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Opportunities & challenges of usage of bioactive compounds in agro-food businesses: a narrative review.

Oportunidades y desafíos del uso de compuestos bioactivos en empresas agroalimentarias: una revisión narrativa.

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ABSTRACT

Bioactive compounds have gained considerable attention in the agro-food industry due to their potential health benefits and functional properties. These compounds are naturally occurring in various plant and animal sources and have been extensively researched for their potential applications in food and beverage products. The objective of the present study is “to provide a thorough overview of the opportunities and challenges associated with the use of bioactive compounds in agro-food businesses”. The method of study was a narrative review and data was retrieved from six academic electronic databases: Scopus, PubMed, ResearchGate, google scholar, and SpringerLink with the keywords like "bioactive compounds," "agro-food industry," "functional food products," "health benefits," and "consumer perception. The peer-reviewed refereed journal was included in the study which was published from 2013 to 2023 (last ten years). The results of the study show that the use of bioactive compounds in agro-food businesses provides several opportunities, including the development of functional food products, increased consumer demand for healthy and natural products, and potential cost savings through the use of natural ingredients. However, several challenges are associated with bioactive compounds in agro-food businesses, including the lack of standardization in extraction and analysis methods, regulatory hurdles, and consumer perception and acceptance.

Keywords: Bioactive compounds; Agro-food industry; Functional food products; Health benefits; Consumer perception.

RESUMEN

Los compuestos bioactivos han ganado considerable atención en la industria agroalimentaria debido a sus posibles beneficios para la salud y sus propiedades funcionales. Estos compuestos se encuentran naturalmente en diversas fuentes vegetales y animales y han sido investigados exhaustivamente por sus posibles aplicaciones en

productos alimenticios y bebidas. El objetivo del presente estudio es "proporcionar una visión exhaustiva de las oportunidades y desafíos asociados con el uso de compuestos bioactivos en las empresas agroalimentarias". El método de estudio fue una revisión narrativa y los datos se recuperaron de seis bases de datos electrónicas académicas: Scopus, PubMed, ResearchGate, google academic y SpringerLink con palabras clave como "compuestos bioactivos", "industria agroalimentaria", "productos alimenticios funcionales", " "beneficios para la salud" y "percepción del consumidor". La revista arbitrada y revisada por pares se incluyó en el estudio que se publicó de 2013 a 2023 (los últimos diez años). Los resultados del estudio muestran que el uso de compuestos bioactivos en la agricultura Las empresas alimentarias ofrecen varias oportunidades, incluido el desarrollo de productos alimenticios funcionales, una mayor demanda de los consumidores de productos saludables y naturales y posibles ahorros de costos mediante el uso de ingredientes naturales. Sin embargo, varios desafíos están asociados con los compuestos bioactivos en las empresas agroalimentarias, incluidos la falta de estandarización en los métodos de extracción y análisis, los obstáculos regulatorios y la percepción y aceptación del consumidor.

Palabras clave: Compuestos bioactivos; Industria agroalimentaria; Productos alimenticios funcionales; Beneficios de la salud; Percepción del consumidor.

INTRODUCTION

Bioactive compounds are naturally occurring or synthetic substances that have biological activity and can positively impact human health. They are present in a wide range of foods, including “fruits, vegetables, grains, nuts, seeds, and spices”, and have been shown to have a variety of health benefits, including antioxidant, anti-inflammatory, and antimicrobial effects. According to a scientific article published in the “Journal of Food Science and Technology”, bioactive compounds are defined as "substances, other than those needed to meet basic human nutritional needs, which are present in small quantities in foods, and which can have an impact on human health beyond basic nutrition" (Mittal and Katare, 2018). These compounds are often extracted from plant sources, such as fruits and vegetables, and can be classified into different groups based on their chemical structure, such as “flavonoids, phenolic acids, carotenoids, and alkaloids”. Numerous therapeutic uses for bioactive substances have been demonstrated, including the prevention and treatment of chronic diseases like “cancer, cardiovascular disease, and diabetes”. For instance, it has been demonstrated that the flavonoids present in fruits and vegetables contain antioxidant and anti-inflammatory properties that may help prevent the onset of cancer and other chronic diseases (Esfahani et al., 2017). Additionally, bioactive substances can enhance cognitive performance, lower inflammation, and improve immunological function, all of which have a good effect on human health.

Bioactive compounds are important in the agro-food industry for several reasons. Firstly, they can enhance the nutritional value of food products. Secondly, they can improve the sensory properties of food, such as flavor and aroma. Thirdly, they can be used as natural preservatives to extend the shelf life of food products. Lastly, they can be

used to develop new food products with health benefits. Nutritional enhancement: Bioactive compounds found in fruits, vegetables, and grains can enhance the nutritional value of processed food products. For example, adding polyphenols from green tea to bread dough can increase its antioxidant capacity, potentially improving the health benefits of bread consumption (Lopez-Valenzuela et al., 2021). Sensory properties: Bioactive compounds can also improve the sensory properties of food products. For example, the addition of terpenes from orange peel to orange juice can enhance its flavor and aroma, making it more appealing to consumers (Zhang et al., 2019). Natural preservation: Bioactive compounds can also be used as natural preservatives to extend the shelf life of food products. For example, the use of plant extracts, such as rosemary and oregano, can inhibit the growth of microorganisms, thereby reducing the risk of spoilage and increasing the shelf life of food products (Santos et al., 2019). New product development: Bioactive compounds can also be used to develop new food products with health benefits (Gómez-Gallego et al., 2016).

The review paper's goal is to offer an in-depth study of the opportunities and difficulties related to the use of bioactive chemicals in the agro-food sector. The purpose of the study is to examine the possible advantages of adding bioactive substances to food products, such as improved sensory qualities, increased nutritional content, natural preservation, and the creation of new products with positive health effects. The review study also seeks to address problems related to the use of bioactive substances, such as regulatory issues, consumer education, and safety concerns. It will provide light on the current state of the study of bioactive substances in the agro-food sector and point out potential areas for further study. The review paper's overall goal is to advance knowledge of the potential of bioactive substances in the agro-food sector and to shed light on the obstacles that must be overcome before that potential can be fully realised.

MATERIAL AND METHODS

The method of study was a narrative review based on secondary data. The data was retrieved from six academic electronic databases: Scopus, PubMed, ResearchGate, google scholar, and SpringerLink with the keywords like "bioactive compounds," "agro-food industry," "functional food products," "health benefits," and "consumer perception. The peer-reviewed refereed journal was included in the study which was published from 2018 to 2023 (last five years).

RESULTS AND DISCUSSION

One possible outcome is the discovery and measurement of bioactive substances in various agro-food items, which can guide the creation of functional foods and nutraceuticals with health-improving qualities. The extension of food products' shelf lives with the addition of bioactive substances with antioxidant and antibacterial activities is

another potential outcome. Additionally, study in this field may result in the creation of innovative methods and tools for the extraction, synthesis, and administration of bioactive substances. Additionally, consumer surveys and focus groups can provide insights into consumer attitudes and preferences toward bioactive compound-containing products, which can inform marketing and product development strategies. Overall, studying the usage of bioactive compounds in agro-food businesses can have important implications for both the food industry and public health.

The Opportunity of Bioactive Compounds in Agro-business: "Bioactive compounds in beer: The effect on human health by Chiva-Blanch et al. (2013)" explores the bioactive compounds present in beer, including polyphenols and hops-derived flavonoids. The authors note that beer has potential health benefits such as improved cardiovascular health and reduced inflammation, but excessive alcohol consumption can negate these benefits (Table 1).

Table 1: Opportunities of Bioactive Compounds in Agro-Businesses

Opportunity	Explanation
Improved food quality	Bioactive compounds can improve the nutritional value, taste, color, and texture of food products.
Health benefits	Bioactive compounds can reduce the risk of chronic diseases, boost the immune system, and promote overall health.
Increased marketability	Health-conscious consumers are looking for functional foods with added health benefits. The use of bioactive compounds can increase the marketability of food products.
Cost-effective	Many bioactive compounds can be extracted from by-products of the food industry, making their use cost-effective for agro-food businesses.

Bioactive compounds in spices: "their role in food preservation and health benefits by Ghosh et al. (2014)" discusses the bioactive compounds present in various spices, such as phenolic acids, terpenoids, and flavonoids, and their potential health benefits. The authors also note that spices can increase shelf life and prevent microbial spoilage in food products.

Bioactive compounds in fish and shellfish: "health benefits and potential use in functional foods by Velasco-Santamaría and González-Fuentes (2016)" explores the bioactive compounds found in fish and shellfish, such as omega-3 fatty acids, peptides, and carotenoids. The authors suggest that these compounds could be used in functional foods and nutraceuticals.

"Bioactive Compounds in edible oils and their health benefits by Thirunavukkarasu and Shanmugam (2018)" discusses the bioactive compounds present in various edible oils, such as fatty acids, phytosterols, and tocopherols, and their potential health benefits. The authors note that the benefits may vary depending on the type of oil and the processing method.

Bioactive Compounds in fermented foods: their significance and potential use by Silva et al. (2021) explores the bioactive compounds present in fermented foods, such as probiotics, organic acids, and peptides, and their potential health benefits. The authors suggest that fermented foods could be used as a source of these compounds in functional foods and nutraceuticals (Table 2).

Table 2. Examples of Polyphenols and their usage in Agro-Food Businesses

Polyphenol	Source	Health Benefits	Usage in Agro-Food Businesses
Catechins	Green tea, cocoa, fruits	Antioxidant, anti-inflammatory	Tea, chocolates, supplements
Quercetin	Onions, berries, tea, apples	Anti-inflammatory, anti-cancer	Supplements, functional foods
Resveratrol	Grapes, berries, peanuts	Cardiovascular health, anti-cancer	Wine, supplements
Curcumin	Turmeric	Anti-inflammatory, anti-cancer	Spices, supplements, functional foods

Bioactive Compounds in Tea: “their role in the Prevention of chronic diseases by Khan and Mukhtar (2013)” explores the bioactive compounds present in tea, such as catechins and theaflavins, and their potential health benefits, including “antioxidant and anti-inflammatory effects”. The authors suggest that tea consumption could help prevent chronic diseases such as “cancer and cardiovascular disease”.

The article "Bioactive Compounds in functional foods: “the case of Oats and barley beta-glucans by Meydani and Ha (2014)” provides a literature review on the bioactive compounds present in oats and barley, specifically beta-glucans. Beta-glucans are polysaccharides that are found in the cell walls of certain foods, such as oats, barley, and mushrooms and have been shown to have various health benefits, such as reducing cholesterol levels and improving immune function. The authors discuss the potential of beta-glucans as a functional food ingredient, which refers to foods that provide health benefits beyond basic nutrition. They describe how beta-glucans can be incorporated into various food products, such as cereals, bread, and pasta, to enhance their nutritional profile and provide specific health benefits. The authors also review various studies that have investigated the effects of beta-glucans on health outcomes, such as cholesterol levels and immune function. They discuss the mechanisms by which beta-glucans may exert these effects, such as through binding to bile acids in the gut and promoting the growth of beneficial gut bacteria.

“The potential of phenolic compounds for health benefits in dairy products and its effect on quality attributes: A review by Munir et al. (2020)”: This review of the research focuses on the phenolic chemicals found in dairy products as prospective health advantages. The authors talk about the numerous sources of phenolic compounds in dairy products such milk, cheese, and yoghurt and how they may help people live healthier lives by

lowering their risk of cancer and cardiovascular disease, for example. The impact of phenolic chemicals on the flavour, texture, and shelf life of dairy products are also examined by the authors.

"Bioactive Compounds in Rice: the role in Health and Nutrition by Hussain et al. (2019)": This review article explores the bioactive compounds present in rice, such as phenolic compounds, flavonoids, and carotenoids, and their potential health benefits. The authors discuss the various rice varieties that contain high levels of these bioactive compounds and their potential to improve health outcomes, such as reducing the risk of chronic diseases. The authors also examine the effects of processing methods on the bioavailability and health benefits of these compounds in rice products.

"Bioactive Compounds in functional meat products by Lorenzo and Munekata (2018)": This review article explores the potential of bioactive compounds in meat products to enhance their nutritional value and provide health benefits. The authors discuss the various sources of bioactive compounds in meat, such as polyunsaturated fatty acids, carotenoids, and vitamins, and their potential to improve health outcomes, such as reducing the risk of chronic diseases. The bioavailability and health advantages of these chemicals in meat products are also examined by the authors in relation to processing techniques.

"Health-promoting effects of bioactive peptides derived from traditional Chinese foods: A review by Zhang et al. (2018)": This literature review focuses on the potential health benefits of bioactive peptides derived from traditional Chinese foods, such as soybean, milk, and fish products. The authors discuss the various bioactive peptides that have been identified in these foods and their potential to improve health outcomes, such as reducing blood pressure and improving immune function. The authors also examine the mechanisms by which these peptides exert their health-promoting effects.

"Bioactive compounds and antioxidant activity in different grafted varieties of watermelon by Yang et al. (2019)": This study investigated the bioactive compounds and antioxidant activity in different varieties of grafted watermelon. The authors found that grafted watermelons had higher levels of bioactive compounds, such as phenolic acids and flavonoids, and higher antioxidant activity compared to non-grafted watermelons. The authors suggest that grafting watermelons could be a promising approach to enhance the nutritional value and antioxidant activity of these fruits.

Challenges of Bioactive Compounds in Agro-Businesses: The utilization of bioactive compounds in agro-food businesses also presents several challenges that must be addressed (Table 3). One major challenge is the cost and availability of bioactive compounds, which can vary depending on factors such as seasonality, location, and extraction method. Another challenge is the stability and bioavailability of bioactive compounds, which can be affected by factors such as processing, storage, and interactions with other food components. Additionally, regulatory issues related to the safety and efficacy of bioactive compounds in food products must be addressed. To address these challenges, researchers and industry professionals must work together to develop innovative technologies for the

extraction and delivery of bioactive compounds, as well as strategies for ensuring their safety and efficacy in food products. For example, encapsulation technologies can be used to protect bioactive compounds from degradation and improve their bioavailability. Additionally, collaboration between different sectors, such as agriculture, food processing, and health, can help to optimize the production and utilization of bioactive compounds.

Table 2: Challenges of Bioactive Compounds in Agro-Businesses

Challenge	Explanation
Regulatory compliance	The use of bioactive compounds in agro-food businesses is subject to strict regulatory compliance. Agro-food businesses must ensure that the bioactive compounds used are safe and comply with all applicable regulations.
Technical challenges	Incorporating bioactive compounds into food products can be technically challenging. Bioactive compounds may have limited stability, solubility, or bioavailability, making their incorporation into food products challenging.
Consumer perception	Consumers may be wary of consuming food products with added bioactive compounds due to concerns about safety, effectiveness, or taste. Agro-food businesses must ensure that they address these concerns through effective communication and marketing.

As conclusion, the usage of bioactive compounds in agro-food businesses presents both opportunities and challenges. By addressing these challenges through research and collaboration, the food industry can develop innovative and sustainable approaches for incorporating bioactive compounds into food products to improve public health and advance the industry. A list of the difficulties and restrictions encountered during the abstraction and characterisation operations was created. The bioactive molecule scenarios were written with the current pandemic condition in mind, while more research is needed. From the perspectives of human health and the sustainability of world resources, this provides a vision of the value of bioactive chemicals. As technology advances, the likelihood of bioactive substances in numerous industries will inevitably rise, opening up new opportunities.

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Opportunities & Challenges of Usage of Bioactive Compounds in Agro-Food Businesses was the topic of our research, and to construct the real dimension and influence of the issue, we needed data and information from reliable sources. For that, we relied on and applied the official information that was published like Scopus, Research Gates, Pubmet, etc.

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