Chapter

Feasibility of Using Yellow Pumpkin (*Cucurbita moschata*) in Developing Bakery Products

Agung Wahyono, Titik Budiati and Hafiz Muhammad Shahbaz

Abstract

The local abundance of yellow pumpkin (*Cucurbica moschata*) makes it a readily available plant. However, its use as a food item is currently limited to simple processing, resulting in a limited presence of pumpkin-based products in the market. Nevertheless, pumpkin is an agricultural product rich in beneficial components such as high pectin, bioactive substances, beta-carotene, vitamin A, tocopherol, and other vitamins. Its high dietary fiber content, specifically pectin, can help regulate insulin serum levels, lower blood sugar, improve glucose tolerance, and offer protection against various diseases like diabetes, cardiovascular disease, constipation, and colon cancer. In light of the increasing prevalence of conditions like obesity, diabetes, and coronary heart disease, there has been a growing public interest in consuming healthy bakery products. This has led to the development of the bakery industry, with a specific focus on producing healthy and purpose-specific breads. Numerous studies have been conducted to explore incorporating pumpkin into bakery products, as this significantly influences the quality of the resulting bakery products. This chapter will delve into the potential of yellow pumpkin as a nutritious ingredient in the development of bakery products, and its impact on the overall quality of these products.

Keywords: bakery, bread, cake, pumpkin, wheat flour

1. Introduction

Pumpkin is a horticultural crop that belongs to the family *Cucurbitaceae.* Around the world, there are five well-known domesticated species, namely: *Cucurbita moschata* Duchesne ex Poiret, *C. pepo* L., *C. maxima* Duchesne, *C. mixta* pangalo, and *C. micifolia*. Some of them (*C. moschata*, *C. pepo* and *C. maxima*) have great economic value because of their high productivity [1].

Pumpkin is a dicotyledonous seed vegetable that has received great attention because of its nutritional value. The nutritional value of pumpkin is varied to one another depend on the cultivar or species [2]. Generally, pumpkin is cultivated in temperate and subtropical zones of the world. In many countries such as China, India, Yugoslavia, Mexico, America, Argentina, and Brazil, it has been used as a vegetable as well as medicine for therapeutic [1].

It has been reported that pumpkin is rich in dietary fiber, particularly pectin, functional compounds, bioactive substances, vitamins (A, B_6, K, C, and E) and minerals (K, Mg, P, Se, and Fe) [3]. Some of the bioactive compounds contained in pumpkin are polysaccharides, proteins and peptides, para-aminobenzoic acid, and sterols [4]. Carotenoids are also greatly abundant in pumpkin. Approximately 60 carotenoids have been identified, including b-carotene, a-carotene, and b-cryptoxanthin [5].

In Indonesia, Yellow pumpkin is greatly abundant. But the use of pumpkin is still limited to simple processing. Some processed products of pumpkin have been developed, such as crackers, biscuits, bread, chips, and several types of cakes. However, the availability of processed products of pumpkin in the market is very limited [6]. In Mexico, *Cucurbita ficifolia* is used broadly for several dishes and candies from their fruit or seeds. In Argentina, *C. moschata* is favored by the local community due to its potential for developing salty or sweet food products [1]. In India, immature fruits are cooked as a vegetable, as the same time mature fruit is used to produce confectionery and beverages [7].

Wheat flour is a main ingredient in making bakery products. Until recently, wheat flour was indispensable to making decent quality bakery products. This is due to the ability of wheat flour to form a viscoelastic dough which can retain gas produced by yeast during fermentation. This ability is a key point in producing a good loaf of bread or some bakery products.

The price of wheat flour around the world is affected by supply and demand, wheat productivity, milling requirement, government policies, and economic situation. Considering the unstable market of wheat flour, a growing demand for bakery and confectionary products has resulted in an enthusiastic work to substitute wheat flour with local raw materials.

Blends of other types of flour with wheat flour are known as composite flour. The use of composite flour to produce a leavened or unleavened bakery product has attracted great attention, particularly in countries depending on import to meet the demand of wheat flour [8].

Considering the potencies of pumpkin, a lot of studies have been done in using pumpkin for composite flour in developing bakery products. Ref. [9] reported a study using pumpkin flour to make cookies and muffins and investigated the effect of those products on the hypocholesterolemic, antioxidant, hepatoprotective and prebiotic properties. Ref. [2] developed a bread using a microwave vacuum-dried pumpkin and evaluated its physical, nutritional, and sensorial characteristics. Ref. [3] developed a bread enriched with pumpkin flour and evaluated its physical and structural properties. In addition, another study has been carried out to evaluate its antioxidant and total phenolic contents [6]. Furthermore, a steamed brownies has been developed using pumpkin's premix flour [10].

In general, the use of pumpkin in manufacturing bakery products resulted in decent quality, but some of those parameters are compromised. In this chapter, the feasibility of using pumpkin to manufacture bakery products is reviewed.

2. Bakery

2.1 Definition and history

According to Cambridge's, Merriam Webster's and Collins's dictionaries, a bakery is a place where bread and cakes are made and sometimes sold. Wikipedia describes a

bakery or baker's shop more completely as an entity or an establishment that produces and sells flour-based food baked in an oven, such as bread, cakes, pies, cookies, donuts, and pastries.

The history of baking started right after the beginning of recorded history. At that time, our ancestors were able to generate fire from stone. Followed by the discovery of different kinds of grasses that can produce grain for nourishment. From a deliberated experimentation, the dough was created. Baking was done by putting the dough over a heated stone. Nowadays, it is well known as flatbread. Thereafter, the invention of baked products changed the eating habits and lifestyle of our ancestors from being hunters to settlers. Based on archeological evidence shows that baking practices may have been initiated about 23,000 years ago (i.e. ~21,000 BC) during Paleolithic Period [11].

The leavened bread was invented by an accidental work in Egyptian history. The leavened bread was produced with wild yeast from the air and mixed with dough. The dough that had been mixed with wild yeast produced a doubled volume and lighten bread than anyone had ever tasted. For 600 years BCE, the ancient Greeks used an enclosed oven that was heated by fires. People who were willing to bake their bread took the large communal oven. Because the oven was so expensive, they could not afford it personally. Finally, several centuries thereafter, commercial production of bread was performed by ancient Rome, and it became the first baker's profession [12].

2.2 Bakery's products

2.2.1 Bread

Bread is a very popular food around the world regardless of whether those countries produce wheat flour or not. It is a symbol of giving. Bread is prepared in a wide variety form with any meal every day. It is consumed as a snack in many countries as well as a staple food in most countries [12]. According to [13], the term of bread is used to describe a variety of products with different characteristics in shapes, textures, sizes, crusts, colors, softness, eating qualities, and flavors. Basic ingredients of bread are flour and water. Flour is always 100%, and another ingredient is percentage of that of flour weight. In general, bread formula is as follows: 2% of yeast, 4% of sugar, and 2% of sugar and shortening agent [14]. **Figure 1** presented appearances of bread loaves made from various proportions of pumpkin flour.

2.2.2 Cakes

The word of cake came from the Norse word "kaka" of the Viking origin. Cake is like bread but sweeter. For a long time, cake is served during celebration of special event like birthday and weddings. Cake was also closely related to rituals and symbolism from different cultures and countries [12]. For centuries, cake-making has been quite the

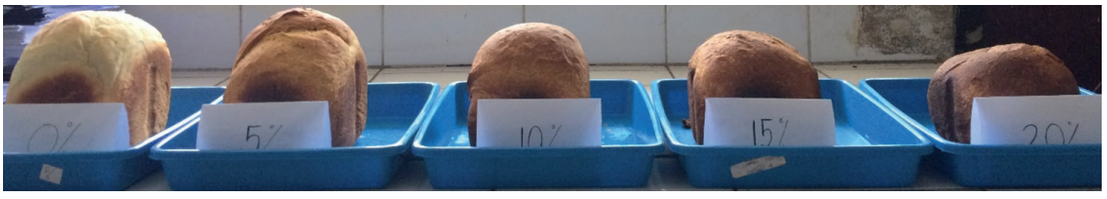

Figure 1.
Appearance of bread loaves made from various proportion of pumpkin flour.

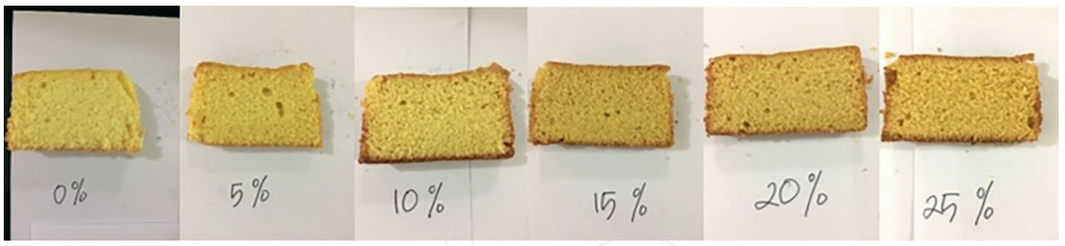

Figure 2.
Cakes made from pumpkin's peel powder.

same. The basic formula of cake comprises of fine wheat flour, refined sugar, butter, and egg. This formula can be modified to produce a wide variety of cakes. Modern cake is defined by a sweet taste, short and tender texture, flavors, and aromas [11]. **Figure 2** presented cakes made from different proportion of pumpkin's peel flour.

2.2.3 Pastries

Pastry made from dough that contained flour, water, and shortening which can be savory or sweetened. If it is sweetened, then we call it baker's confectionery. The terms of pastries are regarding many kinds of baked products made from flour, sugar, milk, butter, shortening, baking powder, and eggs. Pastries are referred to as small tart and other sweet-baked products. Whereas common pastries referred to the dishes include pies, tarts, quiches, and pasties [15, 16]. In addition [11], stipulated that pastries are made by creating alternating layers of dough and fat by folding and rolling the dough.

2.2.4 Biscuits

The name biscuit is synonymous with cookie. Biscuit originated from the word Latin *panis biscotis* meaning twice-cooked bread. This is because the processing of biscuit is divided into two steps by cooking in a hot oven then, followed by drying in cold oven. Biscuit also has two meanings: (i) any of the various small flat sweet cakes, and (ii) small bread leavened with baking powder or soda. In British words, biscuit means a small flattened baked products based on wheat flour with assorted inclusion of fat, sugar, and other ingredients. Today, biscuits are a kind of snack processed with the inclusion of expensive ingredients such as chocolate and cream, resulting luxury gifts, dietary products, also infant food. In general, biscuits are well known as cereal-based products that are baked to a moisture content of less than 5% [11].

2.3 Processing of bakery product

There are some main issues that need to be paid of a lot of attention during the processing of bakery products such as: (i) ingredients should use the exact amount and be measured accurately, (ii) mixing should be done in a correct direction, (iii) pan used in baking should be with regard to the specific product, (iv) correct temperature should be used in baking, (v) pans must be properly prepared for baking to make the baked product easily removed, (vi) preheat the oven to meet the proper temperature for a particular baked product, and (vii) set the temperature and time in accordance to the baked product to get the best quality [17].

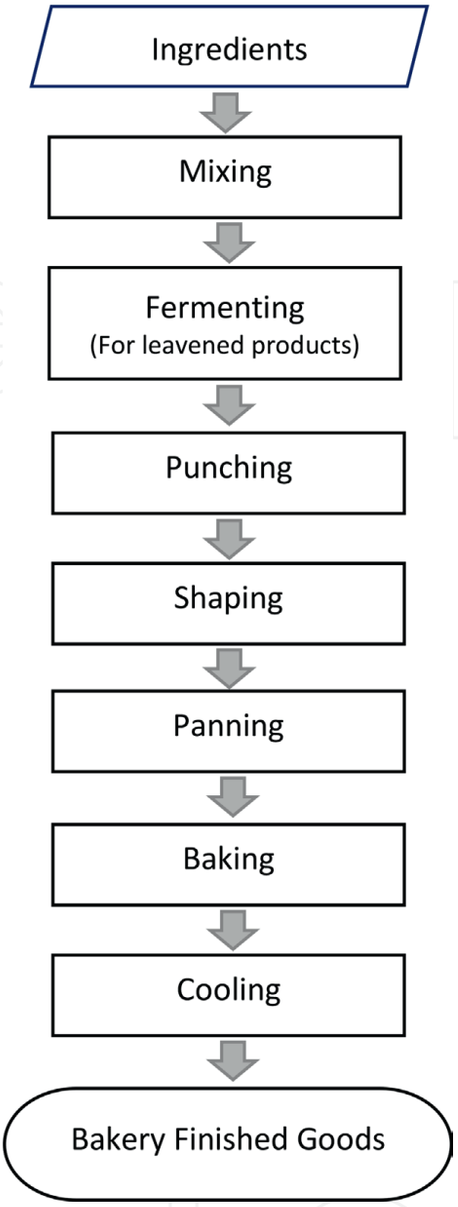

Figure 3.
General processing flows of bakery products.

In general, the processing of bakery products follows several steps, including scaling ingredients, mixing, fermenting (for leavened bread), punching, shaping, panning, baking, and cooling. The general processing flows of bakery's products can be seen in **Figure 3**. Details of the process vary depending on the bakery products. Scaling ingredients must be weighted accurately. Depending on the form of ingredients, scale used to be considered carefully. For example, water, milk, and eggs may be measured by volume. However, if the quantities are large, it is more accurate by weighing. Mixing should be done completely to ensure all ingredients are distributed thoroughly to get a uniform and smooth dough as well as distributing the yeast evenly throughout the dough. Fermentation is the process by which yeast acts on the sugars and starches in the dough to produce carbon dioxide gas and alcohol. It should be aware to not produce an over- or under-fermented dough. An under-fermented dough characterized with un-proper develop volume and coarse texture.

While, over-fermented dough produces sticky, hard-to-work a dough. Punching is hitting the dough by hand to deflate the dough that expels carbon dioxide, redistributes the yeast, relaxes the gluten, and equalizes the temperature throughout the dough. Shaping is performed depending on the bakery products. It can be rounded, flattened, and even un-uniformed. Panning is a process in which the dough is shaped into loaves or rolls and then placed in pans or on baking sheets. Baking is the process in which heat and mass transfer takes place in the dough simultaneously and interdependently and leads to several changes. Cooling is done by removing the baked product from pans and cooled.

3. Quality of bakery products made from pumpkin

3.1 Physical properties

Physical properties are important determinants of food quality. It is related to color, structure, texture, rheology, and interfacial properties. This also applies to bakery products. **Table 1** represents physical properties that are generally evaluated in the bakery products.

In general, study in bakery products examine the physical properties based on the **Table 1**. Physical properties greatly affect the quality of food and can be used to

Product	Physical properties	Methods	References
Bread	Color, measuring luminance (L), red saturation index (a), and yellow saturation index (b)	Color reader	[2]
	Texture, measuring texture profile (TPA)	Texture meter	[18, 19]
	Structure, crumb relative density, and various structural parameters	Image analysis	[20]
	Specific volume, measuring volume-to-weight ratio	Seed displacement methods	[21]
Biscuits	Width and thickness	Scale	[21]
	Spread factor, measuring a ratio between average value of width and average value of thickness	Scale	[21]
Muffin	Specific volume	Seed displacement methods	[21]
	Water absorption index (WAI) and water solubility index (WSI)	Gravimetry	[22]
	Color	Color reader	[22]

Product	Physical properties	Methods	References
Cake	Volume	Seed displacement methods	[23]
	Texture	Texture analyzer	[23]
	Color	Color reader	[24]
	Structure	Image analysis	[24]
Baked rolls	Volume and specific volume	Seed displacement methods	[21]
	Texture	Texture analyzer	[25]

Table 1.
Physical properties of bakery products and methods for determination.

classify and identify them. In a globalized market, the differentiation of food must be based on its physical properties [26]. There have been many studies that have reported the use of pumpkins in developing bakery products. Mostly, incorporation of pumpkin significantly affects the physical properties of bakery products. In baked roll, increased proportion of pumpkin powder resulted in a lower volume and specific volume. The texture of the enriched baked roll also firmer compared to that of the control during storage [25]. In bread, increasing the dried pumpkin proportion resulted in decreasing bread quality. It became unacceptable because of worse porosity and stickier bread crumb. The intensity of the yellow color (*b* value) was more pronounced than that of the control bread. The intents yellow color of bread was contributed from pumpkin color [2]. Ref. [3] reported that at 10% and higher levels of pumpkin lead to decreasing specific volume of enriched bread. Pumpkin enrichment did not affect the texture of bread compared to that of the control bread. The crumb luminance decreases significantly with 10% of pumpkin flour. The addition of pumpkin flour was also significantly affected the crumb structure of bread. Mean cell area of enriched breads became smaller than those of control breads. The crumb feels to the mouth are greatly associated with the cell structure of the crumb. The finer, thin-walled, uniform cells size produced a softer and more elastic texture than that of the coarse and thick-walled cell structures. Ref. [27] reported that progressive addition of pumpkin flour giving bread with relatively low specific volume. Progressive addition resulted in an initial rise and subsequent decrease in loaf volume. Suggested addition of pumpkin powder is up to 10%. In muffins, the partial replacement of wheat flour with pumpkin flour had no significant effect on the firmness and image analysis such as distribution, size, and pore area of the crumb. However, the partial replacement resulted in a darker crust color, higher yellowness, and a lower specific volume compared to that of control muffins. In biscuits, there are three parameters related to the physical properties of biscuit, namely width, thickness, and spread factor. Thickness is a quality parameter of biscuit, which represents height of biscuit. Its optimum value is always desirable by manufacturer. The spread factor is a ratio between the average value of the width and average value of thickness. The addition of pumpkin flour resulted in a significant decrease in width and spread factor. On the other hand, thickness was significantly increased. The decrease in width values of biscuits might be contributed by a lesser water absorption of the blended flour. The increase in thickness of biscuits made from blended flour might be due to the dilution of gluten contents.

The leverage of water absorption in blended flour might produce a greater viscosity of dough which can trigger the increase in thickness of the biscuits reducing its volume spread [28].

3.2 Chemical properties

The chemical properties of food are generally related to the nutritional values of food. In many cases, chemical properties are more important compared to those of physical properties. Some vegetables are indispensable in producing a wide range of bread products because of their chemical compositions [29]. The chemical properties include macronutrients such as saccharides, proteins, fats, and micronutrients such as minerals, vitamins, colorants, additives, fibers, and phytochemicals. In general, analysis of chemicals properties of bakery products is listed in **Table 2**.

Product	Chemical properties	Methods	References
Bread	Total phenolic contents	Spectrophotometry using standard curve	[6]
	Antioxidant	DPPH and ABTS scavenging	[18]
	Protein	Kjeldahl method	[29]
	Moisture content	Oven-drying methods	[2]
	Vitamin C contents	Iodometric	[2]
	Vitamin contents	HPLC	[29]
	Carotenoid	Spectrophotometric	[2]
	Reducing sugar	LVS 252:2000	[2]
	Total fat	ISO 6492:1999	[2]
	Total fat	Soxhlet	[29]
	Minerals	Atomic absorbance spectrometer	[29]
	Ash	Muffle furnace (gravimetry)	[29]
Muffin	Moisture content	Oven-drying	[30]
	Ash	Dry-ashing	[30]
	Fat	Soxhlet	[30]
	Protein	Kjeldahl	[30]
	Carbohydrate	By difference	[31]
	Total dietary fiber	Enzymatic	[31]
Biscuit	Moisture content	Oven-drying	
	Ash	Dry-ashing	[32]
	Insoluble, soluble, and total dietary fiber	Enzymatic	[32]
	Protein	Semi-micro Kjeldahl	[32]
	Fat	Soxleth	[32]
Cake	Moisture contents	Oven-drying	[33]
	B-carotene	Spectrophotometric	[34]

Product	Chemical properties	Methods	References
	Ash	Dry-ashing	[34]
	Crude fat	Soxleth	[33]
	Crude fiber	Enzymatic	[33]
	Carbohydrate	By difference	[33]
	Protein	Micro-Kjeldahl	[33]

Table 2.
Chemical properties of bakery products and methods for determination.

In bread, carotenoid contents increased 5.5 times higher with the addition of pumpkin flour compared to that in control bread. This is due to an abundant proportion of carotenoids in pumpkins. There was no significant difference in moisture content between control bread and bread with pumpkin flour. This is because the moisture content of bread with and without pumpkin addition mainly depends on the amount of water during dough making. The reduced sugar content of bread with pumpkin addition was 1.6 times higher compared to that in control bread. This result explained that higher reduced sugar content in pumpkin bread contributed to a high reduced sugar content in pumpkin flour. Fat content and vitamin C content were comparable between pumpkin bread and control bread [2]. Pumpkin flour significantly enhanced the antioxidant activity of enriched bread. The highest antioxidant activity was observed in bread with an enrichment of 20% of pumpkin flour. The addition of pumpkin flour produced higher levels of β-carotene. Pumpkin flour contained about 180 μg/100 g β-carotene. It is higher than that of wheat flour which does not contain vitamin A. β-Carotene has the ability to be an antioxidant that can play an important role in stabilizing carbon nucleated radicals. β-Carotene in pumpkin flour acted as a provitamin and exhibited an antioxidant activity. Antioxidant activity is also influenced by several components, including phenol compounds which are the basic framework of compounds that have antioxidant activity. Increased levels of pumpkin flour produced a higher level of total phenolic content in enriched bread. The total phenolic content of pumpkin flour is affected by the drying of pumpkin chips during processing. The high level of temperature used during drying leads to the formation of phenolic compounds. The total phenol is directly proportional to the antioxidant activity [6].

In muffins, the addition of 5 g/100 g pumpkin flour produced a comparable level of protein, digestible carbohydrates, and lipids compared to those in the control muffin. However, the enriched muffins showed a higher content of ash and dietary fiber [22].

The incorporation of pumpkin flour for the preparation of the cake produced higher moisture, crude fiber, ash, and β-carotene contents of the resulting cake. On the contrary, the crude protein, crude fat, and carbohydrate in cake decreased. The increase in moisture content might be due to the hygroscopic nature of pumpkin powder and wheat flour and the higher water absorption capacity in the composite flour compared to wheat flour. The higher crude fiber in pumpkin cake was contributed from the highly insoluble dietary fiber which includes cellulose, hemicellulose, and lignin in pumpkin flour. The higher ash and β-carotene of pumpkin cake was attributed to the high ash and β-carotene content in pumpkin flour [34]. In biscuits, the nutritional quality was positively influenced by the incorporation of pumpkin. The incorporation of pumpkin increased the protein, crude fiber, calcium, carotene,

and vitamin C of biscuits. This was because those components were found to be in higher amounts in pumpkin puree. In addition, wheat flour is considered not a good source of carotene and vitamin C [35].

3.3 Sensory properties

Sensory evaluation is a scientific method performed to evoke, measure, analyze, and interpret those responses to products as perceived through the senses of smell, touch, taste, sight, and hearing [36]. Healthy food has attracted a great attention for years. Therefore, many studies have been performed to use healthy ingredients like pumpkin to develop new products. Consumers want their food to be healthy, but when it comes down to making a buying choice, it is taste that matters most [37]. In bakery-enriched pumpkin products, the physical and chemical properties are not the only contributor for bakery quality. The sensory properties are also important to contribute to overall bakery quality. Usually, the sensory properties are studied through consumer research. Consumer research is important to know the general acceptance of consumers to the newly developed product. By this activity, companies or factories determine consumer liking, preference, and opinions on the newly developed products. Finally, this information can be used to decide such as the production and marketing of new products, the reformulation of existing product, the acceptance of suppliers and processes, and the establishment of quality control specifications [2].

In bread, consumer rated higher on bread with a pumpkin than that of control bread. The rated score was 7.3 for bread with pumpkin and 6.7 for the control bread, respectively. A bread sample with pumpkin is tastier than a control bread sample [2]. It has been reported that the increases in loaf volume of bread with pumpkin were accompanied by substantial increases in organoleptic acceptability. It showed an essentially linear dependence on the specific volume up to 4.3 ml/g [27].

The use of pumpkin in muffin rated a higher acceptance by consumers. A 5% of pumpkin addition was preferred by consumers than that of 10% of addition in muffin. The 10% addition of pumpkin powder resulted in a pronounced or strong pumpkin flavor, a strong yellowish color, and a dry texture [22].

In cookies, 10% of pumpkin powder had no significant difference in total acceptance from that of control cookies. Increased levels of pumpkin powder concurrently decreased the consumer acceptance of enriched cookies. In chiffon cake, 20% of pumpkin powder resulted in a comparable acceptance to that of control cake. A higher level of pumpkin powder produced a cake with a lower acceptance. Interestingly, in butter cake, up to 50% of pumpkin powder enrichment had no effect on consumer acceptance compared to that of control cake [38].

4. Conclusions

The utilization of pumpkin in various forms significantly impacts the physical, chemical, and sensory characteristics of bakery products. Typically, when pumpkin is incorporated into bakery items, it leads to a decrease in specific volume, a firmer texture, and a darker appearance. However, the enrichment of bakery products with pumpkin enhances their nutritional value by adding vitamin C, β-carotene, phenolic compounds, minerals, and dietary fiber. Furthermore, the sensory attributes of bakery products are strongly influenced by the inclusion of pumpkin, with the extent of impact depending on the proportion of pumpkin used in the recipe. In general,

bakery products remain acceptable when the pumpkin content does not exceed 20%. Consequently, it can be concluded that incorporating pumpkin into bakery products is a feasible option, albeit with certain compromises in terms of their physical and sensory properties.

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