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Buckwheat processing and its utilization in value-added products: A comprehensive review

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Abstract

Buckwheat (*Fagopyrum esculentum* Moench) is a versatile pseudo-cereal with a long history of cultivation and consumption in various parts of the world. It is known for its nutritional richness, unique flavor, and health-promoting properties. This comprehensive review paper aims to explore the various aspects of buckwheat processing, from processing to utilization in value-added products. The paper covers agricultural practices, post-harvest processing methods, and the development of innovative value-added products from buckwheat, including its incorporation in baked goods, beverages, functional foods, and more. The nutritional and health benefits associated with buckwheat consumption are also discussed, making it evident that buckwheat holds great potential for both consumers and the food industry. The buckwheat processing and its utilization in value-added products present a promising avenue for innovation in the food industry. With its remarkable nutritional composition, distinctive bioactive compounds, and adaptable processing methods, buckwheat holds the potential to contribute to a diverse range of functional and flavourful food products. This comprehensive review underscores the significance of buckwheat as a versatile ingredient for both traditional and emerging food applications, fostering healthier and more sustainable food choices.

Keywords: Buckwheat, value-added products, processing, nutritional benefits, functional foods

1. Introduction

Buckwheat, despite its name, is not a cereal but rather a seed belonging to the Polygonaceae family. It has gained attention due to its exceptional nutritional composition, including high levels of protein, dietary fiber, vitamins, minerals, and bioactive compounds. In recent years, there has been a growing interest in utilizing buckwheat for the development of value-added food products that cater to consumer demands for healthier and functional foods^[1]. Buckwheat (*Fagopyrum esculentum* Moench) stands as a resilient and versatile crop within the realm of pseudo-cereals, cherished for its exceptional nutritional profile and numerous health benefits. Originating in Central Asia, buckwheat has traversed geographical and culinary boundaries to establish itself as a valuable dietary resource in various cultures around the world. Its popularity is attributed not only to its distinct earthy flavor but also to its capacity to flourish in diverse agro-climatic conditions, making it a promising contender for sustainable food production^[2].

In recent years, the escalating demand for functional foods, coupled with an increasing awareness of the importance of a nutrient-rich diet, has prompted researchers and food technologists to explore the untapped potential of buckwheat. This has led to a burgeoning interest in buckwheat processing and the creation of value-added products that capitalize on its nutritional richness and unique functional properties^[3]. From gluten-free bakery products to nutrient-fortified beverages, buckwheat has demonstrated its adaptability as a key ingredient in a wide range of food applications. The processing journey of buckwheat, from cultivation to the development of innovative products, involves a series of intricate steps that influence the final characteristics of the end products. As such, understanding the nuances of buckwheat processing is imperative not only for food industry professionals but also for consumers seeking healthier and more sustainable dietary options. This review paper aims to delve into the multifaceted realm of buckwheat processing, shedding light on agricultural practices, post-harvest techniques, and the subsequent utilization of buckwheat in value-added products^[4].

With a focus on both traditional and modern processing methods, this review intends to provide a comprehensive overview of the strategies employed to transform raw buckwheat into an array of desirable food products. The paper will delve into the optimization of processing methods to maximize the retention of essential nutrients and functional components.

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Moreover, it will explore the challenges and opportunities associated with buckwheat processing, aiming to pave the way for further advancements in this field [5]. By examining the interplay between cultivation, processing, and product development, this review seeks to unveil the potential of buckwheat not only as a staple crop but also as a catalyst for innovation in the food industry. As the pursuit of healthier, more sustainable food choices gains momentum, the insights gleaned from understanding buckwheat processing and its role in value-added products are poised to contribute significantly to the nutritional landscape.

In the subsequent sections, this review will delve into the various stages of buckwheat processing, beginning with agricultural practices, progressing through post-harvest processing, and culminating in the exploration of value-added products that capitalize on buckwheat's nutritional and functional attributes. Through this comprehensive exploration, readers will gain a holistic understanding of the journey that transforms humble buckwheat seeds into a diverse array of products that cater to both culinary delight and nutritional well-being [6].

2. Post-Harvest Processing

Post-harvest processing plays a pivotal role in determining the quality and potential applications of buckwheat. This section covers the steps involved in cleaning, dehulling, and milling buckwheat grains to obtain different fractions such as groats, flour, and bran. Various processing methods, including traditional and modern approaches, are compared in terms of their impact on the final product's nutritional profile and functionality [7].

The post-harvest processing of buckwheat is a pivotal stage that shapes the quality, functionality, and potential applications of its end products. This section of the review delves into the intricate processes that follow the harvest, covering cleaning, dehulling, and milling techniques that transform raw buckwheat seeds into versatile fractions such as groats, flour, and bran. Each step in the processing chain plays a crucial role in determining the nutritional content, flavor profile, and functional properties of the final products [8].

2.1 Cleaning

Upon harvest, buckwheat undergoes cleaning to remove foreign materials, dust, and impurities. This step is crucial in enhancing the quality of the end product and preventing contamination. Mechanical processes such as sieving, aspiration, and magnetic separation are employed to achieve thorough cleaning. Cleaning is a pivotal initial step in the processing of buckwheat (*Fagopyrum esculentum* Moench), ensuring the removal of impurities, foreign materials, and undesirable components [9]. This review comprehensively examines the various aspects of cleaning operations in the context of buckwheat processing. It encompasses the rationale behind cleaning, the types of impurities present in buckwheat, methods employed for cleaning, and the impact of cleaning on the quality of the final product.

Buckwheat, valued for its nutritional composition and unique bioactive compounds, requires thorough cleaning to achieve the desired product quality. The removal of extraneous materials, including stones, chaff, dirt, dust, and broken grains, is essential to prevent contamination and ensure consumer safety. Additionally, the elimination of impurities

contributes to the enhancement of flavor, texture, and shelf-life of the processed buckwheat. The types of impurities commonly found in buckwheat include foreign seeds, weed seeds, hulls, and other non-edible components. These impurities not only deteriorate the sensory attributes of the final product but can also potentially introduce allergens or contaminants that compromise the safety and marketability of the buckwheat-derived products. Several cleaning methods are employed to achieve optimal purity in buckwheat. Pre-cleaning, involving the removal of large-sized impurities, is often followed by gravity separation, which exploits differences in particle density to separate lighter impurities from the buckwheat kernels. Aspiration techniques use air to remove lighter particles, and sieve grading assists in segregating particles based on size. Magnetic separators can effectively remove ferrous impurities, while optical sorting technologies use colour and shape differences to detect and eliminate defects [10].

The effectiveness of cleaning operations has a profound impact on the quality and yield of buckwheat products. Proper cleaning not only guarantees the safety of the end consumer but also reduces losses during subsequent processing stages. Inefficient cleaning can lead to higher levels of impurities in the final product, compromising its nutritional value, flavor, and overall consumer acceptance. The cleaning operations for buckwheat processing play a critical role in producing high-quality and safe products. Proper cleaning ensures the removal of impurities and foreign materials, leading to improved product attributes and enhanced market value. The selection of appropriate cleaning methods depends on the specific impurities present and the desired quality standards. A comprehensive understanding of cleaning operations is essential for optimizing buckwheat processing and achieving the desired product quality in terms of safety, flavor, and overall consumer satisfaction.

2.2 Dehulling

The outer husk, or hull, of buckwheat seeds contains insoluble dietary fiber and tannins that contribute to its distinct flavor. Dehulling is the process of removing these hulls to access the inner groats. Traditional methods involve mechanical abrasion, while modern technologies utilize abrasive rollers, impact mills, or air classification systems. Dehulling reduces bitterness and enhances the nutritional profile of the groats. Dehulling is a fundamental processing step in the production of buckwheat (*Fagopyrum esculentum* Moench) products, aimed at removing the outer husk or hull from the edible kernel. This review provides a comprehensive analysis of dehulling operations in the context of buckwheat processing. It explores the significance of dehulling, the methods employed for hull removal, the impact of dehulling on nutritional and functional properties, and the potential applications of hulled buckwheat fractions. Dehulling serves multiple purposes in buckwheat processing, including the enhancement of palatability, reduction of anti-nutritional factors, and improved processing efficiency. The hull, comprising a substantial portion of the whole buckwheat grain, contains indigestible components such as cellulose and lignin that contribute to its relatively low nutritional accessibility. By removing the hull, the nutrient bioavailability of the kernel is enhanced, rendering it more suitable for human consumption [11].

Various methods are employed for dehulling buckwheat, each with its own advantages and limitations. Abrasive dehulling involves the use of friction to remove the hull, resulting in minimal damage to the kernel. Impact dehulling, on the other hand, employs mechanical force to separate the hull from the kernel, often resulting in higher yields but potentially causing more kernel breakage. Dry and wet methods can be utilized, with considerations for energy efficiency, water usage, and environmental impact. The dehulling process can influence the nutritional and functional properties of the resultant buckwheat products. Removal of the hull decreases the levels of anti-nutritional compounds such as tannins and phytic acid, which can inhibit mineral absorption. Furthermore, dehulling may impact the protein content, starch characteristics, and antioxidant activity of the buckwheat kernel. These changes can have implications for the texture, taste, and overall quality of buckwheat-derived foods. Hulled buckwheat fractions resulting from dehulling operations find diverse applications in the food industry. Buckwheat groats, the hulled kernels, are a versatile ingredient suitable for a wide range of culinary applications. They can be cooked and used as a base for various dishes, incorporated into bakery products, or even processed into noodles and pasta. Buckwheat hulls, the by-product of dehulling, have potential applications in animal feed, as a source of dietary fiber, or for their absorbent properties in packaging materials. Dehulling operations play a vital role in buckwheat processing, impacting the nutritional, functional, and sensory properties of the final products. The choice of dehulling method should consider the desired product characteristics, efficiency, and sustainability. Understanding the effects of dehulling on buckwheat fractions is essential for optimizing processing techniques and developing innovative applications for hulled buckwheat products [12].

2.3 Milling

Milling involves reducing the dehulled buckwheat groats into various particle sizes to obtain different fractions, including buckwheat flour. Depending on the desired end product, different milling techniques can be employed, such as stone milling, roller milling, or impact milling. The resulting fractions, which range from coarse to fine, exhibit distinct characteristics that cater to specific culinary and industrial applications. Milling is a pivotal stage in the processing of buckwheat (*Fagopyrum esculentum* Moench) that transforms raw materials into various value-added products. This review offers a comprehensive analysis of milling operations within the context of buckwheat processing. It delves into the significance of milling, the techniques employed, the impact on product characteristics, and the diverse applications of milled buckwheat fractions. Milling serves as a key bridge between dehulling and the creation of an array of buckwheat-derived products. The main objective of milling is to reduce buckwheat kernels into the desired particle size, influencing texture, taste, and nutritional accessibility. Different milling techniques are available, each influencing the final product characteristics based on factors such as particle size distribution, yield, and energy consumption.

Dry milling and wet milling are two primary methods used for buckwheat processing. Dry milling involves grinding buckwheat kernels into particles using mechanical forces. This method is preferred for its simplicity and efficiency, producing various fractions such as flour and grits with

distinct applications. Wet milling, on the other hand, employs water to facilitate particle size reduction, often leading to improved yield and reduced heat generation. It is particularly beneficial for producing buckwheat starch and other functional ingredients. The milling process profoundly affects the properties of the milled buckwheat fractions. Particle size distribution influences the functionality of the milled products, affecting hydration properties, texture, and sensory attributes. Fine grinding can enhance the surface area and solubility of the particles, potentially impacting the rate of nutrient release during digestion. Additionally, milling can alter the starch structure, affecting its gelatinization properties and applications in food formulations. Milled buckwheat fractions find versatile applications across the food industry. Buckwheat flour, a common product of milling, is utilized in the production of baked goods, pasta, and cereals, often contributing unique flavors and nutritional benefits. Coarser fractions, such as buckwheat grits, are suitable for hot cereals, snacks, and textured food products [13]. Buckwheat starch, extracted through wet milling, can be employed as a thickening and stabilizing agent in various food formulations. Innovative product development has also led to the creation of novel milled buckwheat-based foods, catering to specific dietary preferences and needs. Gluten-free products incorporating buckwheat flour have gained popularity, catering to individuals with gluten sensitivities. Furthermore, the utilization of buckwheat fractions in extruded snacks, meat analogs, and beverages demonstrates its potential as a versatile ingredient for functional and health-focused foods. Milling operations are a pivotal step in the processing of buckwheat, influencing the texture, taste, and applications of milled fractions. The choice of milling technique should be based on the desired characteristics of the final product, processing efficiency, and sustainability. An in-depth understanding of milling effects is crucial for optimizing buckwheat processing methods and expanding the range of innovative buckwheat-based products in the food market.

2.4 Fractionation

The milled buckwheat fractions can be further separated to isolate specific components with unique properties. Fractionation techniques, such as air classification or sieving, can be employed to separate different particle sizes or specific fractions rich in nutrients or functional compounds. Fractionation is a fundamental process in buckwheat (*Fagopyrum esculentum* Moench) processing that involves the separation and isolation of different components based on their physical and chemical properties. This comprehensive review examines the significance of fractionation in buckwheat processing, the methods employed for fractionation, the implications on product characteristics, and the diverse applications of the obtained fractions. Fractionation offers a strategic approach to obtaining distinct components from buckwheat, each possessing unique functionalities and nutritional attributes. The process allows for the separation of major components such as starch, protein, fiber, and lipids, enabling targeted utilization in various food and non-food applications. This tailored approach to fractionation enhances the versatility and value of buckwheat-derived products.

Different methods are employed for fractionation, depending on the specific components of interest. Dry fractionation techniques utilize differences in particle size and density to

separate components, often employing methods such as sieving and air classification. Wet fractionation, on the other hand, leverages solubility differences to separate components, involving processes like centrifugation and sedimentation. Enzymatic and chemical methods are also utilized to isolate specific components, such as proteins and starch. The fractionation process has profound implications on the physical, chemical, and functional properties of the obtained fractions ^[14]. Isolated components, such as starch, proteins, and fiber, exhibit altered characteristics compared to their original state in the buckwheat kernel. Fractionation can lead to changes in solubility, gelatinization behavior, rheological properties, and nutritional profiles, all of which impact the potential applications of the fractions. The applications of fractionated buckwheat components are vast and diverse. Isolated proteins can be utilized to develop plant-based meat analogs, functional foods, and nutritional supplements due to their unique amino acid composition and bioactive properties. Separated starch fractions find application in food formulations, such as thickening agents, gelling agents, and controlled-release systems. Isolated fiber fractions can enhance the fiber content and nutritional profile of food products, catering to consumer demands for healthier options. The utilization of fractionation extends beyond food applications. By-products obtained during fractionation, such as hulls and brans, can be used in animal feed, biofuel production, and as a source of bioactive compounds. The utilization of buckwheat fractions in non-food applications, such as bio plastics and biomaterials, showcases the versatility of fractionated components in various industries. Fractionation is a key process in buckwheat processing that enables the isolation of specific components with unique functionalities and applications. The choice of fractionation method should consider the properties of the target components and the desired applications. A comprehensive understanding of fractionation effects is crucial for optimizing buckwheat processing techniques and maximizing the potential of its diverse components in both food and non-food industries.

3. Value-Added Products

The processed buckwheat fractions serve as valuable ingredients for a wide range of value-added products. Buckwheat groats find application in salads, and side dishes due to their nutty flavor and pleasant texture. Buckwheat flour serves as a gluten-free alternative in baked goods, noodles, pancakes, and more. The bran, rich in fiber and antioxidants, can be used in cereals, granola bars, and as a nutrient-rich livestock feed. Buckwheat, with its unique nutritional composition and bioactive compounds, serves as a versatile raw material for the creation of value-added products. The incorporation of buckwheat into various food formulations enhances the nutritional profile, sensory attributes, and market appeal of the final products. This review highlights the wide spectrum of value-added products encompassing bakery items, snacks, beverages, functional foods, and more ^[15]. Innovative product development has led to the creation of gluten-free baked goods utilizing buckwheat flour as a primary ingredient. Buckwheat imparts distinct flavours, colors, and textures, enhancing the sensory experience of products like bread, cakes, and muffins. Similarly, the inclusion of buckwheat in snacks such as crackers, chips, and granola bars not only adds nutritional value but also

capitalizes on consumer demand for health-conscious and diverse snack options. Buckwheat's adaptability extends to beverages as well. The production of buckwheat-based beverages, such as smoothies, juices, and dairy alternatives, offers consumers novel flavours and functional benefits, including antioxidants and dietary fiber. Additionally, buckwheat has found a place in the functional food segment, with protein-rich products, meat analogy, and fortified foods catering to individuals seeking plant-based protein sources and enhanced nutritional content.

3.1 Nutritional Impact

The post-harvest processing steps significantly influence the nutritional composition of buckwheat products. Dehulling and milling increase the bioavailability of nutrients and facilitate digestion. Buckwheat flour, in particular, retains a higher content of essential amino acids, vitamins (B-complex), minerals (iron, magnesium), and phytonutrients compared to traditional wheat flour. The nutritional benefits of value-added buckwheat products are noteworthy. Buckwheat is a source of high-quality proteins with essential amino acids, dietary fiber, B-complex vitamins, and minerals such as magnesium and zinc. Moreover, its bioactive compounds, including rutin, quercetin, and phenolic acids, contribute to potential health advantages, such as antioxidant, anti-inflammatory, and cardiovascular protective effects. Market trends underscore the growing demand for natural, minimally processed, and health-enhancing foods. Buckwheat-derived value-added products align with these trends, appealing to consumers seeking nutritious alternatives that meet their dietary requirements and align with their values ^[16]. As plant-based diets gain popularity and consumer awareness of nutritional benefits increases, buckwheat-based products are poised to capture a larger market share. The development of value-added products from buckwheat processing showcases the potential for innovation and sustainability in the food industry. Buckwheat's nutritional richness, unique sensory attributes, and versatility make it an ideal candidate for creating products that meet the evolving preferences of consumers. As food trends continue to evolve, the exploration of buckwheat-derived value-added products holds promise for addressing nutritional gaps and offering diverse, functional, and wholesome food choices.

3.2 Functional Properties

The milled fractions of buckwheat exhibit unique functional properties, making them valuable components in various food formulations. Buckwheat flour, for instance, can contribute to improved texture, water-holding capacity, and gelling properties in gluten-free products. The bran fraction adds dietary fiber, antioxidants, and texture-enhancing properties. Buckwheat exhibits a range of functional attributes that contribute to its versatility in various food applications. The unique characteristics of buckwheat include its gel-forming capacity, water-holding capacity, emulsification properties, and foaming ability. These properties are influenced by its protein content, which consists of both globulins and albumins. Buckwheat proteins possess the ability to form gels, stabilizing structures in food formulations and enhancing texture and mouth feel. One of the most notable functional properties of buckwheat is its gluten-free nature, which makes it a suitable option for individuals with celiac disease or gluten sensitivities. The absence of gluten poses challenges in

baking, but innovative processing techniques have led to the creation of gluten-free buckwheat-based products that mimic the texture and structure of traditional wheat-based products [17].

Value-added products derived from buckwheat processing capitalize on its functional properties to create foods with enhanced nutritional profiles and consumer appeal. Buckwheat flour and buckwheat-derived fractions, such as starch and protein isolates, are incorporated into a variety of products to enhance their functional attributes. These products include bakery goods, noodles, meat analogs, snacks, and dairy alternatives. Buckwheat-based value-added products offer several nutritional advantages. They are rich in high-quality proteins with essential amino acids, dietary fiber, B-complex vitamins, and minerals. Additionally, buckwheat's bioactive compounds, such as rutin and quercetin, contribute to antioxidant and potential health-promoting effects, including cardiovascular protection and anti-inflammatory properties. The use of buckwheat in functional foods has opened avenues for targeting specific health concerns. The incorporation of buckwheat fractions into functional foods, such as those aimed at managing diabetes or promoting gut health, leverages its unique functional properties to deliver desired health outcomes. Furthermore, the incorporation of buckwheat in sports nutrition products showcases its potential in the growing market of performance-focused foods. Buckwheat's functional properties play a pivotal role in its value-added products, offering a diverse range of applications in the food industry. The integration of buckwheat into various food formulations enhances their nutritional content, sensory attributes, and potential health benefits. As consumer demand for functional and nutritious foods continues to rise, the exploration of buckwheat's functional properties presents exciting opportunities for innovative product development and healthier dietary choices.

3.3 Challenges and Innovations

Despite the numerous benefits, buckwheat processing presents challenges such as maintaining the integrity of nutrients during processing, reducing bitterness, and achieving optimal fractionation. Research is ongoing to develop innovative processing techniques that address these challenges and maximize the potential of buckwheat in diverse food applications. Buckwheat processing, while offering numerous opportunities for value-added product development, is accompanied by a range of challenges that require innovative solutions. This review provides a comprehensive analysis of the challenges faced in buckwheat processing and explores the cutting-edge innovations that are addressing these hurdles. It delves into aspects such as processing efficiency, product diversification, nutritional enhancement, and sustainability.

One of the primary challenges in buckwheat processing is the removal of the tough hull that encases the edible kernel. Dehulling methods, while effective, can sometimes result in kernel breakage, reducing overall yield. Innovations in dehulling technologies, such as the development of gentle impact dehullers and advanced sorting systems, aim to optimize hull removal efficiency while minimizing kernel damage. The gluten-free nature of buckwheat poses challenges in product formulation, particularly in creating bakery items with desirable texture and structure [18]. Innovations in gluten-free baking involve the incorporation of

different types of buckwheat-derived flours and starches, alongside hydrocolloids and enzymes, to mimic the functionality of gluten and achieve satisfactory product characteristics. Enhancing the nutritional value of buckwheat products is another key challenge. While buckwheat is rich in essential nutrients and bioactive compounds, processing methods can impact its nutritional profile. Innovations focus on preserving and enhancing the bioavailability of nutrients during processing, such as optimizing cooking techniques and incorporating fermentation processes that improve nutrient absorption. Sustainability is a growing concern in the food industry, and buckwheat processing is no exception. Challenges include minimizing water usage, energy consumption, and waste generation during processing. Innovations encompass the development of eco-friendly processing technologies, such as water-efficient duelling methods and utilization of by-products for feed, bioenergy, and biomaterials. Market diversification is essential for sustaining the buckwheat industry. However, limited awareness and consumer acceptance of buckwheat-based products pose challenges for market expansion. Innovations in product development focus on creating novel and attractive buckwheat-based products, such as convenience foods, beverages, and functional foods that align with consumer preferences and nutritional demands. Emerging challenges related to climate change and resource scarcity also impact buckwheat cultivation and processing. Innovations in sustainable agriculture practices, such as precision farming and agro ecological approaches, aim to address these challenges by optimizing resource utilization and minimizing environmental impact. In conclusion, the challenges faced in buckwheat processing are being met with innovative solutions that span various aspects of technology, formulation, sustainability, and market engagement. These innovations not only address the challenges but also open doors for enhanced product quality, nutritional value, and market opportunities. The ongoing commitment to overcoming hurdles and embracing innovation ensures the continued growth and relevance of buckwheat in the evolving landscape of the food industry. The post-harvest processing of buckwheat is a complex sequence of steps that transforms raw seeds into valuable fractions with diverse applications. From duelling to milling and fractionation, each process influences the nutritional and functional attributes of the end products. As consumer demand for healthier and more diverse food options continues to grow, understanding and optimizing buckwheat processing techniques will unlock its potential as a source of nutrient-rich, functional ingredients for a wide range of value-added products [19].

4. Conclusion

Buckwheat, with its remarkable nutritional attributes and versatility, holds significant potential in the development of value-added products that align with modern consumer preferences for health and functionality. This comprehensive review highlights the various stages of buckwheat processing and emphasizes its utilization in innovative food products, underlining its contribution to the food industry and consumer health. The comprehensive exploration of buckwheat processing and its utilization in value-added products underscores the remarkable potential this versatile crop holds in the modern food industry. The in-depth review of buckwheat's journey from its initial processing stages to the

creation of innovative products reveals a dynamic landscape shaped by nutritional richness, functional attributes, and consumer demands. Buckwheat's nutritional profile, featuring proteins with essential amino acids, dietary fibers, vitamins, and minerals, positions it as a promising ingredient for creating health-enhancing value-added products. The presence of bioactive compounds, such as rutin and quercetin, further extends its appeal by offering potential benefits in terms of antioxidative and anti-inflammatory properties. This exceptional nutritional foundation serves as a catalyst for creating products that cater to a diverse range of dietary preferences and health-conscious consumers^[20].

The processing of buckwheat, encompassing cleaning, dehulling, milling, and fractionation, plays a pivotal role in determining the characteristics of the final products. Each processing stage presents challenges and opportunities, prompting innovations that optimize efficiency, enhance nutritional retention, and preserve functional properties. These innovations, coupled with advances in processing technologies and formulation techniques, enable the creation of products that not only meet but also exceed consumer expectations in terms of taste, texture, and nutritional value. Value-added products derived from buckwheat, ranging from gluten-free bakery items to plant-based protein alternatives and functional foods, showcase the breadth of possibilities that arise from understanding and harnessing its unique attributes. The integration of buckwheat-derived fractions into various food applications, guided by consumer preferences and market trends, reflects the adaptability of this crop in addressing contemporary dietary needs. As the food industry continues to evolve, the potential of buckwheat processing and its value-added products remains vibrant. Consumer awareness of nutritional benefits, health-conscious choices, and environmental sustainability continues to grow, aligning with the intrinsic qualities of buckwheat. The innovations discussed in this review, addressing challenges across processing, formulation, sustainability, and market diversification, serve as promising pathways for furthering the prominence of buckwheat in the global food landscape. In summary, buckwheat processing and its utilization in value-added products embody a compelling narrative of innovation, sustainability, and nutritional excellence. The synthesis of tradition and modernity within this realm not only pays homage to its rich history but also positions buckwheat as a resilient, adaptable, and valuable resource for nourishing a health-conscious and diverse consumer base. The journey from field to table is marked by continuous exploration, innovation, and a shared commitment to shaping a more nutritious, flavourful, and sustainable future through buckwheat's extraordinary potential^[21].

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