Romanian gastronomy, and not only, in certain periods of the year, respectively in the winter season, and for this reason we recommendation integration in products with added value and functional role. Pumpkin is a vegetable rich in β-carotene, carbohydrates, dietary fiber, etc., with special sensory properties agreed by the Romanian consumers, with a low caloric content. We also aim to present the different technology and formula that are currently used to obtain foods product with pumpkin and the importance for health and diet.

Keywords: *bakery products, gluten-free products, pumpkin*

INTRODUCTION

Pumpkin (*Cucurbita maxima*) is annual climber plant, belonging to *Cucurbitacae* family, which includes about 130 genera and more than 800 species [50]. In 1584, French explorer Jacques Cartier found great round orange-skinned squash the likes of which he had never seen before. Even though Jacques Cartier traveled 3,500 miles to find pumpkins, the pumpkins have traveled farther. Native to Central America, pumpkins were carried north by indigenous tribes and grown well into Canada [71]. Today, the pumpkins have found its usefulness in animal husbandry (feed for livestock), in food industry used in baked into pies, breads, cakes, muffins and cheesecakes.

The English term "pumpkin" for pumpkin comes from the old form "*pumpion*" derived from the obsolete form "*pompon*" or "*popon*" from French (in Old French "*pepon*"). They come from the Latin "*pepon*" (watermelon).

The Celts who lived 2000 years ago in the area where Ireland, England and northern France are now, celebrated the coming of the New Year on November 1st. This day celebrated the end of summer and rich harvests, and the beginning of a new season, dark and cold. From them remained the celebration where pumpkins are brought, and which is associated in most countries, including Romania, with the Halloween celebration.

Pumpkin it is cultivated all over the world, being a much-appreciated species because it does not require special attention in the culture, but the fruit is large and thorny. It was introduced at the end of the century. XVI in Europe, and the big growers are Italy and Spain. In Romania, it is grown in individual gardens, in tandem with corn crops or in pure culture. Popular species of pumpkin are *Curcubita maxima, Curcubita moschata* and *Curcubita pepo*. It is known for its edible fruit, seed and greens. Fruit is used as vegetable and used in preparation of squashes. Seeds are used in the preparation of sweets or consumed as snacks. In parts of the world pumpkin is used as herbal medicine because of its biologically active components. Although there are no official data reported, the production of pumpkins is high, mainly amongst small farmers and especially of the *Cucurbita moschata* and *Cucurbita maxima* species.

SOCIAL DEMAND FOR GLUTEN-FREE FOOD

Globally, there is an upward trend in the number of people suffering from autoimmune diseases and food intolerances that occur due to lifestyle, diet, environmental conditions, etc. The most worrying problem is that related to gluten intolerance, which if at first was only a problem that was specific only to certain populations, known to have predispositions towards the development of celiac disease.

Worldwide, 1% of the population is considered to suffer from celiac disease, but it is believed that the real percentage is higher [35]. It also found that the global prevalence of celiac disease would be 1.4% [63]. The reported prevalence of celiac disease worldwide is steadily increasing, partly attributed to the development of clinical test detection techniques and improved diagnostic capacity, mainly in Australia, Europe and North America [63; 35]. A meta-analysis found that the global incidence of celiac disease is increasing "significantly". [63] noted that "a real increase in the incidence of celiac disease is occurring beyond diagnostic improvements, most likely due to environmental factors". Celiac disease is a condition that affects people of all races, sexes and ages.

Previous studies suggest that people needing a gluten free diet have an unbalanced intake of proteins, carbohydrates and fats, as well as an insufficient consumption of dietary fiber [11; 69] due to the poor nutritional quality of gluten free products [57]. Therefore, gluten-free products represent a major challenge for the food industry in terms of organoleptic, technological and nutritional characteristics. The absence of gluten has been shown to affect starch digestibility, increasing the postprandial glycemic response [59] another problem that needs to be solved.

Celiac disease is known as an autoimmune condition and inflammatory disease triggered by the presence of gluten in the upper small intestine [28], which untreated or incorrectly treated can have important health consequences such as osteoporosis, infertility, repeated abortions, anemia through iron deficiency and certain forms of cancer. Symptoms in people with celiac disease include malnutrition, diarrhea, stunted growth, anemia, and fatigue [28]. Food allergy is a costly, potentially life-threatening condition [24] if a gluten-free diet and healthy lifestyle are not strictly followed.

Gluten is defined as the rubbery dough-forming protein that remains when wheat flour is washed to remove starch [65; 70]. Gluten is characterised by a unique high content of glutamin and glutenin. It consists of glutenin and gliadin, two seed storage proteins, which have been shown to trigger the pathophysiological and clinical features of coeliac disease. Glutenin is a high-molecular-weight protein fraction insoluble in alcohol. The alcohol-soluble gliadins contain mainly monomeric low-molecular-weight proteins. Gliadins belong to a group of plant storage proteins rich in proline (prolamins). Gliadins contain repetitive peptide units such as QPQPFPPQQPYP and PQQPFPQ. These repetitive peptide units are contained in α, γ, ω subtypes of gliadin, which have all been shown to elicit the disease. A 33-mer peptide (LQLQPSTQPQLPYPQPQLPYPQPQLPYPQPQPF) was the first primary initiator of the inflammatory response in coeliac disease identified [62].

In conclusion, coeliac disease is a life-long autoimmune systemic disorder triggered by gluten and similar cereal storage proteins present in wheat, rye and barley. Its prevalence is estimated to be 0.5 to 1%, and in some areas even more. A gluten-free diet is the conventional treatment. The limit values of 20 and 100 mg/kg of gluten in “gluten-free” and “very low gluten” foods, respectively, help in managing the diet of most patients with coeliac efficiently.

In Europe, according to the EuroPrevall community surveys, the prevalence of self-reported food allergies in European adults ranges from 2% to 37% for any food and from 1% to 19% for 24 selected potentially allergenic foods [42; 23]. EFSA has updated its scientific advice on food allergens and a looks in detail at all the allergenic products and substances whose presence in food must be indicated on labelling, according to EU law. These include cereals containing gluten, milk, eggs, nuts, peanuts, soybeans, fish, crustaceans, mollusks, celery, lupine, sesame, mustard and sulphites [18].

The Opinion is based on a review of all published data on the prevalence of food allergies in Europe. For each food product or substance on the EU list of allergens, information is given on: the prevalence of allergies in unselected populations; proteins identified as food allergens; cross-reactivities; the effects of food processing on the allergenicity of the food or ingredient; methods for detecting

allergens and allergenic foods, including mass spectrometry and DNA methods as well as the more common immunological approach; doses observed to trigger adverse reactions in sensitive individuals.

The results showed that at the level of 2014, in the EU about 75% of allergic reactions among children are caused by egg, peanut, cows' milk, fish and nuts. About 50% of allergic reactions among adults are to fruits of the latex group and of the *Rosaceae* family (which includes apples, pears cherries, raspberries, strawberries and almonds), vegetables of the *Apiaceae* family (which includes celery, carrots and aromatic herbs) and various nuts and peanuts [18].

A gluten-free diet excluding wheat, rye, barley and oats (because oats is commonly contaminated by other grains containing gluten) is the conventional cornerstone treatment for the management of coeliac disease. Owing to individual variation and the clinical heterogeneity of patients with coeliac disease, it is difficult to find an acceptable value for trace amounts of gluten in foods that could be tolerated by the majority of coeliac patients [65; 25].

The usual daily intake of gluten is 15–20 g in the adult European population. In patients with coeliac disease any effort has to be undertaken to exclude gluten/gliadin from the diet.

Based on these observations, *Codex Alimentarius* adopted in 2008 a revised codex standard for foods for special dietary uses addressed to persons intolerant to gluten (*Codex Alimentarius Commission*, 2008). "Gluten-free" foods were defined as dietary foods consisting of or made only from one or more ingredients that do not contain wheat, rye, barley or oats, and in which the gluten content does not exceed 20 mg/kg of the food as sold or distributed to the consumer. In addition, the standard defined foods specially processed to reduce the gluten content to a level > 20 to 100 mg/kg as foods consisting of one or more ingredients from wheat, rye, barley, oats or their crossbred varieties that have been specially processed to reduce the gluten content to these levels. Based on this, the European Commission has issued a Regulation concerning the composition and labelling of foods suitable for people intolerant to gluten, in which the terms "gluten-free" (not exceeding 20 mg/kg) and "very low gluten" (not exceeding 100 mg/kg) are set. It came into force on 1 January 2012[18].

The limit values of 20 and 100 mg/kg of gluten in "gluten-free" and "very low gluten" foods, respectively, help in managing the diet of most patients with coeliac disease efficiently.

Although the labelling of "*gluten-free*" and "*very low gluten*" foods is helpful for the dietary management of most patients with coeliac disease, questions regarding low-dose and long-term gluten sensitivity, and the testing and toxicity of glutenin and gluten hydrolysates, remain open. New standards, new methods of detection of gluten-related proteins in foods and new therapies for coeliac disease are likely to be developed in the future [17; 64].

PUMPKIN USED AS A GOOD EDIBLE PLANT

Pumpkin is an edible food which can be included in our daily diet that can give various health benefits to improve our overall health.

The most important edible parts of the pumpkin are: (1) *pumpkin seeds* - is its low-fat and protein-rich, and the edible oil obtained from the pumpkin seed is rich in oleic acid; (2) the second most important part is its *pumpkin pulp*: (a) the unripe fruit is cooked as a vegetable, while (b) the ripe fruit is sweet. Pumpkin pulp is used for culinary purposes, to prepare various dishes, and in food industry for the production of pastries, baked goods, juices, jams, marinades, and baby food, soft or slightly alcoholic beverages [see fig. 1; 9; 55; 33].

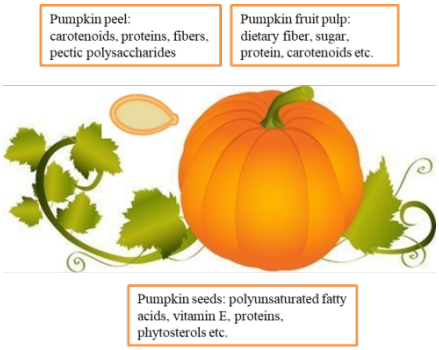


Fig. 1. The nutritional value of pumpkin by components

Pumpkin pulp Nowadays, fruit and vegetable industries produce large quantities of by-products possessing huge economic value. Almost 25 to 60% of the weight of fruits and vegetables are comprised of by-products including greater percentage of peels. These by-products are composed of an interesting chemical composition, leading their potential use in food products.

Thus, pumpkin peel is considered as waste material and discarded, but it contains essential nutrients in sufficient quantities. Dietary fibers such as pectin from pumpkin peels have been reported to slow down the starch digestion, which helps to cure diet-related diseases such as diabetes [10]. Studies have been carried out on the influence of pectic polysaccharides from the peel on the intestinal microflora. Thus, *Jun et al. 2006* extracted the pectic polysaccharides from the pumpkin peel and checked its effect on the growth of human intestinal bacteria. The pectic polysaccharide fractions showed growth promoting activity to good intestinal bacteria such as *B. bifidium, B. longum and L. brevis*, whereas growth retarding activity was observed towards bad intestinal bacteria such as *E. coli* and *C. perfringins* [5]. Pumpkin peel can be dehydrated and mixed with other types of flour, thus increasing its nutritional values of the bakery products but also reduces the cost of production as peels are considered as waste material.

Pumpkin seeds Pumpkin seeds are of high protein, low in fat content and they are good source of elements like potassium, magnesium, copper, zinc, selenium and molybdenum [19]. The phyto-constituents of pumpkin make it vital in different types of diet. Pumpkin seeds are rich source of essential nutrients posing positive impacts on health [1]. Oils extracted from raw pumpkin seeds significantly reduced serum triglycerides, total cholesterols, LDL cholesterols, uric acid, creatinine, serum transaminases and urea, whereas serum HDL cholesterols were significantly increased [46]. Pumpkin seed oil extracts exhibited anti-oxidant, anti-bacterial and anti-inflammatory activities therefore, pumpkin seed oil could be a promising source of ingredients for pharmaceutical and food industries [4].

Pumpkin fruit pulp The pandemic period has increased the degree of consumer concern for healthy ingredients, with antioxidant and body strengthening potential. Thus, the pumpkin began to be more and more present in culinary preparations. This concern is also due to the fact that it does not require chemical substances during the entire vegetation period, which makes it much more attractive. Pumpkin is rich in carotenoids, polysaccharides, oils, sterols, para-amino-benzoic acid and good amount of vitamins and minerals. A polysaccharide with low molecular weight (3.5 kDa) extracted from pumpkin displays antioxidant activities towards free radicals and reduce oxidative stress [30; 38; 5].

Nutritional profile of pumpkin, due to presence of adequate amounts of starch and of dietary fibers, especially pectin, has been found to slow down diet related diseases such as diabetes [10].



Fig. 2. Chemical components potentials of pumpkin pulp [5]

Pumpkin pulp is thought to be a source of carotenoids. So far, most studies on the chemical composition of pumpkin pulp have focused on the content of these compounds [8; 22; 32; 60; 15]. In spite of the considerable interest in the chemical and health-promoting properties of pumpkin, there have been few studies on the profile of other bioactive compounds, which are important for nutrition [51; 71]. There are several studies on pumpkins that analyse the composition of carotenoids in different species and varieties, showing high concentrations of these compounds in fresh pumpkins [8; 12; 45].

Pumpkin pulp has large amounts of carotenoids, which are pigments that derive from isoprene and that give flowers, leaves, and fruits a colouration that ranges from yellow to red [47; 48]. Besides the pro-vitamin A activity of some carotenoids, such as β-carotene, β-cryptoxanthin and α-carotene, studies have also indicated that consumption of carotenoids lowers the risk of degenerative and cardiovascular diseases, cataracts, macular degeneration as well as certain types of carcinomas [53].

The results showed that *C. maxima Duchesne* cultivars contain high amounts of individual carotenoids (β-carotene, lutein and zeaxanthin). Also within the same pumpkin species (*C. maxima Duchesne*) for different varieties there are many significant differences in the content of the bioactive compound; the significant differences were found for polyphenolic compounds (sinapic acid, quercetin), minerals (potassium, magnesium, iron) and vitamins (vitamin C, folates) [33; 34].

The main factor that may affect such discrepancies are the environmental conditions, mainly weather conditions, the climate zone, cultivation methods (eg fertilizer use, sowing and harvesting time), storage conditions for harvested pumpkins (temperature, time) [33].

Since there are double bonds in the carbon chain, carotenoids are susceptible to some reactions such as oxidation and isomerisation (cis–trans) during food processing and storage, especially due to light, heat, acids, and oxygen; thus causing loss of colour and reduction of biological activity [29; 53; 56]. In the case of isomerisation, the trans-isomers are more common and stable in foods while cis-isomers are usually formed during food processing [48]. There are many studies correlating the processing, packaging, and storage conditions with changes in the composition of carotenoids in many foods [14; 39; 68]. There are several factors that may affect the stability of these compounds, such as type and physical form of the carotenoid, oxygen concentration, presence of metals, exposure to light, severity of heat treatment, food matrix, amongst others [56]. Hence, the stability of carotenoids in foods varies greatly [37].

USES OF PUMPKIN IN BAKERY PRODUCTS

Globalization has greatly influenced the eating habits of the population, so that they have led to the diversification of the daily diet by including new foods, ingredients and preparations. The increasing influence of society, values and beliefs (related to sustainability, religion, beliefs, ethics or health) have reshaped the attitude and buying behavior of consumers, as well as the food components of a diet [3; 16; 21].Today, we are at the point where the consumer wants to have a balanced, healthy diet that satisfies all their preferences (vegan, vegetarian, flexitarian, etc.). This trend has a great impact in the European community, as reported by the recent data published by the Eurobarometer (80% of European citizens buy sustainable products) [58]. This evolution has led consumers to include new foods and exclude others [20; 13; 37; 66; 67].

The food industry is evolving at a fast pace, driven by a constant change in eating habits and consumer preferences. In recent years, there has been a growing trend in demand and consumption for gluten-free products. This is due to the increase in the number of people with metabolic problems, the awareness of the various benefits brought to health, so that in the panoply of customers we find gluten-intolerant consumers and gluten-tolerant consumers who adopt a healthy lifestyle.

Gluten-free products have a wide range of advantages: they help prevent and treat health problems, they are extremely useful for people suffering from diabetes, autoimmune problems and digestive disorders. Moreover, these foods can be low in fat and are therefore recommended for people who want to lose weight or reduce their fat intake.

The nutritional profile of the pumpkin leads to its incorporation in many recipes of pastries and confectionery. In the last decade, new products have appeared with a functional role on the body. However, as nutritious and beneficial as pumpkin pulp is for the body, the degree of consumer acceptance may vary. This variable can be given by the way in which the pumpkin is added (fresh, baked, mashed, flakes) or the proportion in which it is added. In the case of obtaining gluten-free products, there are also technological problems.

Park In-Duck, in 2012, studied the effects of sweet pumpkin powder (*Cucurbita Maxima* D.) on the quality characteristics of cookies. The cookies were made using different levels of sweet pumpkin flour (10%, 20% and 30%). The most appreciated products were those in which 10% added sweet pumpkin powder was used. Another study, led by *Atuonwu A.C., Akobundu E.N.T.* in 2010, evaluated the nutritional and sensory attributes of pumpkin (*Cucurbita pepo*) seed flour as a substitute for wheat flour in cookie recipes. Physicochemical and sensory evaluation of the cookies showed that replacing wheat flour with up to 10% pumpkin seed flour resulted in acceptable products similar to the control sample (100% wheat flour). Further research by Mustika & Kartika in 2020 showed that pumpkin cookies, where wheat flour was replaced with modified cassava flour, resulted in a high-fiber, low-energy product.

Turksoy et all in 2011 used the addition of pumpkin pulp powder (*Cucurbita moschat* Duch. ex. Poir.) and carrot pulp powder (*Daucus carota* L.) as an additive in cookies with wheat flour (from two different wheat varieties) to which they added different percentages of vegetable powders, respectively 0, 10, 15, 20 and 25%. The addition of pumpkin pulp powder and carrot pulp powder improved the tenderness, color and consumer acceptance of the product. The authors concluded that, in sensory evaluation, the overall acceptability values may have decreased with increasing levels of pumpkin pulp powder and carrot pulp powder.

In the relevant literature, there is a concern for the use of pumpkin pulp, thus Lukin Aleksandr in 2019 [40] carried out a study aimed at obtaining sugary biscuits with the addition of pumpkin pulp. The purpose of this research was to study 3 varieties of pumpkin, in order to develop a technology for the production of sugar cookies with pumpkin puree. In the recipe for sugar cookies, he replaced part of the wheat flour with pumpkin puree from three local pumpkin varieties: "Rossiyanka", "Candy" and "Olga". The tested biscuit samples were prepared by adding pumpkin puree in the amount of 5%, 10% and 15% of the amount of wheat flour. The organoleptic evaluation proved that biscuits with pumpkin puree in the amount of 5% of the flour mass were the most acceptable in terms of the characteristics and appearance of their flavors for further use.

Shabir et al., in 2019, sensory evaluated gluten-free snacks obtained using a mixture of brown rice flour: chestnut flour in proportions of 100/0, 80/20, 60/40 and 40/60, without affecting negatively the sensory properties of the finished products. The mixture with 40% chestnut flour is the most suitable for the production of good quality rice-chestnut flour snacks. This blend showed the notable amount of minerals in addition to a good sensory acceptability score. It has been observed that the snacks made are rich in mineral substances beneficial for human health.[61]

CONCLUSIONS

In conclusion, pumpkin is an edible plant, which can be included in humans' daily diet that can improve human health by curing many diseases. The present study has shown that pumpkin is a rich source of nutrients and phytochemicals exhibiting bio activities in human health. Through good processing, the pumpkin can be completely valorized, each component being a source of substance with high biological and nutritional value that can be incorporated into products or extracted. Incorporation in gluten free products brings a benefit to people suffering from gluten intolerance. Combinations between gluten free and pumpkin flours result in the diversification of the assortment range and the satisfaction of the consumption needs of people with intolerances. Studies on the optimal formulas that lead to products with good consumer acceptance still need to be carried out.

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