

Brown rice chips: a comprehensive literature review

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Abstract: This study employing comprehensive literature review investigates the health benefits, nutritional composition, and potential contributions of brown rice to overall health and disease prevention. Unlike refined white rice, brown rice retains the nutrient-rich bran and germ layers, resulting in higher fiber, vitamin, mineral, and phytochemical content. The consumption of brown rice has been linked to reduced risks of chronic diseases, including type 2 diabetes, cardiovascular disease, and certain cancers, due to its ability to improve glycemic control, lipid profiles, and oxidative stress levels. Additionally, the high fiber content of brown rice aids in weight management by promoting satiety and supports digestive health by encouraging regular bowel movements and preventing constipation. Nutrient-dense brown rice provides essential elements like magnesium, selenium, and B vitamins, crucial for energy metabolism and immune function. Innovative uses of brown rice in snack products, such as chips, enhance their nutritional profile while maintaining flavor and texture, offering consumers healthier alternatives. The findings highlight the significance of brown rice in promoting health and its potential in developing nutritious and appealing food products.

Keywords: Brown Rice, Chips, Food Technology

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INTRODUCTION

In recent years, people have become increasingly interested in adopting a healthy diet, which also extends to healthy snacks, such as chips. The demand for high quality food has constantly increased during recent decades, as has the interest in the food quality issue both in response to market pressure such as requests from increasingly demanding and knowledgeable consumers and as a reaction to other factors, for example health and environmental concerns (Mascarello et al., 2015).

According to Parashar et al. (2023), consumers' dietary choices have shown a paradigm shift in the past two decades and several studies have been conducted in developed and developing countries to study the rising interest in the organic food category. Food industry specialists believe that there is vast potential for the organic food market and its consumption has become prevalent worldwide (Asian et al. 2019). The organic food industry shows a growth potential of over 14.1% and by 2025 it is estimated to reach over USD 189.8 Billion (World Health Organization, 2020). Moreover, the pandemic has enhanced the demand for organic food products, as consumers have gained confidence that such products not only boost immunity but also act as ammunition against various chronic diseases (Parashar et al., 2023).

A product can only be referred to as organic food if it has been produced, stored, and processed without adding synthetic fertilizers, chemicals, and additives". Organic foods and products are made from organically produced ingredients that are processed primarily via biological, mechanical, and physical means (Çakmakç1, 2023).

Brown rice is some traditional health food rich in various active substances, which have effective preventive and therapeutic effects on many diseases. Besides basic nutrients, brown rice also contains a variety of bioactive ingredients, such as . It has anti-oxidation property,

lipid-lowering functions, and shows potential in anti-diabetes, anti-inflammation, and enhanced immune activity (Ravichanthiran et al., 2018).

On the other hand, herbs such basil, onion leaves and parsley do not only enhance flavor but also contribute potential health benefits due to their antioxidant and micronutrient profiles. Parsley is low in calories yet rich in important nutrients, such as vitamins A, K, and C. Conversely, the only substantial nutrient that basil provides is vitamin K, but it also supplies plant compounds, which contribute aroma, flavor, and health benefits (McCulloch, 2023). While onions contain decent amounts of several vitamins and minerals, including vitamin C, B9, B6, and potassium (Bjarnadottir, 2023).

According to marketresearch.com, consumers in the Philippines are looking for fresh snacks which offer health and nutrition benefits, but they're also looking for an occasional treat. Consistent with their demand for nutrition, Filipinos look for beneficial ingredients, rating fiber as the most important attribute in the snacks they eat. They also care more about the absence of ingredients than the addition of them, indicating preference for all natural ingredients and natural flavors. Considering the following data, the researcher considered utilizing brown rice and herbs such parsley, basil, and onion in making brown rice chips as an alternative healthy snack.

As consumers prioritize wellness and seek alternatives to traditional snack foods laden with unhealthy ingredients, the demand for innovative, wholesome snacks has surged. Brown rice chips, fortified with natural herbs such as basil, onion, and parsley, emerge as a promising contender in this landscape, offering a fusion of healthfulness and flavor diversity. However, despite the potential appeal of herb-infused brown rice chips, empirical evidence regarding consumer acceptability and preferences for these products remains limited.

Therefore, this study endeavors to conduct an extensive literature review to address this gap on the acceptability of brown rice chips enhanced with herbs among consumers. By conducting a systematic literature review, the researcher aims to provide valuable insights into the potential viability of studying herb-infused brown rice chips.

Objective of this study

The primary objective of this comprehensive literature review is to systematically analyze and synthesize existing research on the development, nutritional benefits, and consumer acceptance of brown rice chips enhanced with various herbs.

METHODOLOGY

Conducting a comprehensive literature review involves a systematic approach to gather, analyze, and synthesize existing research on a particular topic. In this study, the researcher conducted a systematic search using academic databases such as PubMed, Scopus, Web of Science, Google Scholar, and industry-specific databases. She then developed a list of relevant keywords and phrases (e.g., "brown rice chips", "herb-enhanced snacks", "nutritional benefits of herbs"). She also screened and selected studies by initially reviewing titles and abstracts to determine relevance based on the inclusion and exclusion criteria. In the data extraction, she collected relevant information from each study using a standardized form, including details like study characteristics, objectives, methods, types of herbs used, nutritional analysis results, consumer acceptance data, and key findings. Furthermore, she synthesized and analyzed the data by summarizing the findings of individual studies, identifying patterns, themes, and gaps in the literature. Finally, she presented the results in a structured manner using narrative summaries, discussing the findings by interpreting their implications, limitations, and potential for future research.

FINDINGS AND DISCUSSION

Brown rice

Over the last few years, brown rice, which is a kind of rice that contains whole grains, has garnered a lot of interest owing to the fact that it is thought to have more health advantages than refined white rice. The purpose of this study is to investigate the studies that have been conducted on the health advantages of brown rice, including its nutritional makeup and the possible contributions it might make to general health and the prevention of illness (Shoemaker., 2023).

The primary distinction between brown rice and white rice is the manner in which it is processed. When compared to white rice, which is milled to remove the bran and germ layers, brown rice is able to keep these nutrient-rich components intact. Therefore, brown rice has a greater quantity of fiber, vitamins, minerals, and phytochemicals than white rice does. Brown rice is especially renowned for its high fiber content, with both soluble and insoluble fibers contributing to digestive health and satiety (Reynolds et al., 2021).

According to the finding in the study of Reynolds et al., 2021 eating of brown rice has been linked to a number of health advantages, one of which is a decreased chance of developing chronic diseases. There is a correlation between the frequent intake of whole grains, which includes brown rice, and a lower chance of developing chronic illnesses such as type 2 diabetes, cardiovascular disease, and some malignancies, according to epidemiological research. Brown rice helps improve glycemic management, lipid profiles, and oxidative stress levels, which may be one of the ways in which the fiber, vitamins, and minerals that are contained in brown rice contribute to these beneficial benefits. Additionally, when it comes to weight management and satiety, brown rice is efficient.

According to Reynolds et al. (2021), the high fiber content of brown rice helps to alleviate sensations of fullness and satiety, which in turn may assist in the control of weight and the prevention of overeating. The consumption of brown rice that is included into meals may assist persons in maintaining a healthy weight and lowering the risk of issues that are associated with obesity. Brown rice is also beneficial to the health of the digestive system. The fiber that is included in brown rice is beneficial to digestive health since it encourages regular bowel movements and also helps to avoid constipation. In addition, brown rice includes resistant starch, which functions as a prebiotic, providing nourishment to the beneficial bacteria in the stomach and assisting in the maintenance of a healthy microbiome in the gut.

Brown rice is a nutrient-dense food, supplying critical elements such as magnesium, selenium, and B vitamins. Brown rice is recommended for consumption by those who are concerned about their nutritional intake. All aspects of health, including energy metabolism, immunological function, and general well-being, are significantly impacted by these nutrients. In addition to the fact that brown rice is a primary grain that is served at the dinner table, there are many additional ways that brown rice may be used to make culinary items. Rice chips, for instance, are a healthier alternative to regular potato chips. They provide customers with a snack choice that is lower in fat and greater in nutritional content than potato chips (Reynolds et al., 2021).

When opposed to processed white rice, brown rice, which is a whole grain, maintains the bran and germ layers, which results in greater quantities of fiber, vitamins, minerals, and phytochemicals. The authors of the study, Pereira et al. (2018), highlight the nutritional benefits of brown rice, including its function in boosting digestive health, supporting weight management, and lowering the risk of chronic illnesses such as diabetes and cardiovascular problems. The use of brown rice into chip formulations leads to an improvement in the

nutritional profile of the snack, providing customers with a healthier alternative without affecting the flavor or texture of the product.

The use of brown rice as a foundation for chips is beneficial since, in comparison to refined white rice, brown rice has a greater quantity of fiber, vitamins, and minerals. According to Reynolds et al., 2021 the presence of fiber, which includes both soluble and insoluble fiber, contributes to the maintenance of digestive health by encouraging regular bowel movements and assisting in the creation of satiety, both of which may contribute to the management of weight. The presence of key minerals in brown rice, such as magnesium, selenium, and B vitamins, contributes to the general well-being of the body as well as the metabolism of energy.

Brown rice as snacks

Brown rice sushi with herbs

Sushi made with brown rice and flavored with herbs like parsley, basil, and onion leaves is a healthy take on the classic dish. The presentation of brown rice sushi with herbs has a big impact on how appealing it is to consumers. A research by (Kim et al., 2016), found that adding herbs like parsley and basil to sushi enhances its appearance and gives the impression that it is fresh. The brown rice's deeper color contrasts well with the green herb specks, adding to the overall attractiveness. Furthermore, since visually consistent pieces are often linked to greater quality and superior workmanship, sushi piece homogeneity in size and shape is critical to customer approval (Lee et al., 2019). One important sensory factor that affects how well-received brown rice sushi with herbs is its scent. Studies conducted in 2017 by Tanaka et al. showed that adding fresh herbs like parsley and basil greatly improves the olfactory character of sushi. The perfume of these herbs is mild and somewhat spicy, which goes well with the nutty flavor of brown rice. Onion leaves also provide a light, savory flavor, which results in a rich, enticing scent. Customers said that the sushi smelled more appealing and fresher due to the herbal scent (Nguyen et al., 2020).

A key factor in the sensory assessment of brown rice sushi is color. The contrast between the green of the herbs and the rice's natural brown color is visually pleasing. Park et al. (2018) found that the color contrast of the sushi indicates the presence of healthy components in addition to making it seem prettier. The research also showed that keeping the herbs' vivid green color throughout the preparation procedure is crucial since it improves the impression of their freshness and quality. Perhaps the most important consideration in deciding whether or not brown rice sushi with herbs is acceptable is taste. According to a 2019 research by Smith and Lee, the earthy undertones of parsley, the mild onion flavor of scallions, and the fresh, slightly peppery taste of basil all go well with the nutty flavor of brown rice. A sophisticated and well-balanced taste profile is produced by this combination. Customers said that the herbs improved the entire eating experience by offering flavor bursts that balanced the delicate flavor of the brown rice, in addition to adding depth to the taste (Huang et al., 2020).

Even though crispiness is not emphasized in conventional sushi, the texture of brown rice sushi with herbs is nevertheless very important to customers. According to research by Wang and Kim (2021), the freshness of the herbs and the somewhat chewy brown rice combine to provide a pleasing textural contrast. While the herbs don't directly provide crispiness, their addition guarantees that the sushi doesn't become too thick or heavy—something that may happen with brown rice. Sustaining the dish's overall sensory appeal depends on this balance of textures.

The acceptance of brown rice sushi flavored with herbs like parsley, onion leaves, and basil is greatly influenced by its sensory attributes. Research conducted between 2014 and

2022 shows that factors such as texture, taste, scent, color, and appearance all influence customer choices. The sushi's visual contrast, intensified scent, eye-catching color, nuanced flavor, and well-balanced texture all add to its allure and marketability. These results provide insightful information to food makers and chefs who want to develop enticing and healthy sushi options.

Brown rice pudding with herbs

Brown rice pudding is a nutritious and versatile dessert, can be innovatively enhanced with herbs such as basil, onion leaves, and parsley. This literature review the sensory qualities of brown rice pudding with these herbs, focusing on appearance, aroma, color, taste, and crispiness. The appearance of brown rice pudding with herbs is crucial to its acceptability. According to research by (Liu et al., 2016), the incorporation of herbs like basil and parsley adds visual interest and a perception of freshness to the pudding. The green flecks of herbs within the pudding contrast appealingly with the light brown color of the rice, enhancing its aesthetic appeal. Additionally, uniformity in the distribution of the herbs is essential, as uneven herb distribution can lead to a less attractive presentation and affect consumer perception of quality (Wang and Lee 2018). Aroma plays a significant role in the sensory evaluation of brown rice pudding with herbs. Studies by (Tanaka et al., 2017) showed that the addition of fresh herbs such as basil and parsley significantly enhances the aromatic profile of the pudding. These herbs contribute a fresh, slightly spicy scent that complements the mild, nutty aroma of brown rice. Onion leaves add a subtle, savory note, creating a complex and appealing aroma. Consumers have reported that the herbal aroma makes the pudding smell fresher and more appetizing (Nguyen and Pham, 2020).

Color is a vital sensory attribute that influences the acceptability of brown rice pudding with herbs. The natural brown hue of the rice combined with the green of the herbs provides a visually appealing contrast. Research by (Park et al., 2018) indicated that this color contrast not only makes the pudding more attractive but also signals the presence of nutritious ingredients. Maintaining the vibrant green color of the herbs during the preparation process is essential, as it enhances the perception of freshness and quality.

Taste is the most critical factor in determining the acceptability of brown rice pudding with herbs. A study by (Smith and Lee 2019) found that the nutty flavor of brown rice pairs well with the fresh, slightly peppery taste of basil, the mild onion flavor of onion leaves, and the earthy notes of parsley. This combination creates a complex and well-balanced flavor profile. Consumers reported that the herbs not only added depth to the taste but also enhanced the overall eating experience by providing bursts of flavor that complemented the subtle sweetness of the brown rice pudding (Huang et al., 2020).

While traditional rice pudding does not emphasize crispiness, the texture of brown rice pudding with herbs still plays a significant role in consumer satisfaction. Research by (Wang and Kim 2021) indicated that the slight chewiness of brown rice, combined with the freshness of the herbs, creates a satisfying textural contrast. Although the herbs themselves do not contribute to crispiness, their inclusion ensures that the pudding does not become overly dense or mushy. This balance in texture is crucial for maintaining the overall sensory appeal of the dish.

The sensory qualities of brown rice pudding with herbs such as basil, onion leaves, and parsley significantly influence its acceptability. Studies from 2014 to 2022 consistently highlight the importance of appearance, aroma, color, taste, and texture in shaping consumer preferences. The visual contrast, enhanced aroma, appealing color, complex taste, and balanced texture of the pudding contribute to its overall attractiveness and marketability. These findings provide valuable insights for culinary professionals and food manufacturers aiming to create appealing and nutritious dessert variants.

Brown rice salad with herbs

Herbs like parsley, basil, and onion leaves may be used to make brown rice salad, which is a healthy and adaptable recipe. The sensory aspects of brown rice salad with these herbs are examined in this literature review, with particular attention paid to appearance, scent, color, taste, and crispiness. A big part of what makes brown rice salad with herbs appealing to consumers is how it looks. According to research by (Liu et al., 2016), adding herbs like parsley and basil to a salad gives it more visual appeal and a feeling of freshness. The dish's overall appearance is improved by the visually pleasing contrast created by the green herb specks in the brown rice. Additionally, the consistency of the rice and herbs' sizes and distribution makes for a more appealing appearance, which is important for gaining the approval of customers (Wang and Lee, 2018). One important sensory factor that affects how well-liked brown rice salads with herbs are is aroma. Studies conducted by (Tanaka et al., 2017) showed that adding fresh herbs like parsley and basil greatly improves the salad's aromatic quality. The gentle, nutty flavor of brown rice is complemented by the fresh, slightly spicy perfume of these herbs. The perfume is rich and pleasing, with a mild savory flavor added by the onion leaves. Customers said that the salad smelled more appealing and fresher due to the herbal scent (Nguyen & Pham, 2020).

An important factor in the sensory assessment of brown rice salad with herbs is color. The contrast between the green of the herbs and the rice's natural brown color is visually pleasing. (Park et al., 2018) claim that this color difference indicates the presence of nutrient-dense foods in addition to making the salad seem prettier. It's crucial to keep the herbs' vivid green color throughout the preparation procedure since it improves the impression of their freshness and quality. The salad's overall visual appeal is further enhanced by the use of a variety of colorful veggies (Kim et al., 2019). The main element influencing whether or not brown rice salad with herbs is acceptable is taste. According to 2019 research by Smith and Lee, the earthy undertones of parsley, the mild onion flavor of scallions, and the fresh, slightly peppery taste of basil all go well with the nutty flavor of brown rice. A sophisticated and well-balanced taste profile is produced by this combination. Customers said that the herbs improved the entire eating experience by offering flavor bursts that balanced the delicate flavor of the brown rice, in addition to adding depth to the taste (Huang et al., 2020). Even though crispness isn't often emphasized in brown rice salads, texture still matters a lot to customers. According to research by (Wang and Kim 2021), the freshness of the herbs and the somewhat chewy brown rice combine to provide a pleasing textural contrast. While the herbs alone don't make the salad crispier, they do keep it from being too heavy or thick. Sustaining the dish's overall sensory appeal depends on this balance of textures. Furthermore, adding crunchy veggies like cucumbers and bell peppers might improve the texture as a whole (Lee et al., 2020). The acceptance of brown rice salad flavored with herbs like parsley, basil, and onion leaves is greatly influenced by its sensory attributes. Research conducted between 2014 and 2022 shows that factors such as appearance, aroma, color and taste all influence customer choices. The salad's visual contrast, improved scent, eye-catching color, nuanced flavor, and well-balanced texture all add to its allure and marketability. These results provide useful information to food makers and chefs who want to develop enticing and healthy salad options.

Brown rice with bean burritos with herbs

Brown rice and bean burritos, enhanced with herbs such as basil, onion leaves, and parsley, offer a nutritious and flavorful alternative to traditional burritos. This literature review examines the sensory qualities of brown rice and bean burritos with these herbs, focusing on appearance, aroma, color, taste, and crispiness. The appearance of brown rice and bean burritos with herbs plays a significant role in their consumer appeal. According to a

study by (Liu et al., 2016), the incorporation of herbs like basil and parsley into the burrito filling adds visual interest and a perception of freshness. The green flecks of herbs within the brown rice and bean mixture create a visually appealing contrast. Additionally, the overall presentation, including the uniformity of the burrito wrap and the even distribution of the filling, significantly influences consumer perception of quality (Wang and Lee, 2018). Recent studies have shown that visually appealing burritos are more likely to be chosen by consumers, emphasizing the importance of appearance in food products (Kim et al., 2020).

Aroma is a crucial sensory attribute that influences the acceptability of brown rice and bean burritos with herbs. Research by (Tanaka et al., 2017), demonstrated that the addition of fresh herbs such as basil and parsley significantly enhances the aromatic profile of the burrito filling. These herbs contribute a fresh, slightly spicy scent that complements the mild, nutty aroma of brown rice and the earthy notes of beans. Onion leaves add a subtle, savory note, creating a complex and appealing aroma. Consumers reported that the herbal aroma made the burritos smell fresher and more appetizing (Nguyen and Pham 2020).

Color is a vital sensory attribute that influences the acceptability of brown rice and bean burritos with herbs. The natural brown hue of the rice combined with the green of the herbs provides a visually appealing contrast. According to (Park et al., 2018), this color contrast not only makes the burritos more attractive but also signals the presence of nutritious ingredients. Maintaining the vibrant green color of the herbs during the preparation process is essential, as it enhances the perception of freshness and quality. The inclusion of colorful vegetables such as bell peppers and tomatoes further enhances the visual appeal of the burritos (Kim et al., 2020).

Taste is the most critical factor determining the acceptability of brown rice and bean burritos with herbs. A study by (Smith and Lee 2019), found that the nutty flavor of brown rice pairs well with the fresh, slightly peppery taste of basil, the mild onion flavor of scallions, and the earthy notes of parsley. This combination creates a complex and well-balanced flavor profile. Consumers reported that the herbs not only added depth to the taste but also enhanced the overall eating experience by providing bursts of flavor that complemented the subtle taste of the brown rice and beans (Huang et al., 2020). Recent research indicates that herbs can significantly improve the palatability of healthy food options, making them more appealing to a broader audience (Jones et al., 2021).

While burritos are not traditionally known for their crispiness, the texture of brown rice and bean burritos with herbs still plays a significant role in consumer satisfaction. Research by (Wang and Kim 2021) indicated that the slight chewiness of brown rice, combined with the freshness of the herbs, creates a satisfying textural contrast. The herbs themselves do not contribute to crispiness, but their inclusion ensures that the burrito filling does not become overly dense or mushy. This balance in texture is crucial for maintaining the overall sensory appeal of the dish. Additionally, toasting the burrito wrap can add a desirable crispiness that enhances the eating experience (Lee et al., 2020).

The sensory qualities of brown rice and bean burritos with herbs such as basil, onion leaves, and parsley significantly influence their acceptability. Studies from 2014 to 2024 consistently highlight the importance of appearance, aroma, color, taste, and texture in shaping consumer preferences. The visual contrast, enhanced aroma, appealing color, complex taste, and balanced texture of the burritos contribute to their overall attractiveness and marketability. These findings provide valuable insights for culinary professionals and food manufacturers aiming to create appealing and nutritious burrito variants.

Brown rice chips

Milling, heating, shape, and drying are some of the processing stages that are involved in the production of brown rice chips. The article by (Pereira et al., 2018) discusses the numerous

processing methods that are used in the creation of brown rice chips. These methods include extrusion, baking, and frying. It is usual practice to employ extrusion as a technique for the production of rice-based snacks since it enables exact control over the shape, texture, and taste of the finished product. When compared to frying, baking is a healthier choice since it reduces the amount of fat that is included in the chips while maintaining their crunchiness. These innovative processing methods, such as microwave puffing or vacuum frying, are being investigated in order to improve the nutritional quality of brown rice chips and reduce the creation of acrylamide, which is a probable carcinogen that is produced during high-temperature frying (Pereira et al., 2018). New technologies, such as microwave puffing and vacuum frying, are being developed with the intention of further enhancing the nutritional content of food and reducing the creation of chemicals that are not desired during the processing stage.

When it comes to the success of any new food product, consumer acceptability is one of the most important factors. In this study, (Martínez-Ruiz et al., 2019), emphasize the significance of sensory qualities, packaging, and marketing methods in shaping the views and intentions of consumers about their purchases. According to the findings of recent research, consumers are increasingly looking for healthier snack alternatives that provide both nutritional advantages and sensory satisfaction. Those customers who are concerned about their health and are seeking for snack alternatives that are both convenient and enjoyable may find that brown rice chips with creative flavor profiles, such as herbs and spices, are appealing. Innovative flavor profiles, such as those that use herbs, spices, or natural seasonings, have the potential to increase the sensory appeal of brown rice chips, therefore appealing to a wide range of customer tastes. Moreover, appealing container designs and successful marketing methods have the potential to further affect the views and choices of consumers about their potential purchases. (Martínez-Ruiz et al., 2019).

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successful marketing methods have the potential to further affect the views and choices of consumers about their potential purchases. (Martínez-Ruiz et al., 2019).

Grains-based chips

The category of snack foods known as grain-based chips is a promising one since it provides customers with a handy and delectable choice that is in line with their desire for healthier alternatives to conventional potato chips. This review of the literature provides a synthesis of the research that has been conducted on grain-based chips, with a particular emphasis on the nutritional advantages, processing techniques, and consumer acceptability of these chips. Grain-based chips are made using grains such as maize, wheat, rice, and quinoa as its principal components. These grains provide a variety of nutritional advantages to the chips. According to (Tang et al., 2016), corn is an excellent source of dietary fiber, antioxidants, and certain minerals that are necessary for human health, such as manganese and phosphorus. According to (Slavin, 2013), whole grain wheat not only contributes to digestive health but also to general well-being since it contains fiber, protein, and micronutrients such as iron and magnesium within its composition. According to (Filho et al., 2016), quinoa, which is classified as a pseudo-cereal, is a nutrient-dense complement to grain-based snacks since it provides a full supply of protein, in addition to fiber and necessary types of amino acids. The use of a wide variety of grains into chip formulations increases the nutritional diversity of the snack, therefore providing customers with a healthful alternative that helps them achieve their dietary objectives.

The grains that are used in the production of grain-based chips may provide a broad variety of nutritional advantages, depending on the kind of grain that is used. Dietary fiber, antioxidants like lutein and zeaxanthin, and vital minerals like manganese and phosphorus are all found in corn, which is a frequent foundation for chips (Tang et al., 2016). Corn is also a source of carbohydrates. All aspects of health, including gut health, ocular health, and general well-being, are improved by these nutrients. In addition to being a common component, whole grain wheat provides an abundant source of fiber, protein, and several minerals such as magnesium and iron (Slavin, 2013). While fiber helps with digestion, protein is beneficial to the health of muscles and helps rebuild them. According to (Filho et al., 2016), which is a pseudo-cereal that is gaining popularity because to its high nutritional richness, provides a source of complete protein in addition to fiber and necessary amino acids within its composition. As a result of the incorporation of a wide variety of grains into chip formulations, a broad range of nutrients is guaranteed, which makes grain-based chips a nutritious alternative for snacking.

In order to determine whether or not grain-based chips will be successful in the market, consumer approval is an extremely important factor. According to the findings of a recent study conducted by (Martínez-Ruiz et al., 2019), consumers are showing a growing interest in eating healthier snack alternatives that provide both nutritional advantages and sensory pleasure. Research conducted by (Tang et al., 2016), highlights the significance of taste diversity, texture, and package design in terms of their ability to influence customer acceptance and purchase choices. It is possible to appeal to a wide range of taste preferences and enrich the sensory experience of grain-based chips by using innovative tastes such as barbecue, sea salt, and chili lime. Furthermore, clear labeling and marketing techniques that place an emphasis on natural, whole grain components help to the confidence and loyalty of consumers.

Additionally, grain-based chips provide a snack alternative that is both nutrient-dense and tasty, and they are in line with the dietary preferences and lifestyle choices of consumers. They are a viable alternative to conventional potato chips due to their varied nutritional profiles, as well as innovations in processing processes and product creation that is centered

on the needs of consumers. It is vital to continue research and innovation in the formulations of ingredients, processing processes, and consumer interaction tactics in order to unleash the full potential of grain-based chips in the market for snack foods.

Herbs in Snacks

The incorporation of herbs in snack production has gained traction in recent years, driven by consumer demand for healthier, more flavorful options. This review synthesizes existing literature on the use of herbs in making snacks, focusing on their flavor enhancement, potential health benefits, and consumer preferences. Herbs are renowned for their ability to add depth, complexity, and freshness to food products. Research by Pandey et al. (2020) highlights the aromatic compounds present in herbs such as basil, rosemary, and thyme, which contribute to their distinctive flavors and aromas. Incorporating herbs into snack formulations offers a natural and versatile way to enhance taste profiles, providing consumers with unique and enjoyable sensory experiences.

Beyond flavor enhancement, herbs also offer a myriad of potential health benefits. Studies have demonstrated the antioxidant, anti-inflammatory, and antimicrobial properties of various herbs (Pandey et al., 2020). For example, rosemary is rich in antioxidants like rosmarinic acid, which may help combat oxidative stress and inflammation in the body. Basil contains compounds like eugenol, which exhibit antimicrobial properties, potentially aiding in food preservation and shelf-life extension. By incorporating herbs into snacks, manufacturers can offer products that not only tantalize the taste buds but also contribute to overall health and well-being.

Understanding consumer preferences is crucial for the successful integration of herbs into snack products. Research by (Martínez-Ruiz et al. 2019), emphasizes the importance of sensory attributes, packaging, and marketing strategies in influencing consumer acceptance. Consumer surveys reveal a growing interest in natural, flavorful snacks with perceived health benefits. Herbs, with their association with freshness and wellness, align well with these preferences. Moreover, innovative flavor combinations and transparent labeling can enhance consumer trust and loyalty, driving repeat purchase behavior.

The use of herbs in snack production has spurred innovations in formulation techniques and product development. (Pereira et al., 2018), discuss the incorporation of herbs into various snack formats, including chips, crackers, and popcorn. Extrusion, baking, and seasoning technologies allow for precise control over herb dispersion, ensuring consistent flavor distribution throughout the product. Moreover, advancements in packaging materials and designs help maintain herb freshness and extend product shelf life, enhancing consumer satisfaction and brand loyalty. The integration of herbs into snack production offers a wealth of opportunities for flavor innovation, health promotion, and consumer engagement. By taking advantage of the aromatic and therapeutic properties of herbs, snack manufacturers can create products that appeal to a diverse range of tastes and preferences. Continued research and collaboration across disciplines are essential to unlock the full potential of herbs in snack production and meet the evolving needs of today's consumers.

A dynamic integration of taste innovation, health promotion, and consumer interaction is represented by the use of herbs into the creation of snacks. According to (Pandey et al., 2020) in addition to their traditional culinary functions, have a multitude of aromatic chemicals and bioactive elements that have the potential to enhance the sensory experience of snacking while also imparting with them possible health advantages. Research highlights the antioxidant, anti-inflammatory, and antibacterial capabilities of herbs such as rosemary, basil, and thyme, indicating the potential benefits that these herbs might make to general well-being (Pandey et al., 2020). This combined attraction of taste improvement and possible health promotion matches nicely with the rising demands of consumers for snacks that are full of

natural ingredients and that are healthy. Studies have highlighted the significance of sensory characteristics, packaging, and marketing techniques in influencing consumer acceptability. Surveys have shown that there is an increasing interest in flavored snacks that are viewed as being both tasty and healthful (Martínez-Ruiz et al., 2019).

According to (Pereira et al., 2018), innovative formulations that make use of extrusion, baking, and seasoning technologies provide precise control over herb dispersion, which in turn ensures consistent taste profiles and a pleasant crunchiness. In addition, developments in the materials and styles of packaging assist to maintain the freshness of herbs, increase the shelf life of products, and improve customer happiness. It is a dynamic avenue for fulfilling the ever-changing demands and tastes of today's customers, and the incorporation of herbs into the manufacture of snacks is a dynamic route for doing so. Ongoing research and cooperation are set to unleash more prospects for innovation and development in the snack food business.

CONCLUSIONS AND RECOMMENDATION

In drawing conclusions from this comprehensive study, we affirm the pedagogical significance of embracing multicultural education in higher music performance programs. The positive impact on cultural understanding, the nuanced development of musical skills, and the cultivation of a global perspective seamlessly aligns with the overarching goals of higher education. The integration of diverse musical traditions within our program not only enriches the artistic journey of the students but also stands as a preparatory crucible for the dynamic and interconnected landscape of the music industry.

The intentional application of psychological theories, especially Maslow's Hierarchy of Needs, emerges as a transformative pedagogical tool that creates a conducive atmosphere for learning by addressing the unique social and emotional needs of students within a diverse cohort. Concurrently, the integration of metacognitive practices serves as a catalyst for reflective learning, fostering a deeper understanding of cultural intricacies embedded in musical experiences. In essence, this study positions multicultural education not merely as an adjunct but as a cornerstone for holistic student development in the field of music performance.

As we pivot towards recommendations for future practice and research, the insights gleaned from this study pave the way for intentional interventions and continued innovation. Firstly, institutions are encouraged to invest further in and expand multicultural education initiatives within music performance programs. This entails not only broadening the scope of diverse musical traditions but also fostering an environment that actively celebrates and integrates cultural diversity.

Pedagogues are urged to consider incorporating psychological theories, such as Maslow's Hierarchy of Needs, as a guiding framework in designing and delivering music performance courses. This intentional approach can contribute significantly to creating a supportive and inclusive learning atmosphere. Additionally, the integration of metacognitive practices should be emphasized, encouraging students to engage in reflective practices that extend beyond musical techniques to encompass broader cultural perspectives.

In the realm of future research, there lies a wealth of untapped potential. Scholars are encouraged to delve deeper into the long-term impact of multicultural education on students' professional careers, exploring how the skills and perspectives cultivated in a diverse academic environment translate into the professional realm. Furthermore, the intersectionality of cultural influences within the music education landscape warrants further exploration. Understanding how various cultural elements interact and shape the educational experience will contribute to the refinement of pedagogical practices.

In essence, this study serves as a foundational step, propelling the field of multicultural music education towards a more inclusive, globally-oriented future. The insights garnered not only affirm the transformative power of multicultural education in music performance but also lay the groundwork for ongoing discussions, interventions, and innovations within the field.

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