DEVELOPMENT AND EVALUATION OF EXTRUDED PROTEIN SNACKS ADDED LENTIL AND TEXTURIZED SOY PROTEIN

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RESUMO

This work aimed to develop an extruded protein snack added to lentil flour (L) and textured soy protein (S) and to evaluate sensorially, physicochemically, and physically the developed formulations. Five formulations were prepared: PA (100% flour corn (M)), MS40% (60% flour corn; 40% soybean), MSL20% (80% flour corn; 15% soybean; 5% lentil), MSL15% (85% corn; 7.5% soybean; 7.5 % lentil) and MSL10% (90% corn; 7 % soybean; 3 % lentil). The research was approved by the Research Ethics Committee of the University of Passo Fundo (55484622.2.0000.5342). Seventy untrained tasters participated in the acceptance test, where the MSL15% and MSL10% formulations were the most accepted (83,5 % and 80,2 %, respectively). In the physicochemical characterization, it was observed that all formulations improve nutritional quality, with a significant increase in protein content (11% to 23%) in all formulations. Physically, the formulations with corn replacement rates showed higher resistance and lower crunchiness. Furthermore, all formulations showed higher water activity (0.55 to 0.61 aw) than the standard sample (0.34 aw). Therefore, the incorporation of lentils and soy flours benefited the nutritional quality of the snacks but negatively affected the physical parameters and sensory acceptability.

INTRODUCTION

Currently, people have less and less time to prepare food at home and therefore end up prioritizing practical foods such as extruded snacks. Snacks are practical, spicy quick snacks produced by extrusion, a cooking technique that employs high temperatures and high pressures. However, these foods have low nutritional quality, as they have a high glycemic index, high percentage of fat and sodium, and are deficient in macronutrients such as protein and fiber [1,2]. The consumption of foods with a high glycemic index and a high percentage of fat has been associated with the development of food addiction, type 2 diabetes, and cholesterol [3,4,5].

Because of this, several studies have been carried out incorporating legume flours such as lentils and soy in the production of extruded snacks since legumes are excellent protein sources and have a good profile of essential amino acids [6]. Legumes, when combined with cereals such as corn, improve considerably the nutritional value of the food and increase the protein contents of these foods, which in some cases can even be considered as a source of protein and an alternative to the lack of this nutrient.[7]. Therefore, this present work sought to develop an extruded protein snack added with lentil and textured soy protein.

OBJECTIVE

Develop extruded protein snacks added with vegetable raw materials (Lentil and Textured Soy Protein) and evaluate the physicochemical, sensory, and physical formulations developed.

METHODOLOGY

Production of snacks

Four extruded snack formulations were developed in an automated twin-screw extruder line (RX 200, series 3586, Rafamáquinas, 2018), with a pressure of 30 bar and flow rate of 180 kg.h-1. The format of the snack was the shape of the moon and the flavors were cheese and barbecue. The rates of replacement of corn flour in snacks with textured soy and lentil protein were MSL10%- corn 90%; soybean 7%; 3% lentil; MSL15%- with 85%; soybean 7.5%; 7.5% lentil; MSL20%- with 80%; soybean 15%; 5% lentil; MS40%- with 60%; soybean 40%.

Physicochemical analysis

Proteins, lipids, moisture, ash, carbohydrates, and fibers were determined according to the methodology described in the AOAC [8].

Physical Analysis

The density of the snacks was determined by weighing and measuring the length and diameter [9]. To analyze water activity, the samples of snacks were placed in a metallic chamber with a probe. The section was hermetically closed and placed at temperature equilibrium (25±1°C) in an electric thermohygrometer of direct measurement. The texture was determined using a texture analyzer (TA-XT plus, Stable Micro System) with a 50 kg load cell. Test parameters were set at a 10 mm distance between probe and base, a speed of 1 mm/s and a distance between the two bases supports of 1.5 mm. The result was expressed as the mean of the repetitions.

Sensory analyzes

A total of 70 untrained consumers from the city of Passo Fundo-RS participated in the acceptability test with a hedonic scale ranging from 1-9 points. The research was approved by the Research Ethics Committee of the Universidade de Passo Fundo and generated the approval number 55484622.2.0000.5342.

RESULT AND DISCUSSION

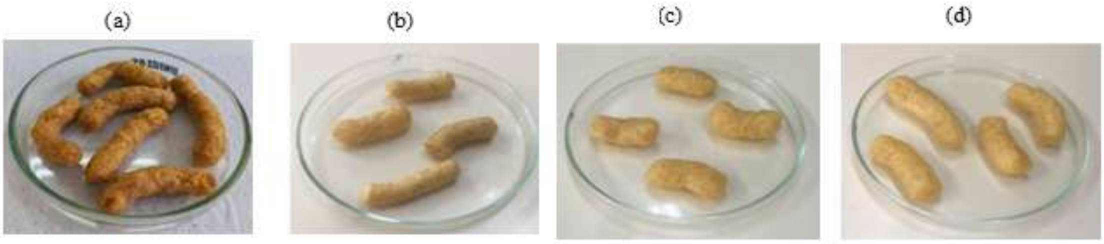
The flours used in the present study showed average crude protein values of (19%) for lentils and (38%) for textured soy protein. The incorporation of lentil flour (L) and textured soy protein (S) in the production of snacks resulted in a marked improvement in the protein component of interest. This increase is significant in all formulations when compared to the standard sample, especially in formulations with 40% and 20% replacement (Table 1). The MS40% formulation, according to normative instruction nº 75 of the nutritional labeling, is considered a source of protein, as it presents 10% of the recommended value for daily consumption of this macronutrient. The increase in proteins and the reduction in carbohydrates in the MS40% formulation is mainly due to the greater substitution of corn in the formulation for soy only. Soy is a flour with a high protein content but low carbohydrate content which affects the expansion of the snack. So to help improve the expansion of the snack during extrusion, lipids are added to the formulation and as a consequence increases the fat content of the snack (Table 1).

Table 1.: Centesimal composition of formulations and standard sample

Formulations	Prot	Fib	Lip	Ash	Carb	Accep	IA (%)
AP	8^{d}	1,06^{a}	9,65^{b}	3,27^{a}	81^{a}	---	---
MS40%	23^{a}	1,26^{a}	20,09^{a}	3,79^{a}	57^{d}	5,9^{b}	65,7
MSL20%	15^{b}	0,84^{a}	11,23^{b}	2,96^{a}	73^{bc}	6^{b}	66,7
MSL15%	12^{c}	0,36^{a}	15,52^{a}	3,74^{a}	70^{c}	7,5^{a}	83,5
MSL10%	11^{c}	0,76^{a}	8,39^{b}	1,32^{b}	80^{ab}	7,2^{a}	80,2

* Prot-Protein; Fib-Fibers; Lip-Lipids; Ash-Ashes; Carb-Carbohydrates; Accep- Acceptability. Same letters in the same column do not differ statistically p (<0,5). PA (100% corn (M)), MS40% (corn 60%; soybean 40%), MSL20% (corn 80%; soybean 15%; lentil 5%), MSL15% (corn 85%; soybean 7.5%; lentil 7.5 %) and MSL10% (corn 90%; soybean 7 %; lentil 3 %).

Figure 1.:Appearance of the developed formulations



*(a) MS40% formulation; (b) MSL20% formulation; (c) MSL15% formulation; (d) MSL10% formulation

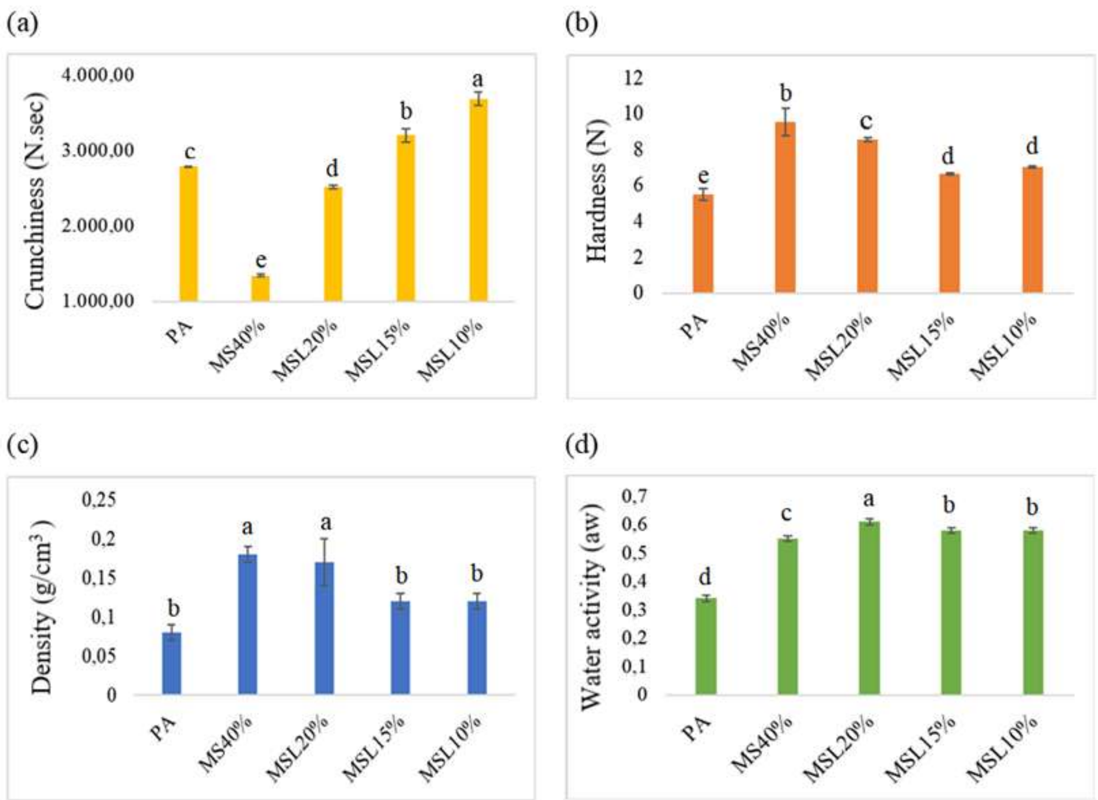
In Figure 1 it is possible to observe the appearance of the developed formulations. The influence of the addition of flour on the expansion of snacks is clear in Figure 1.(a) and (b), as the snacks are less expanded, with a darker color and oily appearance.

Figures 1.(c) and (d) did not show major visual and expansion changes, looking very similar to commercial corn snacks. Therefore, the low replacement rate of corn flour in these formulations and the higher concentration of carbohydrates, suggest a higher percentage of starch, which guarantees a better expansion.

The most accepted formulations were those with the lowest replacement rate (Table 1) because they were the ones that did not show major changes in texture and appearance, in addition to having a taste closer to that of corn snacks, referring to the tasters of the commercial snack.

On the other hand, the formulations with the highest replacement rate were not sensory well accepted due to their compact appearance and darker color (Figure 1). Additionally, tasters typically described the samples as having a soggy texture and a mild salty taste that is uncharacteristic of snack foods.

Figure 2.: Results of the physical parameters crispness, hardness, density, and water activity of the developed snacks and the standard sample



* Same letters in the same column do not differ statistically p (<0,5). (a) MS40% formulation; (b) MSL20% formulation (c) MSL15% formulation; (d) MSL10% formulation.

The physical parameters of the snacks were also evaluated and the results can be seen in Figure 2. Texture is one of the mst important attributes in determining the quality of an extruded snack. Because extruded snacks are characterized as having a crunchy texture with little hardness. However, when adding or replacing ingredients, changes occur that can increase hardness and reduce crispness, as can be seen in Figures 2. (a) and (b). As the replacement rate increased, there was a significant increase in hardness as well as a reduction in crispness. The higher concentration of proteins in the dough during extrusion favored the formation of stronger protein-starch bonds and compromised the starch gelatinization during cooking in the extruder, which interfered with expansion and compromised the texture of the snacks [10].

Density is an excellent indicator of snack expansion, as the denser the snack, the smaller the expansion. In Figure 2. (c) it is possible to observe that the formulations MS40% and MSL20% were the ones with the highest density. This result is attributed to the high rate replacement of corn in these formulations. Since the increase in fiber and protein in the medium will trigger competition for water between protein, fiber, and starch, making it difficult for the complete gelatinization of the starch and the adequate formation of bubbles to form gas, making the snack walls thicker and the snack more compact and dense [11].

The water activity, like the previous parameters, is very important for the quality of the extruded snack. Snacks are foods that have low water activity. However, the formulations developed showed significantly higher water activity than the standard sample, thus indicating that they may have a loss of sensory and physical quality during the storage period. In addition, unwanted chemical and microbiological reactions can occur, such as hydrolytic rancidity and microbial growth that would make consumption unfeasible [12].

CONCLUSION

We concluded that the best formulation developed was MSL15% based on results for protein, physical and sensory parameters. The incorporation of protein raw materials in the production of extruded snacks is viable and very beneficial from a nutritional point of view, but its effects on the physical characteristics of the snacks are still a limiting factor. The MS40% formulation can be considered a protein source according to normative instruction nº 75 of the nutritional labeling, however, it was not well-accepted sensorially, which makes its commercialization difficult

REFERENCES

1. NATABIRWA, H.; NAKIMBUGWE, D.; LUNG'AHO, M.; TUMWESIGYE, K. S.; MUYONGA, J. H. Bean-based nutrient-enriched puffed snacks: Formulation design, functional evaluation, and optimizatio. **Food Sci Nutr**, v.8, p. 4763–4772, 2020.
2. JIAPONG, S.; RUTTARATTANAMONGKOL, K. Development of direct expanded high protein snack products fortified with sacha inchi seed meal. **J Microbiol Biotech Food Sci**, v. 10, n. 4, p. 680-684, 2021.
3. BELIK, W. **Um retrato do sistema alimentar brasileiro e suas contradições (resumo)**. p. 36, 2020.
4. ROBERTS, S. B. High-glycemic Index Foods, Hunger, and Obesity: Is There a Connection? **Nutrition Reviews**, v. 58, n. 6, p. 163–169, 27, 2009.
5. LENNERZ, B.; LENNERZ, J. K. Food Addiction, High-Glycemic-Index Carbohydrates, and Obesity. **Clinical Chemistry**, v. 64, n. 1, p. 64–71,1, 2018.
6. MARTIN, A., SCHMIDT, V., OSEN, R., BEZ, J., ORTNER, E., & MITTERMAIER, S. Texture, sensory properties, and functionality of extruded snacks from pulses and pseudocereal proteins. **Journal of the Science of Food and Agriculture, v.** 102, n. 12, p. 5011–5021. 2021.
7. MOSIBO, O. K.; FERRENTINO, G.; ALAM, M. R.; MOROZOVA, K.; SCAMPICCHIO, M. Extrusion cooking of protein-based products: potentials and challenges, **Critical Reviews Food Science and Nutrition,** 2020.
8. ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTRY – AOAC. **Official Methods of Analysis of the AOAC International**. 16 ed. Arlington: AOAC, 2005, 1025p.
9. STOJCESKA, V. et al. The effect of extrusion cooking using different water feed rates on the quality of ready-to-eat snacks made from food by-products. **Food Chemistry**, v. 114, n. 1, p. 226–232, 2009.
10. MONNET, A.-F.; LALEG, K.; MICHON, C.; MICARD, V. Legume enriched cereal products: A generic approach derived from material science to predict their structuring by the process and their final properties. **Trends in Food Science & Technology**, v. 86, p. 131–143, 2019.
11. SELANI, M. M.; BRAZACA, S, G. C.; DIAS, C. T. dos S.; WAJIRA, S. R.; FLORES, R. A.; BIANCHINI, A. Characterisation and potential application of pineapple pomace in an extruded product for fibre enhancement. **Food Chemistry**, v. 163, p. 23-30, 2014.
12. SHAH, F. U. H.; SHARIF, M. K.; BUTT, M. S.; SHAHID, M. Development of protein, dietary fiber, and micronutrient enriched extruded corn snacks. **Journal Texture Studies**, v. 48, p. 221–230, 2017.