ANALYSIS AND POSSIBLE USES OF CANNING PLANT WASTE

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Abstract

The research focuses on the valorization of plant-based waste and by-products generated in the canning industry. In light of growing environmental concerns, minimizing waste production and promoting the reuse of agricultural by-products for the development of value-added products has become increasingly important. The primary aim of this study was to utilize substandard green pea seeds, a by-product of green pea processing. Thereby contributing to the reduction of industrial food waste.

The research involved the development of a food product based on green pea flour, specifically a cracker. For this purpose the rejected green peas were dried and milled into flour, which was subsequently analyzed for its nutritional composition. The evaluation included the determination of fat, protein, fiber, and ash content to assess the flour's nutritional value and its potential applicability in food product development.

Introduction

Sustainable food production and waste reduction are gaining increasing importance in the food industry. The food industry generates a significant amount of plant-based by-products, which are often discarded as waste, despite their potentially valuable nutrient content. The canning industry, in particular, produces large quantities of such plant waste, including vegetable and fruit peels, stems, and also seeds. In 2004, companies in the European food industry generated nearly 222 million tons of processing losses. In the fruit and vegetable preservation sector. waste accounted for approximately 4.5% of the total production. (Baiano, 2014) These by-products are most commonly used as animal feed, compost, or disposed of as waste; however their reuse in food production offers promising opportunities.

During the canning process of green peas, substantial amounts of plant-based waste are generated, such as the green pea pods, seeds and other parts of the plant. These by-products are rich in fiber and protein, making them worth utilizing. In recent years. there has been a growing research interest focused on the alternative use of such plant-based residues,—such as grinding them into flour for application in bakery products.

The aim of the present study was to process green pea canning waste into flour and to use this flour to produce a simple. savory bakery product: crackers. The study focused on analyzing both the physical and sensory characteristics of the resulting flour and the properties of the crackers made from it.

Experimental

The green pea by-product used for the study originated from industrial canning processes. The waste material was collected immediately after processing and, due to its seasonal availability, it was stored frozen until use.

Prior to use, the green pea seeds were thawed and pureed, then dried in a drying oven at 60 °C for 20–22 hours. This relatively low-temperature, long-duration drying process was chosen to considering the high moisture content of the material and to prevent protein denaturation. After drying, the material was initially coarsely crushed. then further milled into a fine flour

consistency. The resulting flour was stored in airtight containers until further use. After milling, the nutritional composition of the green pea flour was analyzed.
Firstly, the **dry matter** content was determined according to the MSZ EN ISO 712 standard. A known amount of flour was dried at 130°C for one hour, after which the sample was weighed again to calculate moisture loss.
The **protein content** was assessed using the Kjeldahl method. The sample was digested in the presence of sulfuric acid at 400°C. After digestion. sodium hydroxide (NaOH) was added and the mixture was distilled. The resulting distillate was collected in boric acid, and then titrated with 0.100 M hydrochloric acid (HCl) solution using mixed indicator. The nitrogen content obtained from the titration was multiplied by a conversion factor of 6.25 to calculate the total protein content of the green pea flour.
The **fat content** of the green pea flour was determined gravimetrically using the Soxhlet extraction method, with a Soxtec extraction unit. The procedure began with a 1.5-hour hot extraction phase during which the sample was immersed in warm petroleum ether, followed by a 1.5-hour cold extraction phase, during which the sample was exposed only to the vapor of petroleum ether. After extraction, the recovered fat fraction was dried in a drying oven at 100 °C for approximately one hour, and the fat content was calculated based on the mass of the extracted material.
The **mineral content** of the sample was determined by measuring the ash content of the flour. The weighed samples were first incinerated over an open flame and then placed in a muffle furnace at 600 °C for 6 hours to complete the ashing process.
The **crude fiber** content was determined using an extraction-based method. The samples were first defatted by washing with ethanol, followed by boiling in diluted acid for 30 minutes, and then boiling in diluted alkali for another 30 minutes. After the chemical treatments, the residue was dried and weighed to determine the fiber content gravimetrically.

Following the analysis of the nutritional composition of the green pea flour, the next objective was to develop a food product. Green pea flour is gluten-free and nutritionally valuable due to its high fiber and protein content, as well as its low glycaemic index.
Based on these attributes, the aim was to create a product that is not only gluten-free but also free from common allergenic ingredients and animal-derived components, making it suitable for both vegetarians and vegans.
The choice fell on crackers, as they are simple to prepare yet widely popular snack products consumed by many people on a daily basis. Pea flour is rarely used alone; it is typically blended with other flours. For this purpose, rice flour and red lentil flour were applied separately, both of which are also gluten-free.
The selected basic recipe included green pea flour, rice flour or red lentil flour, water, olive oil, salt, and spices for a pleasant flavor. During the study, the addition of baking powder and yeast was also tested, but these formulations were discarded because the resulting product had a texture resembling shortcrust pastry rather than the desired crispiness expected in crackers.
As a texture improver, aquafaba—the cooking water of chickpeas—was used as an egg replacer. Depending on the amount. aquafaba can substitute egg yolk, egg white, or whole egg. The primary spices added were oregano, basil, and garlic, which imparted a pleasant flavor to the crispy crackers.
Baking conditions (temperature, duration, convection, etc.) were tested, and based on preliminary sensory evaluation, the optimal product was obtained by baking the crackers at 150 °C for 35 minutes.
The finished crackers were analyzed for protein, fiber, ash, and fat content, and their structural properties (e.g., hardness, crispness, brittleness) were evaluated using texture analysis.

In addition, a texture analysis was performed on three different cracker samples. During the texture analysis, I examined various parameters such as fracturability, hardness, and the required hardness work.

Results and discussion

The green pea flour obtained from canning industry by-products exhibited a fine texture with a characteristic greenish hue. The proximate analysis revealed a dry matter content consistent with expectations for dried legume-based flours. The obtained values for the various samples are summarized in Table 1. Protein content was notably high, reflecting the rich leguminous source, while the fiber content confirmed the potential of the flour as a valuable dietary fiber contributor. The flour has a protein content of 24.75% and a fiber content of 9.58%. Fat and ash contents were within typical ranges for pulse-derived flours, supporting its nutritional value. Fat content was found to be 2.39%. and the ash content 2.97%. For reference purposes, the compositional parameters of a flour produced using a similar method were utilized. (Sallam, El-Salam, & Abaza, 2021)

Table 1. Pea flour and crackers proximate composition

Proximate compositions				
Values are based on dry matter [%]	**Green pea flour**	**Cracker with rice flour**	**Cracker with rice flour and aquafaba**	**Cracker with red lentil flour and aquafaba**
Carbohydrates	56.62	56.44	55.97	53.16
Protein	26.42	24.76	24.83	27.50
Crude fiber	10.87	9.99	9.92	9.77
Fat	2.72	4.48	4.70	4.83
Ash	3.37	4.33	4.58	4.74
Energy content of 100g product	378.38 kcal	385.10 kcal	385.34 kcal	385.65 kcal

Formulation trials demonstrated that green pea flour could not be used as a sole flour in cracker production due to texture challenges. When combined with gluten-free rice or red lentil flours, the dough exhibited improved handling and baking properties. Attempts to incorporate leavening agents such as baking powder and yeast resulted in crackers with a softer, shortcrust-like texture rather than the desirable crispiness typical of crackers. leading to the exclusion of these additives. The use of aquafaba as an egg replacer proved effective in improving dough binding and texture without compromising the vegan and allergen-free objectives. Sensory evaluation favored crackers spiced with oregano, basil, and garlic, which enhanced the flavor profile and consumer acceptability.

Optimization of baking conditions identified 150 °C for 35 minutes as the ideal setting, producing crackers with optimal crispness and structural integrity. Texture analysis confirmed the products' desirable hardness, brittleness, and crunchiness, meeting expectations for a savory snack product. The nutritional composition of the final crackers retained significant levels of protein, fiber, and minerals, confirming that the valorization of green pea processing waste into a novel bakery product is both feasible and nutritionally advantageous. This approach not only contributes to reducing industrial plant waste but also offers a gluten-free, vegan-friendly snack option with promising market potential.

During the texture analysis, I recorded the characteristic texture profile curve of the product, which clearly illustrates the differences between the three samples(Figure 1.). The crackers show similar kind of response to the deforming force applied to them during measurements, in general. However, the results clearly indicate that the two different types of flour, as well as the addition of aquafaba, had a significant impact on the texture and structural properties of the crackers. Addition of rice flour and aqufaba led to weakest structure, showing lowest hardness among the samples.

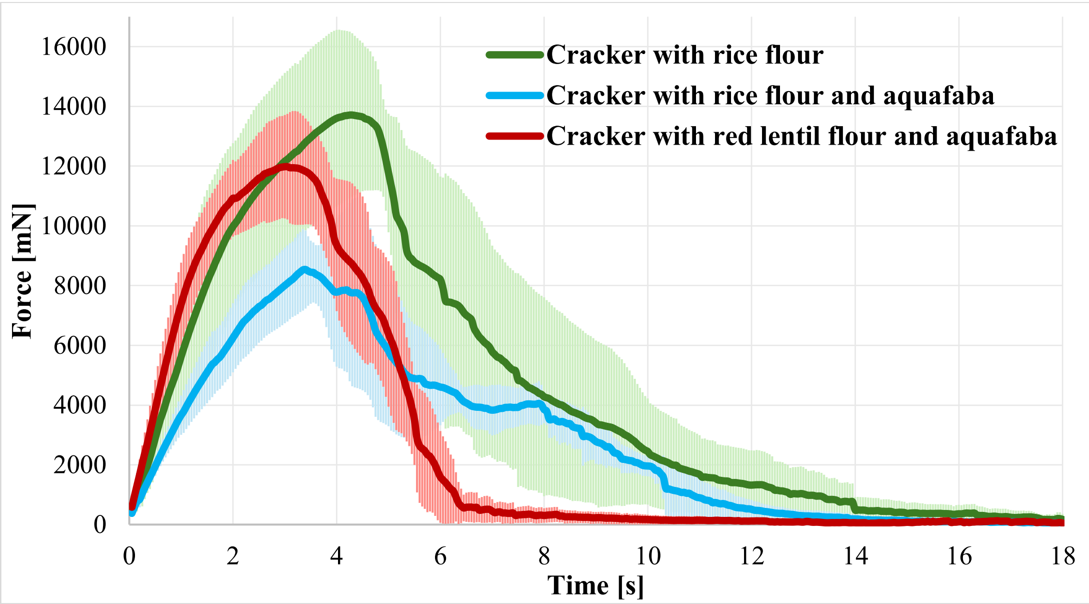

Figure 1. *Texture curves of pea crackers*

Conclusion

In my research, I investigated whether plant-based by-products generated during processing could be used to produce a raw material suitable for the development of various products. As a first step, I analyzed the nutritional composition of the material and compared the results with data found in the scientific literature. Based on my measurements, green pea proved to be an excellent source of protein and fiber, with a particularly favorable composition. Subsequently, crackers were produced from green pea flour using different formulations, and these were also examined. At this stage, the crackers serve as prototypes; further development is required, including sensory evaluations, in order to create a snack product that is both palatable and appealing to consumers. Future research could focus on a more detailed analysis of the protein and carbohydrate components, as well as digestibility experiments to determine the extent to which the flour or the final product can be utilized by the human body.

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