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Sensory and physical-chemical analyzes of a gluten-free salt snack: development of a product based on oat flour enriched with chickpeas and carrots

Análises sensorial e físico-químico de *snack* salgado sem glúten: Desenvolvimento de produto à base de farinha de aveia enriquecida com grão-de-bico e cenoura

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ABSTRACT
Snacks are practical and quick-to-consume foods, often included in snacks and small meals, exerting a great influence on the diet of the general population. However, they are not recognized as healthy foods due to their low nutritional properties, excess fat, high calorie content, and for excluding celiac people. This highlights the need to develop projects aimed at the production of *snacks* with superior sensory and palatable characteristics. To meet this demand, a product was developed with the addition of chickpeas, carrots and oat flour, replacing the wheat flour commonly used in existing formulations. This was developed from the elaboration of a vegetable paste and the molding of a dough compatible with the typical shapes of these foods. The results of the analysis of water, humidity and pH activity revealed levels very close to those of *snacks* sold on supermarket shelves, but the concentration of proteins in the product was a great highlight (more than 20%), demonstrating that a tasty, convenient product with a prolonged shelf life can have its nutritional values high. In the sensory analysis, the product stood out in the attributes of crunchiness, with the sum of the concepts "loved" and "liked" of 89.8% and flavor with 87.7%.

Keywords: *Cicer arietinum,* Protein, *Daucus carota* L., Gluten, Oatmeal.

INTRODUCTION

The term *snack*, of American origin, literally translated as "snack", clearly defines the function of these products in food. This designation covers a wide variety of foods that are easy and quick to consume (BRANDÃO; SCHMIDT, 2019). Due to their sensory characteristics, providing a highly satisfying consumption experience and exceptional convenience, *snacks* have gained wide acceptance and success among consumers looking for a practical diet, which can be consumed in any environment or situation. Over time, there has been a significant diversification of *snacks* in the food market, creating several options and making this type of food practically universal.

However, this product is not considered healthy, as it is rich in saturated fats and calories, which has caused the consumer to become aware of the need for nutritionally rich and at the same time convenient products (CHANDRASHEKHAR et al., 2019). For this reason, there was a need to develop *snacks* from legumes, vegetables, in short, other raw materials that would add greater nutritional value and a lower addition of sodium, fats and simple carbohydrates to this food.

Snacks developed from plants became popular and ended up gaining visibility in the market, the increase in demand for these types of products in the food market has been gradually increasing. According to Balan et al. (2021), market research shows that consumers are concerned about their health and are looking for nutritional quality products and minimally processed foods, which are produced with sliced vegetables (e.g., beets, carrots, and pumpkin)

that are blanched, seasoned, or freeze-dried.

Chickpeas are a food rich in fiber and protein, acting on weight maintenance, controlling blood sugar levels and helping to protect against chronic non-communicable diseases, such as cancer and heart problems (HARE; AMARAL, 2017). It also has high amounts of minerals such as calcium, magnesium, phosphorus, iron, potassium and manganese, making chickpeas a food with high nutritional power, in addition to being a viable alternative in the manufacture of gluten-free pasta (MOREIRA, 2023).

Carrots, on the other hand, are a source of carotenoids, potassium, fiber, and antioxidants, all of which provide exceptional health benefits. Regular consumption of this tuberous root is able to prevent premature aging and the emergence of some types of cancer, in addition to strengthening the immune system (ROSSO et al., 2021).

Oats are a cereal widely incorporated into the diet, known for their flour obtained from the milling of the grain, which is a rich source of fiber, B vitamins, iron, zinc, magnesium, amino acids, fatty acids and antioxidants essential for health. Compared to conventional wheat flour, oat flour stands out for being gluten-free, thus making it an excellent option for celiacs, gluten intolerants, and those who choose to avoid its consumption (SCHMIELE et al., 2011).

Therefore, this work sought through sensory and physicochemical analyses to verify the acceptance and characteristics of the salty snack based on oat flour enriched with chickpeas and carrots, without the addition of wheat flour.

MATERIAL AND METHODS

RAW MATERIAL

The ingredients used in the formulation were fresh carrots, dried chickpeas, oat flour, sunflower oil, chimichurri seasoning and salt, and dried chickpeas, carrots, sunflower oil and salt were purchased in a supermarket chain in the city of Marília/SP.

On the other hand, the oat flour and the chimichurri seasoning were purchased in a local health food store, both are sold in bulk, that is, it is not possible to affirm the existence of allergen control in these products.

FORMULATION AND PREPARATION OF THE *SNACK*

The chickpeas were placed in a container and covered with drinking water under refrigeration for hydration for 8 hours, after which the chickpeas were pressured with sliced carrots for approximately 35 minutes (Table 1).

Table 1 – Raw materials used in the formulation of the snack, in percentages.

Ingredients	Quantities (%)
Chickpea	67.3
Oatmeal flour	6.6
Carrot	16.8
Sunflower oil	8.2
Chimichurri	0.6
salt	0.5
Total	100%

After cooking, the carrot and chickpeas were taken to the blender along with the sunflower oil for homogenization of the ingredients and formation of paste. When the desired point and texture were reached, the chimichurri and salt were added.

Subsequently, the paste from this processing was mixed with oat flour, and all the ingredients were homogenized until a mass that could be molded was obtained (Figure 1).

Figure 1 – Snack dough to be shaped for cooking.

After obtaining a consistent dough, small pieces were divided into portions of approximately 8 grams each. They were then shaped into thin circles, arranged on a baking sheet and placed in an industrial oven at 90°C for 3 hours. As a result of the calculated formulation, about 45 units of plant-based snacks were produced (Figure 2).

Figure 2 – Snacks after cooking in an industrial oven

SENSORY ANALYSIS

The sensory analysis was performed by 48 untrained tasters, students, professors and employees of the Faculty of Food Technology – FATEC/Marília/S.P. The *snack* was served to the tasters in a circular format at room temperature, along with a disposable cup of drinking water at room temperature (200 mL disposable cup) and a sensory sheet (Figure 3).

Figure 3 – Sensory sheet prepared for snack evaluation

Ficha de Análise Sensorial

Nome: _____ Idade: _____ Sexo (F/M): _____

Assinale se você é celíaco, ou seja, não pode consumir Farinha de trigo.

( ) Sim ( ) Não

Você busca consumir produtos com apelo saudável diariamente?

( ) Sim ( ) Não

Com que frequência você consume "snack" salgados vendidos em supermercados?

( ) Todos os dias ( ) 3x na semana

( ) 1x a cada 15 dias ( ) 1x ao mês

Você tem costume de consumir qual "snacks" abaixo:

( ) Pringles ( ) Ruffles ( ) Torcida ( ) Fandangos ( ) Lay's

( ) Mãe Terra Tribos integral ( ) Eqlibri ( ) GoodSoy snack ( ) Vitao snack proteico

( ) outros _____

Por favor, agora deguste a amostra de "Snack", e indique o quanto você gostou ou desgostou do produto usando a escala abaixo como referência para dar a sua nota.

5. ADOREI
4. GOSTEI
3. INDIFERENTE
2. NÃO GOSTEI
1. DESGOSTEI

ODOR	
SABOR	
APARENCIA	
CROCANCIA	
COR	

The samples were coded with random numbers of 3 digits, using the 5-point hedonic scale, and the method used was the affective method in a monadic way, where the minimum score 1 represents "disliked" and the maximum score 5 "loved", and the attributes such as odor, flavor, appearance, crunchiness and color were evaluated. Also in the sensory form, questions were asked to the tasters related mainly to the consumption of commercial snacks. In addition, questions were asked about healthiness, gluten intolerance and the commercial brands that tasters consume the most.

PHYSICOCHEMICAL ANALYSIS

The analyses were carried out at the Physicochemical and Microbiological Research Laboratory of Fatec Marília.

A total of 100 grams of *the snack* sample were used for the analysis of water activity, pH, total proteins and moisture determined by methods recommended by the INSTITUTO ADOLFO LUTZ (IAL, 2008).

RESULTS AND DISCUSSIONS

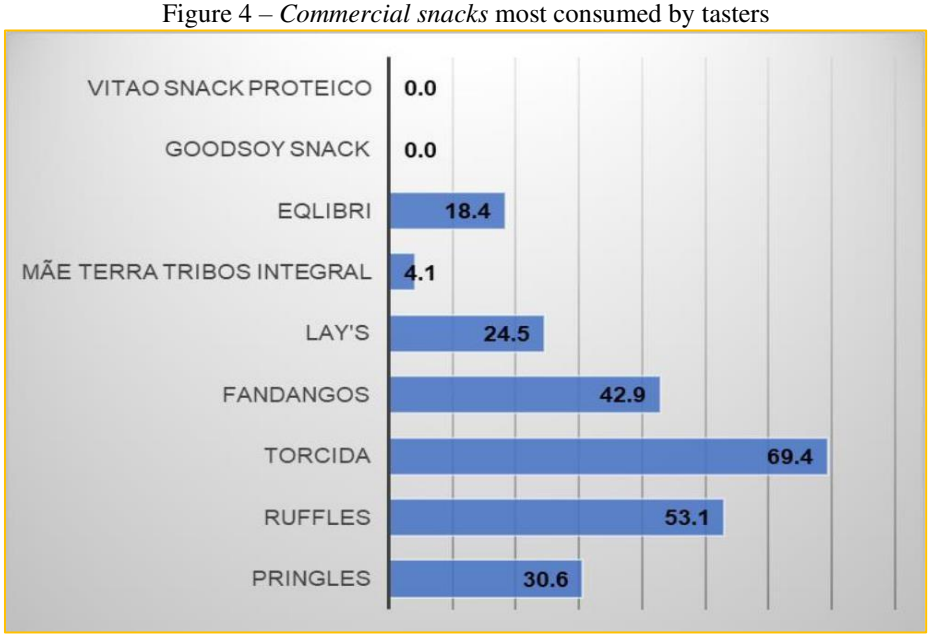
SENSORY ANALYSIS

According to the information obtained through the results of the sensory tests, it was possible to observe that 59.2% of the tasters were female and 40.8% were male. Regarding the affirmation of being celiac, 12.2% affirmed the diagnosis, 13.8% women and 10.0% men.

69% of the tasters answered that they consume healthy products in their daily lives, but following the reasoning for the next two questions, there was a contradiction and/or lack of understanding from the tasters.

In the third question, about the consumption of *snacks* sold in supermarkets, the majority (46.9%) answered "once a month", 44.9% "three times a week", 8.2% "once a week" and "every day" was not signaled. The contradiction appears when the evaluators are asked about the most consumed snacks, because if there is a concern to buy healthy products, and they demonstrate that they buy few "commercial" snacks (which are mostly rich in simple carbohydrates and saturated fats), it is indicated that brands such as: "Vitao protein snack", "*Goodsoy snack*", "Eqlibri" and "Mãe terra tribos integral" should be the products that the evaluators would signal the most. However, the *snacks* that tasters most commonly consume were, respectively, Torcida, Ruffles and Fandangos (Figure 4).

Figure 4 – *Commercial snacks* most consumed by tasters



According to Duarte et al. (2021), although consumers express positive evaluations of healthier options, their purchase intentions do not always correspond to what they claim, due to differences in perception between adding (such as fiber) and reducing ingredients (such as sugar). This discrepancy can be explained by skepticism towards the claims, the less attractive taste, higher price, and limited availability of these products. Additionally, factors such as taste, brand, and price play a significant role in the purchase decision, with taste and price being the most influential.

The last question, referring to the developed product, obtained the best scores for the attributes flavor (87.7%) and crunchiness (89.8%), when the concepts "loved" and "liked" were added, and the results with the lowest acceptance rate were color (14.3%) and appearance (16.3%) (Table 2).

Table 2 - Results of the sensory analysis of the *snack* by the tasters, in relation to the attributes of odor, flavor, appearance, crunchiness and color (%).

Answers	Attributes				
	Odor	Flavor	Appearance	Crunchiness	Color
I loved	22.4	40.8	12.2	32.7	4.1
I liked	46.9	46.9	42.9	57.1	55.1
Indifferent	24.5	8.2	28.6	8.2	22.4
Did not like	4.1	4.1	10.2	2.0	10.2
I disliked it	2.0	0.0	6.1	0.0	4.1

Every product has an expected appearance and color that is associated with personal reactions of acceptance, indifference, or rejection. The form is usually related to the natural form, or to a culturally consecrated commercial form (TEIXEIRA, 2009). The color of the *snack* developed had a dull orange pigmentation, due to the insertion of the carrot and because it contains few lipids, unlike the brands most consumed by the tasters.

PHYSICOCHEMICAL ANALYSIS

The protein values found in 100 grams of the *snack* were approximately 20 grams (Table 3), being considered a product with "high protein content", because according to the technical regulation on the recommended daily intake (RDI) of protein, vitamins and minerals, RDC No. 269 of September 22, 2005, at least 20% of the RDI is required. which for adults is 50 g (RUFFI, 2011).

Comparing the amount of protein found in the *oatmeal snack* enriched with chickpeas and carrots with the study by Kanai (2021), who developed vegan cookies with three different processed chickpea flours, obtaining values of 22.50%, 24.88% and 18.99%, these were similar to the current project (20.7%).

Comparing with the commercial product "Vitao *protein snack* ", it is possible to observe the difference between the amounts of proteins, the mentioned product has about 12% of protein in every 100g of it, a variation of about 8% compared to the *snack* based on oat flour enriched with chickpeas and carrots developed with chickpeas.

Table 3 – Values of the physicochemical results found in the *snack*: total proteins (%), water activity (Aw), moisture (%) and pH.

	Results
Total Proteins (%)	20.7
Water activity (Aw)	0.455
Moisture (%)	1.3
pH (20°C 10% solution)	5.85

Source: Physicochemical Research Laboratory of Fatec/Marília

According to the results shown in the table above, it is possible to notice the low content of water activity (Aw) (0.45) and moisture content in the product (1.3%), which are very important factors to inhibit the development and growth of fungi and microorganisms,

consequently prolonging the shelf life of this product. *Sweet potato snack* developed by Campos (2014) had a moisture content of 5.47% and vegan cookies added to processed chickpea flours formulated by Kanai (2021) had moisture content between 9.30% and 10.7%, being similar products or with the same raw materials, but with moisture content higher than the project.

Ruffi (2011) evaluated the technological performance of cracker crackers obtained with the use of soybean derivatives (protein isolate and dietary fiber) in partial replacement of wheat flour, aiming at nutritional improvement (amino acid content and profile) with functional properties (fibers and isoflavones), performing 12 trials in total, which ranged from 0.45 to 0.61 in water activity values. with an average value of 0.43, which is analogous to the *project's* snack.

CONCLUSION

It was concluded that it was possible to develop a *snack*, for quick and/or immediate consumption, with a high protein content, and a base of healthier and more nutritious ingredients, in addition to a shelf life similar to those of similar products available in the market.

Regarding the sensory evaluation, the results for the flavor and crunchiness attributes obtained more than 80% in the sum of the positive concepts ("loved" and "liked").

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