CHAPTER
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Chickpea flour in gluten-free baked products

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Rafaela Soares dos Santos Kanai
Master in Food Technology from the Federal Technological University of Paraná. SL Alimentos, Mauá da Serra, PR, Brazil.

Bianca de Souza
Veterinary Physician by Unifil. Master's student in Food Technology at the Federal Technological University of Paraná, Londrina campus, PR, Brazil.

Marianne Ayumi Shirai
Ph.D. in Food Science from the State University of Londrina. Graduate Program in Food Technology, Federal Technological University of Paraná, Londrina campus, PR, Brazil.

ABSTRACT
The market for gluten-free products has been growing and its main objective is to attend people with celiac disease or allergies related to gluten consumption. The treatment of this disease consists of adopting a gluten-free diet, which is mainly present in wheat, barley and rye. However, replacing wheat flour in the preparation of bakery products remains a challenge for the food industry and research related to the development of new gluten-free products is still necessary. In this context, chickpea flour has highlighted as a potential ingredient in the formulation of gluten-free bakery products, due to the significant concentration of proteins, dietary fiber and micronutrients. This chapter aimed to carry out a literature review on the production and application of chickpea flour in bakery products such as bread, biscuits and cakes. The composition of chickpea, production of chickpea flour and examples of research that applied chickpea flour in bakery products were described.

Keywords: Pulse, Bakery, Milling, Gluten.

1 INTRODUCTION

According to the Brazilian Association of Industries of Biscuits, Pasta, Breads and Industrialized Cakes (ABIMAPI), in 2020, Brazil sold about 1.475 billion tons of cookies and 0.580 billion tons of industrialized breads and cakes. The national per capita consumption of breads, pasta and industrialized cakes in the same year was 16,764 kg/inhabitant, representing an increase of approximately 4.55% over the previous year. Of this total, there was an increase of about 1.42% in the consumption of cookies in relation to the same period, representing 7,211 kg/inhabitant, making this segment the most commercialized and consumed. This is probably due to large varieties of products in this line, with different presentations, formats, quantities, flavors and prices.

The fundamental ingredient for the production of baked goods is wheat flour, due to the presence of gluten, which is one of the responsible for providing the required functional and technological properties. Gluten is a storage protein formed from the prolamins, glutenin and gliadin, present especially in wheat, being one of the most complex protein networks and has an essential function in determining the rheological behavior of baked goods. However, gluten has been identified as the component capable of triggering immune-mediated disorders, such as celiac disease (BIESIEKIERSKI, 2017), which can occur in both children and adults, resulting in atrophy of the mucosa of the small intestine, impairing intestinal absorption. Symptoms of individuals with celiac disease include malnutrition, diarrhea, growth retardation, anemia, and fatigue (GREEN & JABRI, 2003).

The prevalence of celiac disease is estimated to be approximately 1% worldwide and is still increasing over time, partially attributed to more clinical trials and improved diagnostic capability, primarily in Australia, Europe, and North America (LEBWOHL, LUDVIGSSON, & GREEN, 2015; MAHADOV & GREEN, 2011; RUBIO–TAPIA et al., 2009). To date, the treatment for celiac disease and gluten-related disorders is the adoption of a gluten-free diet of this compound, which consists of the consumption of naturally occurring gluten-free foods (gluten-free cereals, pseudocereals, fruits, vegetables, legumes, meats and milks) and gluten-free processed foods in which wheat flour is replaced by others free of gluten (CAIRANO et al., 2018).

Faced with this problem, a great demand for new research of bakery products with gluten-free alternative flours, with functionality and efficiency similar to wheat flour, emerges. However, the replacement of wheat flour is a major technological challenge due to its rheological properties, as gluten has a specific role in defining the quality and processing of the final product (WESLEY; ANDREW; CLERICI, 2021). Among the ingredients are legume flours or pulses that enable the enrichment of baked goods with proteins, without significantly altering the technological (structure formation, elasticity and cohesiveness) and sensory (BESSADA; BARRIER; OLIVEIRA, 2019).

In this sense, chickpeas (*Cicer arietinum* L.) stand out as a source of protein (20 to 22 %) and as an ingredient for the production of flour for baked goods. The protein fraction of chickpeas consists mainly of globulin (53–60%), glutelin (19–25%), albumin (8–12%), and prolamine (3–7%). Relatively high levels of free amino acids, particularly glutamate and arginine aspartate, are also reported. The presence of arginine can be considered of special interest, because this amino acid participates in the synthesis of adenosine triphosphate (ATP), calcium release, vasodilation, neurotransmission processes, cell proliferation and immunity, besides being an intermediate in the urea cycle, where it is involved in the synthesis of nitric oxide, ornithine and polyamines (BOYE et al., 2010; CORTÉS-GIRALDO et al., 2016; Day, 2013).

The culture of chickpeas is not very widespread in Brazil and to reverse this situation, the development of new products to boost consumption is necessary. The Brazilian climate is favorable for the cultivation of chickpeas, and regions with dry periods, medium altitudes, favor its adaptation and extensive crops are distributed in the states of Goiás, Mato Grosso, Minas Gerais and Bahia (RODRIGUES, 2017).

This work aims to perform a bibliographic review on the use of chickpea flour in the formulation of baked goods, highlighting the main products developed, their technological, nutritional and sensory properties, aiming to expand its use in the formulation of different gluten-free foods.

2 THE CHICKPEAS

The chickpea (*Cicer arietinum* L.) belongs to the family Fabaceae and subfamily Faboidae and had its origin in the region of Turkey, more precisely in the southeast region and then was taken to India and Europe. In Brazil, the introduction of this food was through Spanish and Middle Eastern immigrants (NASCIMENTO et al., 1998). It is an herbaceous, cold-season, drought-resistant plant, and annual plant that appears as a small shrub with branches spreading from its base.

The seed of the chickpea is composed of an integument, an embryo and two cotyledons. The integument is divided into two layers, the outer forehead and the inner tegmen, and a hilum, acting as the attachment point of the seed to the pod. Below the hilum, there is an opening, known as a micropyle, and above it is a ridge, called a raphe. The embryo, in turn, is composed of two cotyledons and an axis, the pointed end of the axis, called the radicle, and the other end, plumule (SINGH; DIWACAR, 1995).

Chickpea cultivars vary in size, color and shape of seeds and can be classified into two types, being macrosperm and microsperm. In the macrosperm the seeds are rounded with beige coloration, plants with medium size, white flowers, large leaflets ranging from 10 to 20 mm, and pods with one or two seeds, being commonly known as Kabuli. The microsperm, better known as Desi, has small seeds, irregular angular shape, integument of varied and dark colors, small plants, small leaflets ranging from 6 to 9 mm, pods with two or three seeds (NASCIMENTO et al., 1998; KAUR; PRASAD, 2021).

Chickpeas are the second most consumed legume in the world, second only to soybeans, and the estimate is about 20 million tons per year (NASCIMENTO, 2016). Although this legume has limited consumption in Brazil in relation to the others, it has the potential to minimize protein deficiencies of tryptophan, threonine and essential amino acids in addition to minerals, as it is rich in phosphorus, magnesium, iron, potassium, cobalt and manganese (FERREIRA; BRAZACA, ARTHUR, 2006).

In general, chickpeas are consumed cooked, mixed with other foods such as meats, vegetables, sauces and condiments. They can also be consumed peeled and crushed by applying it to soups, pastes or desserts. Its flour can be used in the preparation of breads, cakes, and especially in formulations of children's foods to meet the nutritional needs of malnourished children and affected by chronic diarrhea (NASCIMENTO, 2016).

3 COMPOSITION OF CHICKPEAS

Chickpeas are a protein-rich legume of high nutritional value and high digestibility when compared to other legumes. When comparing the values of lysine present in chickpeas, they are higher than those detected in cereals, being 428 mg in a portion of 100 g, in addition, they are rich in amino acids that contain sulfur, so the combination of the consumption of chickpeas and cereals provides balanced amino acids in the diet (QUEIROGA et al., 2019). Chickpeas are still a source of carbohydrates, dietary fiber, minerals, vitamins, and bioactive compounds such as phenolic acids, carotenoids, isoflavones, oligosaccharides, and bioactive peptides (KAUR; PRASAD, 2021).

Chickpea seeds consist of 60 - 65% carbohydrates, with starch being the main polysaccharide present (from 30.8 to 37.9% of the dry matter) (MUDRYJ et.al., 2014). The starch granules of chickpeas are smooth and oval and have a high content of amylose, which is responsible for its higher rate of retrogradation, consequently, increases the glycemic index, since the starch becomes resistant to enzymatic action. In addition, the low glycemic index of chickpeas is associated with the presence of resistant starch (FREDRIKSSON et al., 2000). Resistant starch has a physiological function similar to that of dietary fiber when it reaches the large intestine, without being hydrolyzed or digested.

The soluble and insoluble dietary fiber content in chickpeas is 1.42 and 27.84%, respectively (KHATOON; PRAKASH, 2004). Oligosaccharides, such as raffinose, verbascose, cicerytol and stachyose, are also among the carbohydrates that make up chickpeas and have prebiotic potential, acting in the modulation of the intestinal microbiota and stimulating the growth of bifidobacteria in the colon. The amount of dietary fiber in the Desi type is higher than in Kabuli because of the thickness of the integument and shell (RINCÓN, MARTÍNEZ, & IBÁÑEZ, 1998).

Regarding the lipid content, chickpeas contain on average 6.04% (BHATIA et al., 2001). The fatty acid composition is 66 % polyunsaturated fatty acids, 19 % monounsaturated fatty acids and 15 % saturated fatty acids. Linoleic acid (omega 6) and oleic acid (omega 9) are the main fatty acids found in chickpeas (DADON; ABBO; REIFEN, 2017; WANG; DAUN, 2004).

Chickpeas are also a source of vitamins (C, E and B complex) and minerals, such as sodium, potassium, calcium, magnesium and phosphorus, with potassium identified in greater amounts. El-Adawy (2002) found 870 mg of potassium in 100 grams of chickpeas. It also has a significant content of iron and zinc, being 4.9 - 5.0 mg/100 g and 2.0 - 2.7mg/100 g, respectively (JUKANTI et al., 2012; HEMALATHA, PLATEL, SRINIVASAN & 2007). Selenium concentration of 15.3 to 56.3 μg/100 g was found in chickpeas grown in North America (THAVARAJAH, 2012).

Although chickpeas present important nutrients for a balanced diet, as in several foods of plant origin, this has antinutritional factors that promote poor digestibility and absorption of nutrients, harming the health of the individual (BENEVIDES et al, 2011). Among the antinutritional compounds stand out phytates, nitrates, oxalates and tannins, of which some can hinder the absorption of minerals and certain amino acids by inhibiting proteolytic enzymes (trypsins). When consumed in excess can cause damage to health, irritations and lesions in the intestinal mucosa (LOPES et al., 2009).

Phytates are derived from phytic acid or myoinositol hexaphosphoric acid, with the ability to form chelators with divalent ions, such as calcium and magnesium, forming soluble complexes resistant to absorption in the intestinal tract, as well as interacting with basic protein residues and participating in the inhibition of digestive enzymes such as pepsin, pancreatin and α-amylase. Oxalate, often found in vegetables, cannot be metabolized by humans and is excreted in the urine. The high amount of oxalate in the urine increases the risk of the formation of calcium oxalate stones in the kidneys, in which about 75% of all kidney stones are due to the high concentration of this compound and can cause irritations in the intestinal mucosa (BENEVIDES et al., 2011).

4 CHICKPEA FLOUR

To make chickpeas palatable, it is subjected to physical (grinding and immersion), biochemical (germination and fermentation) and thermal (roasting and extrusion) treatments to increase the nutritional value, improve digestibility and assist in the reduction of antinutritional factors (KHATTAK, ZEB; BIBI, 2008). India stands out as the largest consumer of chickpeas and about 80% of legumes in this country are consumed in the form of flour (MANGARAJ et.al., 2005). Chickpea flour is used in the preparation of various traditional Indian foods such as boondi, dhokla, pakora, bhujia, sweets, in the form of dough or paste, showing itself as a potential ingredient in the elaboration of gluten-free baked goods.

In Brazil, Collegiate Board Resolution (RDC) No. 262, of September 22, 2005, defines that flours are products obtained from edible parts of one or more species of cereals, legumes, fruits, seeds, tubers and rhizomes, through the milling process and, or other technological processes considered safe for food production. Its designation shall be followed by the common name(s) of the plant species(es) used.

To obtain chickpea flour, the grain first goes through a peeling step in order to increase protein digestibility, palatability, nutritional quality and reduction of insoluble fiber and antinutritional factors (WOOD; Malcolmson, 2011). Then the grain is fragmented into impact mills or pin mills. Impact fragmentation has the advantage of breaking through cell walls and producing flours with particles small enough in size that starch granules and highly interlaced protein matrix are properly exposed for separation, without the starch granule being severely damaged to the point of interfering with the posterior classification (WU; NICHOLS, 2005; DIJKINK et al., 2007; REMPEL; GENG; ZHANG, 2019).

After grinding it is possible to perform the fractionation of chickpea flour by the aeroclassification technique, obtaining flours with two different sizes and densities, called light fraction (protein) with fine particles and heavy (starchy) with coarse particles (BOYE; ZARE; Pletch, 2010; KANAI, 2021). The aeroclassification begins with the dispersion of the fine flour in a large flow of air; then, the flow enters a conical chamber where it meets a classifier disc with blades that creates a centrifugal counterflow that separates the large particles from the small ones, and the density also influences the separation (SCHUTYSER et al., 2015). If the protein is still adhered to the surface of the starch granules, after classification, the process can be repeated until it reaches the desired efficacy of separation (GUEGUEN et al., 1984).

In the literature it was reported that the fractionation of chickpea flour in an aeroclassifier was successfully performed, obtaining flours with different granulometries, color, composition (carbohydrates and protein) and technological properties (KANAI, 2021; XING et al., 2020), being possible its application in the formulation of different foods.

5 CHICKPEA FLOUR IN BAKED GOODS

Among the main bakery products most consumed are cakes, breads and cookies that, in general, use wheat flour in their formulation, because it has better technological and sensory characteristics (ZANATA, 2010). However, due to the scarcity of wheat in some regions and allergies associated with gluten consumption, wheat flour has been replaced by other vegetable flours as an ingredient (SIBIAN; RIAR, 2020; SILVEIRA et al., 2016). In this context, because it is an important legume cultivated around the world, chickpeas have not only gained an important role in food, but also in the production of flour for different purposes (SINGH et al., 2016).

Chickpeas are a potential functional food due to their high content of protein, dietary fiber, and several beneficial physiological health effects that reduce the chances of chronic diseases. With an increase in global food security issues and the requirement for a sustainable protein source, chickpeas can be a source with excellent nutritional value of vegetable protein produced at low cost. Several studies are being conducted to incorporate chickpea flour into gluten-free baked goods. Chart 1 lists the studies that used chickpea flour in the development of gluten-free baked goods.

Table 1 – Research related to the use of chickpea flour in baked goods

Product	Goal	Reference
Bread	To compare the effect of different legume flours (chickpeas, peas, soybeans and carob) on physicochemical and sensory properties	Miñarro et al. (2012)
	To evaluate different concentrations of corn flour, chickpea flour and hydroxypropylmethylcellulose in the properties of breads.	Rostamian, Milani, Maleki (2014)
	To investigate the potential of chickpea flour, psyllium and their combination in the sensory properties of bread prepared with rice flour and cassava starch.	Santos et al. (2021)
	To evaluate the effect of pre-treatment of cassava starch and wheat flour in microwave on the properties of the dough.	Garske et al. (2022)
	Develop breads with raw, toasted or peeled chickpea flour.	Kahraman et al. (2022)
	Enrich breads based on rice flour and cornstarch with a mixture of acorn flour and chickpea flour.	Gkountenoudi-Eskitzi et al. (2023)
Cookies	Develop cake with flour composed of rice-chickpeas and addition of exudate of acacia, apricot or karaya gums.	Hamdani et al. (2020)
	Incorporate xanthan gum and carob gum into children's biscuits based on rice flour and chickpea flour.	Benkadri et al. (2021)
	Produce vegan cookies with different types of chickpea flour.	Kanai (2021)
	Develop a nutritionally balanced cookie with low sugar and high protein content with the use of compound flours (chickpea flour, buckwheat, corn and almond milk residues.	Özer (2022)
	To evaluate the effect of xanthan gum in biscuits based on rice flour and chickpeas.	Benkadri et al. (2018)
	Use a mix consisting of chickpea flour and chestnut flour in cookies.	Torra et al. (2021)
Cake	To evaluate the replacement of rice and chickpea flours by pregelatinized corn starch in the physical, textural and sensory properties of the cake.	Boz (2021)
	Develop a cupcake enriched with chickpea flour, almonds and flaxseed.	Jabeen et al. (2022)
	Chickpea flour together with hydrocolloids resulted in increased viscoelasticity of the dough and improved sensory quality.	Herranz et al. (2016)
	To investigate the impact of incorporating different legumes (chickpeas, peas, lentils and beans) on the quality, chemical composition and in vitro digestibility of gluten-free cake protein and starch.	Gularte, Gómez and Rosell (2012)

Source: Own authorship.

The examples of studies cited in Chart 1 indicate that most bakery products use chickpea flour in association with other vegetable and hydrocolloid flours, with the objective of improving technological properties and sensory characteristics. This indicates that replacing wheat flour for the production of gluten-free baked goods is still a challenge for the food industry.

6 FINAL CONSIDERATIONS

According to the data found in the literature, it is concluded that chickpeas are still a legume that has potential in the manufacture of flours for use in baked goods. However, studies are still needed to improve the rheological characteristics of the dough to enable its application in gluten-free baked goods.

REFERENCES

Abimapi. Associação brasileira das indústrias de biscoitos, massas alimentícias e pães. Estatísticas (massas alimentícias). Disponível em: https://www.abimapi.com.br/estatisticas.php. Acesso em: 3 dez. 2022.

Benevides, c. M. J., souza, m. V.; souza, r. D. B.; lopes, m. V. Fatores antinutricionais em alimentos: revisão. Segurança alimentar e nutricional, v. 18, n. 2, p. 67-79, 2011.

Benkadri, s. Et al. Optimization of xanthan and locust bean gum in a gluten-free infant biscuit based on rice-chickpea flour using response surface methodology. Foods, v. 10, n. 1, p. 12, 2021.

Bessada, s. M. F., barreira, j. C. M., oliveira, m. B. P.p. pulses and food security: dietary protein, digestibility, bioactive and functional properties. Trends in food science & technology, v. 93, p. 53-68, 2019.

Bhatia, c.r., maluszynski, m., nichterlein, k., van zanten l. Grain legume cultivar derived from induced mutations, and mutations affecting nodulation. Mutation breeding review, n. 13, p. 1-44, 2001.

Biesiekierski, j.r. what is gluten? Journal of gastroenteroly and hepatology, v. 1, p. 78–81, 2017.

Boz, h. Effect of rice and chickpea flours on physical, textural, and sensorial properties of pregelatinized maize starch cake. Starch – stärke, v. 73, p. 2000239, 2021.

Boye, j.; zare, f.; pletch, a. Pulse proteins: processing, characterization, functional properties and applications in food and feed. Food research international, v. 43, n. 2, p. 414-431, 2010.

Brasil. Regulamento técnico para produtos de cereais, amidos, farinhas e farelos (resolução rdc nº 263, de 22 de setembro de 2005). Diário oficial [da] república federativa do brasil, 2005. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/anvisa/2005/rdc0263_22_09_2005.html. Acesso em: 24 set. 2022.

Cairano et al. Focus on gluten free biscuits: ingredients and issues. Trends in food science & technology, v. 81, p. 203-212, 2018.

Cortés-giraldo, i.; megías, c.; alaiz, m.; girón-calle, j.; vioque, j. Purification of free arginine from chickpea (cicer arietinum l) seeds. Food chemistry, v. 192, p. 114–118, 2016.

Dadon, s.b-e.; abbo, s.; reifen, r. Leveraging traditional crops for better nutrition and health - the case of chickpea. Trends in food science and technology, v. 64, p.39-47, 2017.

Day, l. Proteins from land plants - potential resources for human nutrition and food security. Trends in food science & technology, v. 32, p. 25-42, 2013.

Dijkink, b. H. Et al. Air dispersion of starch–protein mixtures: a predictive tool for air classification performance. Powder technology, v. 172, p. 113-119, 2007.

Ferreira, a.c.p.; brazaca, s.g.c.; arthur, v. Alterações químicas e nutricionais do grão-de-bico (*cicer arietinum* l.) Cru, irradiado e submetido a cocção. Ciência e tecnologia de alimentos, v. 26, n.1, p. 80-88, 2006.

Fredriksson, h. Et al. Studies on α-amylase degradation of retrograded starch gels from waxy. Carbohydrate polymers, v. 43, n. 1, p. 81-87, 2000.

Garske, r.p. et al. Cassava starch and chickpea flour pre-treated by microwave as a substitute for gluten-free bread additives. Journal of food science and technology, v.60, p. 53-63, 2023.

Gueguen, j. Et al. Purificação e caracterização em larga escala de globulinas de ervilha. Jornal da ciência da alimentação e agricultura, v. 35, n. 9, p. 1024-1033, 1984.

Green, h. R. P., jabri, b. Coeliac disease. The lancet, v. 362, p. 383-391, 2003.

Gularte, m.a., gómez, m., rosell, c.m. impact of legume flours on quality and in vitro digestibility of starch and protein from gluten-free cakes. Food bioprocess and technology, v. 5, p. 3142–3150, 2012.

Gkountenoudi-eskitzi et al. In vitro and in vivo glycemic responses and antioxidant potency of acorn and chickpea fortified gluten-free breads. Food research international, v. 166, p. 112579, 2023.

Hamdani, a. M.; wani, i. A.; bhat, n. A. Pasting, rheology, antioxidant and texture profile of gluten free cookies with added seed gum hydrocolloids. Food science and technology internacional, v. 27, n. 7, p. 649-659, 2020.

Hemalatha, s., platel, k., srinivasan, k. Zinc and iron contents and their bioaccessibility in cereals and pulses consumed in india. Food chemistry, v. 102, p. 1328–1336, 2007.

Jukanti, a. K. Et al. Nutritional quality and health benefits of chickpea (*cicer arietinum* l.): a review. British journal of nutrition, v. 108, p. S11-s26, 2012.

Kanai, r. S. S. Produção de farinha de grão de bico (*cicer arietinum* l.) E aplicação na formulação de biscoito tipo cookie vegano. Dissertação de mestrado em tecnologia de alimentos. 2021, 79 f. Programa de pós-graduação em tecnologia de alimentos. Universidade tecnológica federal do paraná. Londrina, 2021.

Lebwohl, b., ludvigsson, j. F., green, p. H. Celiac disease and non-celiac gluten sensitivity. British medical journal, v. 351, p. 43-47, 2015.

Herranz, b. Et al. Characterisation of chickpea flour-based gluten-free batters and muffins with added biopolymers: rheological, physical and sensory properties. International journal of food science and technology, v. 51, p. 1087-1098, 2016.

Kahraman, g. Et al. Impact of raw, roasted and dehulled chickpea flours on technological and nutritional characteristics of gluten-free. Foods, v. 11, n. 2, p. 199, 2022.

Kaur, r.; prasad, k. Technological, processing and nutritional aspects of chickpea (cicer arietinum) – a review. Trends in food science & tecnhology, v. 109, p. 448-463, 2021.

Khatoon, n; prakash, j. Nutritional quality of microwave-cooked and pressure- cooked legumes. International journal of food sciences and nutrition, v. 55, n. 6, p. 441-448, 2004.

Khattak, a. B., zeb, a., & bibi, n. Impact of germination time and type of illumination on carotenoidcontent, protein solubility and in vitro protein digestibility of chickpea (*cicer arietinum* l.) Sprouts. Food chemistry, v. 109, p. 797–801, 2008.

Lebwohl, b., ludvigsson, j. F., green, p. H. Celiac disease and non-celiac gluten sensitivity. British medical journal, v. 351, p. 43-47, 2015.

Lopes, c. O. Et al. Aproveitamento, composição nutricional e antinutricional da farinha de quinoa (chenopodium quinoa). Alimentos e nutrição, v. 20, n. 4, p. 669- 675, 2009.

Mahadov, s., green, p. H. R. Celiac disease: a challenge for all physicians. Gastroenterology and hepatology, v. 7, n. 8, p. 554–556, 2011.

Mangaraj, s. Et al. Studies on physical properties and effect of pre-milling treatments on cooking quality of pulses. Journal of food science and technology, v. 42, p. 258–262, 2005.

Miñarro b. Et al. Effect of legume flours on baking characteristics of gluten free bread. Journal of cereal science, v. 56, n. 2, p. 476-481, 2012.

Mudryj, a. N., yu, n., aukema, h. M. Nutritional and health benefits of pulses. Applied physiology nutrition and metabolism, v. 39, p. 1197-1204, 2014.

Nascimento, w. M.; pessoa, h. B. S. V.; giordano, l. B. Cultivo do grão-de-bico (cicer arietinum l.). Disponível em: https://www.embrapa.br/busca-de-publicacoes/-/publicacao/765566/cultivo-do-grao-de-bico-cicer-arietinum-l. Acesso: 09 set. 2020.

Nascimento, w. M; hortaliças. Leguminosas de inverno: alternativa para a região dos cerrados. Embrapa, 2016.

Queiroga, v. P; girão, e. G; albuquerque, e. M. B. Grão de bico (*cicer arietinum* l.) Tecnologias de plantio e utilização, v.1, 2021.

Rempel, c; geng, x.; zhang, y. Industrial scale preparation of pea flour fractions with enhanced nutritive composition by dry fractionation. Food chemistry, v. 276, p. 119– 128, 2019.

Rincón, f., martínez, b., ibáñez, m. V. Proximate composition and antinutritive substances in chickpea (cicer arietinum l) as affected by the biotype factor. Journal of the science of food and agriculture, v. 78, p. 382–388, 1998.

Rostamian, m., milani, j. M., maleki, g. Physical properties of gluten-free bread made of corn and chickpea flour. International journal of food engineering, v. 10, n. 3, p. 467-472, 2014.

Rubio tapia, a. Et al. Increased prevalence and mortality in undiagnosed celiac disease. Gastroenterology, v. 137, n. 1, p. 88–93, 2009.

Rodrigues, p. Pesquisa brasileira desenvolve grão-de-bico mirando mercado asiático. Disponível em: https://www.embrapa.br/busca-de-noticias/-/noticia/26381597/pesquisa-brasileira-desenvolve-grao-de-bico-mirando-mercado- asiatico. Acesso em: 10 de out. De 2019.

Santos, f. G et al. An integrated instrumental and sensory approach to describe the effects of chickpea flour, psyllium, and their combination at reducing gluten-free bread staling. Food packaging and shelf life, v. 28, p. 5- 8, 2021.

Schutyser, m. A. I. Et al. Dry fractionation for sustainable production of functional legume protein concentrates. Trends in food science & technology, v. 45, n. 2, p. 327-335, 2015.

Sibian, m. S; riar, c. S. Formulation and characterization of cookies prepared from the composite flour of germinated kidney bean, chickpea, and wheat. Legume science, v. 2, n. 3, p. E42, 2020.

Silveira, m. L. R. Et al. Aproveitamento tecnológico das sementes de goiaba (*psidium guajava* l.) Como farinha na elaboração de biscoitos. Boletim ceppa, v. 34, n. 1, p.1-21, 2016.

Singh, v. K. Et al. Qtl-seq for rapid identification of candidate genes for 100-seed weight and root/total plant dry weight ratio under rainfed conditions in chickpea. Plant biotechnology journal, v.14, n.11, p. 2110 - 2119, 2016.

Singh, f., diwakar, b. Chickpea botany and production practices. Patancheru: international crops research institute for the semi-arid tropics, v. 502, n. 16, p.324, 1995.

Jabeen, s. Et al. Development of gluten-free cupcakes enriched with almond, flaxseed, and chickpea flours. Journal of food quality, v. 2022.

Thavarajah, p. Evaluation of chickpea (*cicer arietinum* l.) Micronutrient composition: biofortification opportunities to combat global micronutrient malnutrition. Food research international, v. 49, p. 99–104, 2012.

Torra, m. Et al. Chickpea and chestnut flours as non-gluten alternatives in cookies. Foods, v. 10, n. 5, p. 1–13, 2021.

Wang, n; daun, j. K. The chemical composition and nutritive value of canadian pulses. Canadian grain commission report, p. 19–29, 2004.

Wesley, s. D.; andré, b. H. M.; clerici, m. T. P. S. Gluten-free rice & bean biscuit: characterization of a new food product. Heliyon, v. 7, p. 5-11, 2021.

Wu, v. Y., nichols, n. N. Fine grinding and air classification of field pea. Cereal chemistry, v. 82, n. 3, p. 341-344, 2005.

Xing, q. Et al. A two-step air classification and electrostatic separation process for protein enrichment of starch-containing legumes. Innovative food science and emerging technology, v.66, p. 2-7, 2020.

Zanata, c. L. Avaliação da qualidade físico-química e microbiológica de farinhas obtidas a partir de vegetais não conformes à comercialização. Disponível em: https://www.univates.br/bdu/items/da450106-dfb8-43f6-9682-e238cdcbe338. Acesso em: 5 dez. 2022.