

Physicochemical, Digestibility, Antioxidant and Acceptability Analysis of Probiotic-Enhanced Quinoa Snacks

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DESCRIPTION

Second-generation snacks represent an evolution beyond traditional options, offering innovative features and enhanced nutritional benefits such as high levels of protein, fiber, prebiotics, probiotics, vitamins, omega-3 fatty acids and antioxidants. These snacks frequently utilize plant-based ingredients like pea proteins, chickpea flour, or seaweed, promoting more sustainable and eco-friendly choices. The development of such products often involves advanced technologies like 3D printing, ingredient extrusion, or molecular cooking, resulting in unique textures and shapes.

The creation of these novel products can also improve production systems by incorporating ancient ingredients like quinoa. This ancient grain, known for its adaptability to diverse environmental conditions, has been cultivated for centuries and retains valuable genetic traits. Introducing these innovative foods can address global food insecurity, as highlighted by the Food and Agriculture Organization of the United Nations (FAO), which reports that 843 million people globally suffer from hunger, and nearly one billion lack adequate protein intake. For example, in Colombia, data from the University Alliance for the Human Right to Adequate Food indicates that over 71% of households experience food insecurity, with 26% facing moderate and 14% severe insecurity. Some households even lack access to the three essential daily meals necessary for their activities. To tackle these issues, this study proposes structural measures to enhance food production and protect national producers.

New food products made from alternative ingredients offer diverse nutritional benefits. These include plant-based snacks, seaweed, ancestral seeds and insects, among others. Known as second-generation snacks, these innovative items provide high-quality, affordable options with a long shelf life, ease of transport and rich nutrient profiles, including protein and bioactive compounds. They offer a valuable dietary alternative for all age groups and are suitable for various times of the day.

Quinoa, an ancient grain renowned for its adaptability to different climates and stress conditions, is particularly important. Naturally gluten-free, quinoa is rich in essential nutrients such as unsaturated fatty acids, vitamins and minerals. Its high protein content (18%) and digestibility (over 90% after thermal treatment and high-pressure processing) make it an attractive option for vegan foods. Ensuring the sustainability of these products requires developing bioprocesses to remove anti-nutritional factors and extract bioactive compounds on an industrial scale. This approach aims to optimize production, ensuring efficiency, safety and market availability.

Innovations in functional foods enhanced with probiotics add significant value to the supply chain of ancestral grains. These advancements benefit producers and facilitate the delivery of nutritious, transportable foods to consumers. Probiotic bacteria of the genus *Bacillus*, known for their spore-forming capability, can endure extreme conditions during food processing, such as high-temperature extrusion and low-moisture environments, while also resisting the acidic conditions of gastric and pancreatic juices. Building on these principles.

CONCLUSION

The various formulations were significantly impacted the physical characteristics of the extruded snacks, including expansion index, porosity, bulk density, texture and color. The addition of High-Protein Quinoa Flour (HPQF) affected the crispiness of the snacks, with higher amounts of quinoa flour leading to reduced crispiness. This issue can potentially be addressed by optimizing the formulation, adjusting processing conditions, possibly incorporating enzymes and controlling the final product's moisture content to enhance the attractiveness and palatability of the extruded high-protein foods. This study aims to develop a novel snack by incorporating the concentrated quinoa protein flour and also probiotics before the extrusion.

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