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Development of healthy and gluten-free instant chickpea noodles and nutritional comparison with conventional versions found in markets

Desenvolvimento de macarrão instantâneo de grão-de-bico saudável e sem glúten e comparação nutricional com versões convencionais encontradas em mercados

Abstract

Introduction: Brazil is the Latin-American country whose population consumes the most instant noodles, an ultra-processed food that contains high levels of sodium, saturated as well as trans fats. The excessive consumption of these nutrients is directly related to an increased risk of obesity and the development of chronic No-communicable Diseases. *Objectives*: To develop chickpea flour-based instant noodles, in order to provide a practical and nutritional alternative to the public. *Methods*: Instant noodles were developed with fresh or minimally processed food ingredients. The nutritional composition was calculated, as well as Daily Reference Values for macronutrients, dietary fiber, sodium and calories per serving, in accordance with the new regulations on nutrition labeling of packaged food products, and these values were compared with those of conventional instant noodles. *Results*: The chickpea instant noodles produced present numerous advantages over existing commercially available options, as they are not ultra-processed and have greater nutritional value. Furthermore, they contain no gluten or trans-fat, have less than half the calories, around 40% more dietary fiber and a significant reduction in sodium content, compared with conventional products of the same category. *Conclusions*: Instant chickpea noodles can integrate a healthy diet, as a good alternative for the young public, especially those with gluten-restricted diets. Future studies are necessary in order to evaluate the product's acceptance and purchase intent.

Keywords: Processed food. Dietary guidelines. Pasta. Flour. Gluten-free diet.

Resumo

Introdução: O Brasil é o país latino-americano cuja população mais consome macarrão instantâneo, alimento ultraprocessado que contém altos teores de sódio, gorduras saturadas e trans. O consumo excessivo destes nutrientes está diretamente relacionado ao aumento da obesidade e do desenvolvimento de doenças crônicas não transmissíveis. *Objetivos*: Neste trabalho foi proposto o desenvolvimento de um macarrão instantâneo à base de farinha de grão-de-bico, a fim de oferecer uma alternativa prática e nutritiva para o público. *Métodos*: O macarrão instantâneo foi desenvolvido com ingredientes culinários e alimentos *in natura* ou minimamente processados. Foram calculadas a composição nutricional e a porcentagem do Valor Diário de Referência para macronutrientes, fibra alimentar, sódio e valor energético da porção, conforme a nova rotulagem nutricional, sendo estes valores comparados

com as informações nutricionais de macarrões instantâneos convencionais. *Resultados*: O macarrão instantâneo de grão-de-bico produzido apresenta inúmeras vantagens em relação àqueles já existentes no mercado, pois não é um alimento ultraprocessado e tem boa qualidade nutricional. Além disso, não contém glúten e gorduras trans, e apresentou redução maior do que 50% do valor calórico total, aumento de cerca de 40% no teor de fibras e redução importante na concentração de sódio, em relação aos produtos convencionais da mesma categoria. *Conclusões*: O macarrão instantâneo de grão-de-bico pode contribuir para compor uma alimentação saudável, sendo uma boa alternativa para os jovens, especialmente para o público com restrição à ingestão de glúten. Estudos futuros são necessários para avaliar a aceitação e a intenção de compra deste produto.

Palavras-chave: Alimento processado. Guias alimentares. Massas alimentícias. Farinha. Dieta livre de glúten.

INTRODUCTION

The prevalence of overweight and obesity has significantly increased in developing countries such as Brazil, a factor that burdens national health services, owing to the large demand to treat diseases associated with these dietary states.[1]

According to VIGITEL (2023), the frequency of overweight and obesity in Brazil has evolved unfavorably since 2006, with a prevalence of overweight among adult Brazilians reaching 61,4% in 2023, while obesity reached 24,3%. In the same year, around a quarter of this population was diagnosed with systemic arterial hypertension and 10% with Type 2 Diabetes *Mellitus*.[2] This increase has also been observed among Brazilian children and teenagers, whose estimated prevalence of obesity ranges from 22% to 25%, surpassing that of African and Southeast Asian countries. [3]

This nutritional scenario is intimately connected with the epidemiological transitions of the last four decades, which explain the rising incidence of chronic Non-communicable Diseases (NCDs). Such changes characterize the nutritional transition, resulting from economic and demographic factors that influence life habits, such as those related to physical activity and food consumption.[4]

Many studies demonstrate that the excess consumption of ultra-processed foods is associated with overweight and obesity, increasing, consequently, the risk of developing NCDs, such as hypertension, type 2 diabetes *mellitus* and some types of cancer.[4-7] This can be explained by the low nutritional quality of these foods, due to modifications suffered during industrial processing, which make them rich in additives, sodium, trans and saturated fats, and poor in vitamins, minerals, dietary fiber and antioxidants.[8,9]

These foods constituted to nearly 20% of total calories consumed in Brazilian homes in the years of 2017 and 2018. Together with processed foods, this amounts to a third of total calories consumed.[10] Worsening this situation further, the consumption of these foods in Brazil had a significant increase during the Covid-19 pandemic.[11]

Among ultra-processed foods, instant noodles are a product of quick and easy preparation, enjoyed by many as it contains high amounts of additives, sodium and fats - the latter due to deep-frying in one of the steps of production.[12,13]

A survey performed in 2022 by the World Instant Noodle Association (WINA) showed that Brazilians consumed around 2,8 million servings of this product, which ranked the country as tenth greatest consumer of instant noodles in the world, and first in Latin America.[14] Corroborating this evidence, data obtained by the Sistema Nacional de Vigilância Alimentar e Nutricional (National System of Food and Nutrition Surveillance) show that in 2023, in the state of São Paulo, around 49% of children and teenagers, 37% of adults and 24% of the elderly consumed instant noodles, packaged snacks or salted crackers.[15]

This data is worrying, as, according to the Tabela Brasileira de Composição de Alimentos (2023) (Brazilian Food Composition Table), a single serving of 100g of instant noodles amounts to 75,8% of the recommended daily intake of sodium, 25,7% of total fats, 41,2% of saturated fats and 37,5% of trans fats, considering a consumption of 2,000kcal/day by a healthy adult individual.[13]

Still, the majority of these commercially available products are derived from white wheat flour, that is, flour that is poor in dietary fiber, proteins, vitamins and minerals.[16] Also, wheat contains gluten, a protein that can cause autoimmune reactions and inflammatory processes, associated or not with celiac disease, in individuals with genetic predispositions.[17]

With the presence of gluten in conventional instant noodles in mind, as well as its unbalanced nutritional composition, it is possible to consider alternative flours and methods of preparation for the development of this product. Fernandes et al.,[18] for example, analyzed the technological properties of chickpea flour in order to verify its potential as an ingredient in food products and found it has affinity to water, oil and milk, which allows it to be processed with these components. Moreover, its use guarantees the nutritional enrichment of preparations, since chickpea is a legume with good quantities of dietary fiber, calcium, magnesium, folic acid and bioactive compounds.[19]

Furthermore, in being gluten-free, the use of chickpea flour can contribute to widening the variety and enriching the diet of individuals with celiac disease, who have difficulty finding foods that are absent in this protein and, when they do, can spend up to around 44% more than a person living without dietary restrictions.[20]

Factors such as ease of access, palatability, practicality of preparation and lack of culinary skills, many times, make instant noodles an attractive food option to the population. Conversely, negative consequences to health stemming from excess consumption of this type of food are already known. In this manner, it is pertinent to develop a product similar to conventional instant noodles in practicality and flavor, while also being nutritious and whose consumption won't contribute to the increase in prevalence of NCDs.

Therefore, this study aimed to develop less processed, chickpea flour-based instant noodles, that won't provide excess fat, sodium and additives in its composition, in order to obtain a product that is gluten-free, as well as nutritious, being a practical alternative to the public, especially the young and including those who suffer from celiac disease.

METHODS

The research was conducted through pratical experimentation. All steps of this study occurred in the Laboratório de Técnica Dietética (Laboratory of Dietetic Technique) of Escola Técnica Estadual Irmã Agostina (Sister Agostina State School) in the city of São Paulo, following good handling practices.

 To prepare the dough, the ingredients (chickpea flour, egg, refined salt and rice flour for kneading) were mixed; subsequently, the dough was flattened with a rolling pin and shaped. The product was then immersed in boiling water for 8 minutes for instantization and dried in a gas oven at 200ºC for 20 minutes. Lastly, the product was vacuum packaged for storage. (Figure 1).

The seasoning was obtained by mixing refined salt, garlic and onion powder, black pepper, curcumin, sweet paprika, chimichurri and oregano, with quantities defined considering balance of flavors, until 5g of the mixture were achieved. The established serving of the product was 85g (80g of dough + 5g of seasoning), following the standard for other noodles of the same category.

In order to evaluate the nutritional composition of the developed noodles, nutritional calculations were performed with the Excel program, from the Microsoft Office®[21] package and the Tabelas Brasileiras de Composição de Alimentos (BrazilianTables of Food Composition).[13,22] Further, the percentages of Daily Reference Values (%DRV) were calculated for macronutrients, dietary fiber, sodium and total calories of a serving. Calculations were made considering the new regulations on nutrition labeling of packaged food products, according to Resolução da Diretoria Colegiada (Board of Directors Resolution) no. 429/2020[23] and to Instrução Normativa (Normative Instruction) no. 75/2020.[24]

Additionally, nutritional information regarding commercially available instant noodles was collected, in order to compare the average nutritional composition with the values obtained from chickpea instant noodles. The products referenced for this comparison belonged to the lead brand in sales for this food category, according to research done in 2021 by the Associação Brasileira de Supermercados (Brazilian Supermarket Association).[25] Also, the preferred flavors by Brazilians (chicken, meat, tomato, bacon and cheese) were considered, based on a statement by the WINA.[14]

RESULTS

The results obtained regarding the chemical composition of the developed product can be observed in Table 1, which shows important differences between nutritional values of the compared noodles.

Table 1. Comparison between nutrition facts of conventional instant noodles and those of instant chickpea noodles. São Paulo, SP, Brazil.

|	Chickpea Instant noodles		Conventional Instant Noodles	
	Quantity per serving	%VDR	Quantity per serving	%VDR
Calories	163kcal	8	395kcal	20
Carbohydrates	24g	8	54g	18
Proteins	9g	18	9g	18
Total fat	3.5g	5	16g	24
Saturated fat	0.8g	4	7.1g	36
Trans fat	-	-	-	-
Dietaryfiber	4.4g	18	1.9g	8
Sodium	231mg	12	1419mg	71

Nutrition facts
Serving of 85g (80g ofnoodles +5 g of seasoning)
*Average value for products of lead brand in Brazilian sales.

The instant noodles were found to have 60% less calories than analyzed conventional instant noodles. It is possible to observe that substitution of refined wheat flour for chickpea flour generated a pasta with 43% more fiber and 55% less total carbohydrates. Still, despite the developed noodles having the same amount of protein as conventional noodles, they are gluten-free.

Regarding sodium, conventional instant noodles were found to have an average content of 1,418.8 mg, which is more than double the recommended value for an entire day. However, in consuming a serving of instant chickpea noodles, one intakes 231 mg of sodium, which corresponds to 12% of the Daily Reference Value for this nutrient.

Figure 1. Steps of the production of Instant Chickpea Noodles
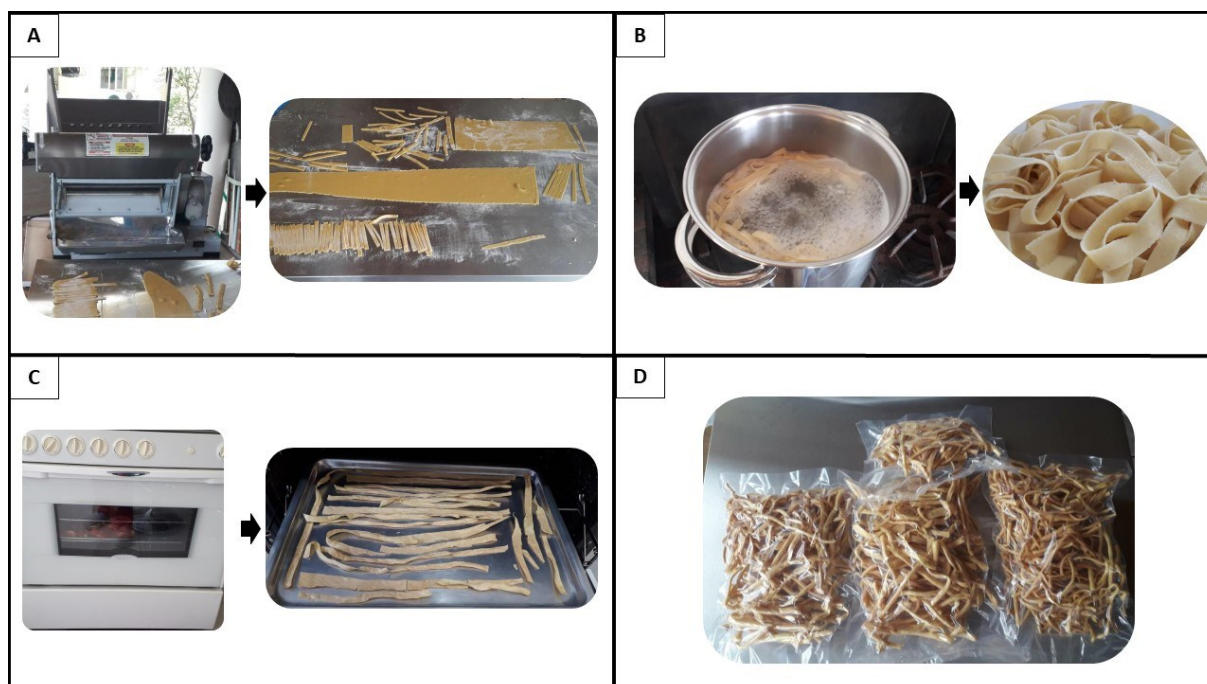
A: Flattening and shaping of the dough; **B:** Noodle instantization; **C:** Drying of the noodles; **D:** Vacuum packaging of the noodles for storage.

DISCUSSION

O *Guia Alimentar para a População Brasileira* (2014) (*Dietary Guidelines for the Brazilian Population*) is an essential document for the education of the people on nutrition and food. It classifies food and beverages according to degree of processing and use: unprocessed or minimally processed foods, culinary ingredients; processed foods and ultra processed foods. Conventional instant noodles are classified as an ultra-processed food, as it is a formulation of substances derived from fractionation of fresh foods, with the addition of several ingredients of exclusive use by the food industry, as well as flavoring, emulsifiers and other additives that give product sensory properties similar to those found in natural foods.[8]

The instant chickpea noodles developed in this study, on the other hand, can be classified as a processed food, having been obtained from a mixture of culinary ingredients and unprocessed foods, subjected to simple conservation processes, such as cooking in wet and dry heat.[8] According to Monteiro et al.,[26] processed foods can be a part of meals, as long as unprocessed or minimally processed foods remain the main components of a diet. Ultra-processed foods, however, should be avoided.

The consumption of ultra-processed foods is directly related with the low ingestion of micronutrients in the Brazilian diet. Louzada et al.[27] observed that of 17 assessed micronutrients, 16 presented lower levels in diets rich in ultra-processed foods, than those present in diets with a predominance of unprocessed or minimally processed foods. Among those nutrients with lowered levels, vitamins B3, B5, B12, D and E, and minerals iron, phosphorus, magnesium, selenium and zinc stand out, while nutrients like sodium and vitamins B1 and B2 were present in excess in ultra-processed food-based diets. Moreover, it is known that a preference for less processed foods is directly associated with weight reduction and diminished risk of developing cardiovascular diseases.[28]

Upon analyzing the comparative table (Table 1), it is possible to observe important differences between nutritional values of the compared noodles. The instant chickpea noodle was found to be less calorically

dense than the other noodles. One of the reasons for this decrease in calories was a substantially lower amount of total fat in the developed product, which can be explained by the chosen drying method. In opting for the oven to achieve this step, deep-frying was substituted by a method in which dry heat is applied without the addition of fats, through convective air currents.[30]

Aside from the drying method, instant chickpea noodles do not have any type of added fat or oil in their formulation, which results in inferior lipid concentrations than those present in conventional instant noodles. This reduction, especially in saturated and trans fats, contributes toward health benefits, as these nutrients, when in excess, elevate the LDL fraction of blood cholesterol, favoring lipoidal deposition onto blood vessel walls, leading to the appearance of atheromatous plaques and heightening the odds of a cardiac event.[30]

Furthermore, it is known that despite ultra-processed foodsreporting an absence of trans fats in their packages, ingredients like hydrogenated vegetable oils are commonly used in the food industries,[31] such as that of instant noodles. Therefore, it is important to highlight that instant chickpea noodles do not contain trans fat, since no form of hydrogenated fat was used in its processing and preparation.

Regarding carbohydrates, it can be observed that substituting refined wheat flour for chickpea flour increases the concentration of dietary fiber in instant noodles and reduces total carbohydrates. This increase can be attributed to the fact that the legume flour is wholegrain. That is, it contains a good amount of oligosaccharides and has less starch than the wheat flour generally used in manufacturing these noodles.[32] According to Huang et al.,[33] diets containing large quantities of simple carbohydrates increase glycemia and insulinemia in a much faster and more pronounced manner, being considered more harmful than beneficial to health.

Despite the developed product having presented no significant difference in protein content, it is gluten-free, which can be advantageous, since it is a safe option for the public suffering from celiac disease, which has increased in number in recent times due to the improvement of diagnostic methods of this pathology.[34]

With regard to sodium content, it is important to highlight that, according to the Organização Mundial da Saúde (2012) (World Health Organization), the daily intake of table salt by adult individuals should be of at most 5g (2g of sodium) and, for children under two years old, this number must be adjusted depending on age, weight and individual caloric necessities.[35]

However, in the Pesquisa Nacional de Saúde (National Health Survey), performed in Brazil in 2013, it was verified that average daily table salt consumption by Brazilians is of 9.4g per day.[36] Aiming toward dealing with this situation, the Ministério da Saúde (Ministry of Health) has proposed to the Associação Brasileira da Indústria de Alimentos (Brazilian Food Industry Association) that the amount of sodium in some ultra-processed foods be voluntarily reduced, and among them are instant noodles. Nevertheless, despite there having been a decrease in the amount of this micronutrient found in these products, they still contain high levels of table salt and require revision of their formulations and monitoring of their sodium content.[37]

This elevated sodium content was confirmed in the present study, when observing the nutrition fact labels of instant noodles from the lead brand of the sector in sales. The average amount of this micronutrient in each serving is equivalent to three quarters of the recommended daily intake. These high amounts were also confirmed in the research conducted by Silva et al.,[38] which reports that the average sodium content in an 85g serving of instant noodles, among 13 different brands is 1,530mg, which corresponds to 76% of the DRV for adults. However, in consuming a serving of instant chickpea noodles, an individual would ingest only 12% of the DRV for sodium, which makes this product a healthier option when compared with those found

in markets, for this lower amount can prevent arterial hypertension and, consequently, cardiovascular diseases, as well as chronic renal disease, obesity and hepatic and intestinal cancer.[39]

It is important to stress that chickpea contains antinutritional factors, such as physic acid, tannins, saponins, oxalates and trypsin inhibitors, which are associated with the plant's functions for protection and self-maintenance. Even so, it is known that the adoption of dietetic techniques associated to heat, like boiling, pressure cooking and roasting, such as those that were used in the production of instant chickpea noodles, reduce the presence of these factors, leading to a better absorption of protein.[40]

Lastly, it is known that among the characteristics of instant noodles responsible for their increased consumption are convenience and palatability.[41] Instant chickpea noodles maintain convenience, as it requires at most four minutes for preparation; Nevertheless, sensory analysis is needed to evaluate the acceptance of the product by the public and, therefore, its commercial viability.

The ease of preparation of the developed product stems from the steps of instantization by boiling and drying in the oven, which enable the gelatinization of the starch present in the noodles when submitted to high temperatures.[42] A generally longer preparation time for instant chickpea noodles has also been observed by Khatkar and Kaur when comparing cooking times of different instant noodles obtained by oven drying with those by deep-frying.[43]

Also, to guarantee palatability, in the production of conventional instant noodles methods of immersion in fat are used, as well as the additives like monosodium glutamate and flavoring in the seasoning that accompany their products,[44] which places these foods in the category of foods to be avoided.[8] For being a less processed food, the seasonings that accompanies the developed instant noodles is composed only of table salt and natural condiments, which, despite contributing toward a better nutritional profile, be limiting of the product's appeal.

CONCLUSION

Instant chickpea noodles have shown to be a healthy alternative for the general public, as well as for those suffering from celiac disease. The ingredients used and chosen method of production allowed for positive modification in the nutritional profile commonly presented by this product's category and contributed to the chickpea instant noodle's classification as a processed food, according to the *Guia Alimentar para a População Brasileira* (*Dietary Guidelines for the Brazilian Population)*, since it is free from additives and industrial processing. The developed noodle's preparation time is still minimal, which classifies them as instant noodles; However, for greater likeness to conventional products, it is pertinent that the cut shape of the noodle dough be more similar to them. Lastly, future studies with the product are necessary, as its palatability needs testing in order to evaluate acceptance and intent of purchase by the consumer public.

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