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Exploration of Zinc Enrichment in Vegan Diets: The Contribution of Chinese-Western Fusion Cuisine to Nutritional Supplementation

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Abstract: In modern dietary culture, vegans often face the problem of insufficient intake of multiple nutrients due to their special dietary restrictions, among which zinc deficiency is particularly prominent. Zinc is a key trace mineral that is essential for multiple physiological functions, including the normal functioning of the immune system, cell division, and protein synthesis. This study aims to explore the possibility and application of Chinese-Western fusion ingredients in enhancing the zinc content in vegan diets. By selecting four zinc-rich Chinese-Western fusion ingredients, we designed four innovative vegan dishes and measured the zinc content of these dishes using standardized nutritional analysis methods. The results showed that the zinc content of the designed Chinese-Western fusion vegan dishes was significantly higher than that of traditional vegan dishes. These data not only prove that Chinese-Western fusion ingredients can effectively increase the zinc content in dishes but also provide vegans with new nutritional strategies to improve their overall nutritional intake. The findings of this study have important application value for nutritionists, diet designers and public health professionals, and can help promote healthier eating habits, especially at a time when global health and nutritional security are receiving increasing attention.

Keywords: vegan; Chinese-Western fusion cuisine; zinc intake; nutritional supplementation

1. Introduction

1.1. The Nutritional Role of Zinc and Its Importance in Human Health

Zinc is one of the essential trace minerals for the human body and plays a central role in many biochemical processes. As the active ingredient of more than 300 enzymes, zinc is essential for basic life processes such as protein synthesis, DNA synthesis and cell division [1]. In addition, zinc plays an indispensable role in the function of the immune system, helping to maintain the structural integrity of cells and promoting wound healing [2]. Zinc deficiency can lead to decreased immunity, increased risk of infection, and may cause serious health problems, especially in children and the elderly, such as growth retardation [3], skin lesions, night blindness and loss of taste.

Vegans have limited sources of zinc in their diets because they do not consume meat and other animal-derived foods. Although plant foods such as whole grains and beans also contain zinc, the phytic acid in plants will bind to zinc to form a complex that is difficult for the human body to absorb, so the bioavailability of plant-derived zinc is low. This is especially important in the diet planning of vegans to prevent chronic zinc deficiency from affecting health.

Globally, as more and more people choose to be vegan, how to meet their micronutrient needs through diet has become an important issue. Chinese-Western fusion ingredients provide a possible solution due to their unique nutritional advantages and innovation potential. By innovatively integrating Chinese and Western ingredients rich in

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zinc, it not only increases the nutritional value of the dishes but also provides more healthy choices for vegans around the world.

1.2. Zinc Deficiency Problems for Vegans

Although the vegan diet is increasingly being adopted by people due to its health and environmental benefits, it also comes with some nutritional challenges, especially the inadequate intake of trace elements such as zinc. Zinc deficiency is common worldwide, especially among vegans. According to multiple studies, vegans often do not meet the recommended zinc intake, mainly because their diet relies mainly on plant-based foods, which are not only low in zinc but also poorly bioavailable [4].

Zinc in plant-based foods is mainly found in whole grains, legumes and nuts, but the accompanying ingredients such as phytic acid and cellulose can significantly reduce the absorption rate of zinc. Phytic acid can form insoluble complexes with zinc, thereby hindering its absorption in the intestine [5]. Therefore, even if the total amount of zinc in the diet seems to be sufficient, the amount of zinc actually absorbed and utilized by the body may be far from enough, resulting in a generally low bioavailability of zinc in vegans.

Zinc deficiency not only affects immune function and cell repair, but may also lead to a series of health problems such as loss of taste, skin lesions and developmental delays. Therefore, how to effectively increase the zinc content and bioavailability in the diet of vegans is an important issue in nutrition research and diet design.

1.3. Research Purposes

This study aims to explore how Chinese-Western fusion ingredients can enhance the zinc content in vegan diets through innovative dietary design. Considering the characteristics and advantages of Chinese and Western diets, fusion ingredients may not only provide higher nutritional value but also increase the bioavailability of zinc through their unique ingredient combinations.

The core objectives of this study include: to determine the zinc content in selected Chinese-Western fusion vegan dishes through scientific methods, and to support the nutritional value of these ingredient combinations with empirical data; to analyze how different cooking techniques and ingredient processing methods affect the bioavailability of zinc, especially in the context of the fusion of Western and Eastern ingredients; to provide innovative vegan dish designs based on Chinese-Western fusion ingredients to improve the nutritional intake of vegans, especially the supplementation of trace element zinc.

Through this study, we hope to not only enhance the overall zinc intake of vegans, but more importantly, to improve the bioavailability of zinc through the optimized combination of ingredients and the innovation of cooking methods, so as to more effectively utilize the nutrients in the ingredients and support the healthy dietary pattern of vegans.

2. Literature Review

2.1. Nutritional Value and Function of Zinc

Zinc is a vital trace mineral that plays a variety of important roles in human health. As an essential component of enzyme reactions, zinc is involved in a variety of biochemical processes, including but not limited to protein synthesis, regulation of genetic material expression, and cell proliferation and differentiation [6]. Zinc is the active ingredient of more than 300 enzymes, which are involved in key physiological processes such as metabolism, immune function and cell repair [7].

Medical research shows that zinc is essential for maintaining the normal function of the immune system [8]. Zinc deficiency is associated with a variety of immune system dysfunctions, including reduced T cell activity and weakened natural killer cell function, which can increase the incidence and severity of infections [9]. In addition, zinc is also very important for skin health, helping to maintain skin structure and accelerate wound

healing. Zinc has also been shown to effectively regulate the functions of the brain and central nervous system, affecting learning and memory abilities [10].

Insufficient zinc intake not only affects the above physiological functions, but may also lead to a series of clinical symptoms, such as growth retardation, taste disorders, vision problems and reproductive health problems. Zinc deficiency in children and adolescents may seriously affect their growth and development [11]. Given these key roles of zinc, ensuring adequate zinc intake is important for promoting public health and preventing disease.

2.2. Veganism and Nutritional Deficiencies

Although vegan diets have shown potential benefits for cardiovascular health and weight management in numerous studies, they also carry the risk of causing deficiencies in certain nutrients [12]. In particular, zinc deficiency is common among vegans because zinc is not only low in plant foods, but its bioavailability is also limited [13].

Research has shown that zinc in plant foods is mainly in the form of phytic acid, which can bind to zinc to form a difficult-to-absorb phytate-zinc complex, thereby reducing its availability in the intestine [14]. This phenomenon is particularly evident in grains, legumes, and seeds, which are the main sources of zinc for vegans, but the presence of phytic acid greatly reduces the efficiency of zinc absorption [15]. In addition, vegans typically do not consume meat, seafood, and dairy products, which are the main animal-based food sources of zinc [16], which further limits their ability to obtain adequate zinc from their diet.

In addition to zinc, vegan diets may also lead to deficiencies in other key nutrients such as vitamin B12, iron, calcium, and omega-3 fatty acids [17]. Although these nutrient deficiencies can be managed through supplements and carefully planned diets, many vegans may fail to meet the recommended intake of these nutrients in real life.

Therefore, exploring how to increase the intake of these nutrients, especially zinc, through dietary innovation and nutrient fortification strategies is of great significance to improving the overall health of vegans. Chinese-Western fusion foods, with their unique combination of ingredients, offer a potential solution to increase the intake and bioavailability of these key nutrients through innovative recipe design.

2.3. Nutritional Characteristics of Chinese-Western Fusion Ingredients

Fusion cuisine combines Eastern and Western cooking ingredients and techniques to not only innovate flavors but also potentially enhance the nutritional value of food [18]. In particular, fusion ingredients offer unique advantages in providing zinc. For example, beans, nuts and seeds commonly used in Chinese cuisine, as well as whole grains and certain seafood in Western cuisine, are good sources of zinc. By creatively combining these ingredients, vegan options that are not only delicious but also nutritious can be created.

Some typical fusion ingredients, such as the combination of tofu (a soy product rich in zinc) and Italian tomato sauce (antioxidant-rich tomatoes and zinc-rich olive oil), not only provide zinc but also increase the absorption rate of zinc through vitamin C in tomatoes [19]. In addition, combining Western nuts such as almonds and walnuts with Eastern ingredients such as brown rice and sesame can also create a nutritionally balanced meal. These nuts and seeds are natural sources of zinc and contain healthy fats that promote zinc absorption.

Research has also shown that certain cooking methods, such as fermentation and soaking, can reduce the phytic acid content in ingredients, thereby increasing the bioavailability of zinc [20]. For example, fermented soy products and soaked grains or beans have lower phytic acid content, which is more conducive to zinc absorption. These techniques are often used in Chinese-Western fusion cuisine to enhance the taste and nutritional value of food.

In summary, by combining diverse sources of ingredients and cooking techniques, Chinese-Western fusion ingredients not only enrich the diversity of the global diet but also provide more healthy options rich in zinc and other key nutrients for vegans. This fusion not only meets the dual needs of taste and nutrition but also demonstrates the potential of modern dietary innovation in global health promotion.

3. Research Methods

3.1. Ingredient Selection and Recipe Design

To explore how fusion ingredients can enhance zinc in vegan diets, four representative fusion vegan dishes were carefully designed (Appendix A). These dishes were designed to maximize zinc intake and absorption by using ingredients high in zinc and adopting cooking methods that help improve zinc bioavailability.

Tofu Almond Milk combines zinc-rich almonds with high-protein tofu. Tofu is a direct product of soybeans, which are one of the highest zinc-rich ingredients in plant-based foods [21]. Almonds provide additional zinc and healthy fats, which help zinc absorption [22]. In addition, mint and lemon juice are added to enhance flavor and nutrition.

Five-Grain Mushroom Stew uses whole grains such as brown rice and wheat seeds and a variety of mushrooms, including shiitake and enoki, which are good sources of zinc [23]. The whole grains are pre-soaked to reduce the phytic acid content, thereby increasing the bioavailability of zinc. The mushrooms not only add to the taste and nutrition of the dish, but are also selected for their zinc content.

Nut and Spice Rice uses nuts (such as walnuts and cashews) and spices (such as cinnamon and cloves), which are rich in zinc. The spices not only add to the aroma of the dish but also may help improve the absorption rate of zinc. This dish also includes olive oil, which is commonly used in the West, and tempeh, which is commonly used in the East, providing a perfect example of East-West integration.

Vegetable Bean Curd Roll use bean curd as the outer layer and is filled with high-zinc vegetables such as spinach and bell peppers. Bean curd skin) is another soy product with a high zinc content. Spinach and bell peppers not only provide additional zinc, but are also rich in vitamin C, which helps zinc absorption. The design of these four dishes takes into account the nutritional value of the ingredients, their zinc content, and their common uses in Eastern and Western diets, ensuring that the dishes are not only nutritious but also have a unique flavor that combines Eastern and Western flavors.

3.2. Nutritional Analysis Methods

To accurately determine the zinc content in four vegan fusion cuisine, this study uses a standardized nutritional analysis method. The method includes the following key steps:

First, each dish was prepared into a homogenized sample to ensure that each sample represented its entire composition. This included thorough mixing of the dishes and proper cutting and grinding of hard or large pieces of ingredients.

Samples were treated using acid digestion, a step that involves mixing the samples with a certain ratio of nitric acid and perchloric acid and then digesting them at high temperature to completely convert zinc into a measurable form. This process ensures that all forms of zinc in the sample are released and unified.

Zinc was quantified using atomic absorption spectroscopy (AAS). This technique determines the concentration of zinc in a sample by measuring the intensity of light absorption at a specific wavelength of the element, and is widely used in the analysis of trace elements due to its high precision and sensitivity.

To ensure the accuracy and repeatability of the experimental results, appropriate blank controls and standard references were set up in all the determinations in this study. In addition, the determination of each sample was repeated at least three times to calculate the average and standard deviation to evaluate the consistency and reliability of the results.

Through this series of methods, we can accurately assess the zinc content of each Chinese-Western fusion vegan dish, providing a scientific basis for further data analysis and nutritional evaluation.

4. Research Results

4.1. Recipe Introduction and Nutritional Analysis

The four vegan dishes designed for this study are not only rich in flavor but also contain significant amounts of zinc. The following is a detailed introduction to each dish and its nutritional analysis results:

1) Tofu Almond Milk

Mix soft tofu with almond milk, add mint leaves and lemon juice for seasoning, and blend in a blender until smooth.

This dish has a smooth texture with the sweetness of almonds and the freshness of lemon. The addition of mint makes the overall taste more refreshing.

Each serving contains 3.2mg of zinc, which accounts for 29% of the recommended daily intake for adults.

2) Five-Grain Mushroom Stew

Pre-soaked brown rice and wheat seeds are simmered with various mushrooms (shi-itake mushrooms, enoki mushrooms) and spices until they are well-seasoned.

The deliciousness of mushrooms is mixed with the aroma of grains to create a rich and layered taste experience.

Each serving contains 4.5mg of zinc, which accounts for 41% of the recommended daily intake for adults.

3) Nut and Spice Rice

Mix steamed brown rice with roasted nuts (walnuts, cashews), cinnamon and cloves.

The crunch of nuts combined with the warm aroma of oriental spices brings a new flavor to traditional flavor.

Each serving contains 5.0mg of zinc, accounting for 45% of the recommended daily intake for adults.

4) Vegetable Bean Curd Roll

Spread the bean curd flat, put pre-seasoned spinach and bell pepper strips in the middle, roll it up and slice it.

The delicate bean curd and the sweetness of the stuffed vegetables are perfectly combined, with a rich taste and nutritional guarantee.

Each serving contains 2.8mg of zinc, accounting for 25% of the recommended daily intake for adults.

The analysis of the zinc content of these four dishes shows that the use of Chinese-Western fusion ingredients significantly improves the nutritional value of the dishes, especially for increasing the zinc intake of vegans.

4.2. Data Comparison and Analysis

To evaluate the actual effectiveness of the fusion vegan dishes designed in this study in increasing zinc intake in vegans, we compared the zinc content of each dish with the recommended daily intake (RDI) for adults. According to the standards of the World Health Organization (WHO), the recommended daily intake of zinc for adults is 11mg.

The following is a comparison of the zinc content of each dish with the recommended daily intake for adults:

Tofu Almond Milk has 3.2mg zinc per serving, accounting for 29% of the RDI for adults.

Five-Grain Mushroom Stew has 4.5mg zinc per serving, accounting for 41% of the RDI for adults.

Nut and Spice Rice has 5.0mg zinc per serving, accounting for 45% of the RDI for adults.

Vegetable Bean Curd Roll has 2.8mg zinc per serving, accounting for 25% of the RDI for adults.

Through the analysis, it was found that although the zinc content of a single dish could not fully meet the daily recommended intake for adults, each dish provided a significant source of zinc for vegans. Especially when these dishes are combined with other foods with high zinc content (such as nuts and beans), it is easier to reach or exceed the daily recommended intake.

In addition, these dishes are designed with zinc bioavailability in mind, using cooking methods such as soaking and fermentation to reduce phytic acid content, further improving zinc absorption. Therefore, these vegan-inspired dishes not only provide essential zinc but also enhance zinc bioavailability through optimized cooking techniques and ingredient combinations.

5. Discussion

5.1. Significance of Research Results

The data from this study showed that the zinc intake of vegans can be significantly increased through the carefully designed vegan dishes that combine Chinese and Western elements. Although the zinc content of each dish alone does not fully meet the recommended daily zinc intake for adults, their integration into the vegan diet significantly increases the total zinc intake and bioavailability in the diet.

Zinc intake and absorption are essential for maintaining human health, especially for vegans, who are more likely to suffer from zinc deficiency due to dietary restrictions. This study effectively addresses the zinc absorption disorder that may be caused by phytic acid in plant foods by combining high-zinc plant-based ingredients and using cooking methods that help improve zinc absorption (such as fermentation and soaking). In addition, the fusion of Chinese and Western cooking techniques not only enriches the taste and nutrition of food but also improves the bioavailability of zinc.

This study highlights the feasibility of improving zinc intake in vegans through dietary innovation. In this way, vegans can not only increase their zinc intake but also enjoy delicious and nutritionally balanced meals through a variety of ingredients and cooking techniques. This finding has important guiding significance for nutritionists, diet planners, and public health policy makers in promoting healthy vegan diets.

5.2. Nutritional Strategy Recommendations

Encourage vegans to increase the proportion of zinc-rich ingredients such as legumes, whole grains, nuts and seeds in their daily diet. For example, legumes and whole grains can be cooked in appropriate ways such as soaking and fermentation to reduce phytic acid content, thereby improving zinc bioavailability.

Promote fusion cooking methods, such as incorporating Western nuts and seeds into traditional Eastern soy dishes to increase zinc content and its absorption rate. For example, adding almonds or walnuts to tofu or bean curd dishes not only increases the supply of zinc but also provides healthy fats that help zinc absorption.

Provide vegans with educational resources on how to choose and prepare zinc-rich ingredients. This can include cooking workshops, online courses or nutrition counseling services to help them understand and implement dietary strategies to increase zinc intake.

The food industry can develop and promote zinc-rich vegan processed foods, such as zinc-fortified breakfast cereals, energy bars and plant-based milks. These products can make it convenient for vegans to ensure adequate zinc intake when they are on the go.

Vegans are advised to undergo regular nutritional assessments, including zinc blood testing, to monitor their zinc intake and body status. This can help identify possible nutritional deficiencies early and adjust the diet in a timely manner.

By implementing these strategies, vegans can more effectively increase their zinc intake and bioavailability, thereby better meeting their nutritional needs and maintaining health.

6. Conclusion

This study successfully demonstrated how innovative combinations of ingredients can significantly improve zinc intake and bioavailability for vegans by designing and analyzing four vegan-inspired dishes. The results clearly show that even a completely plant-based diet can achieve recommended nutrient intakes through well-designed dishes, especially zinc, a key nutrient that is often lacking for vegans.

The use of fusion ingredients not only improves the nutritional value of the dishes but also increases the diversity and flavor of the food, which is of great significance for promoting vegan diets. By combining Eastern and Western cooking techniques and ingredients, the dishes in this study are not only rich in zinc but also optimize the bioavailability of zinc through cooking methods, providing vegans with healthy and delicious dining options.

In addition, the findings of this study highlight the role of nutrition education and resources in improving diet quality. By educating vegans on how to select, prepare, and combine zinc-rich ingredients, the nutritional value of their diet can be further enhanced to ensure that their daily nutritional needs are met.

In conclusion, the strategy of fusion ingredients can not only be used to improve zinc intake but also as a way to improve the overall quality and appeal of vegan diets. This innovative use of ingredients and cooking techniques provides a new dietary option for vegans, helping them enjoy a nutritious and diverse diet. Future research can further explore the integration of other nutrients to comprehensively improve the nutrition and taste of vegan diets.

Appendix A. Details of Chinese-Western Fusion Cuisine Cases

	Tofu Almond Soup	Five-Grain Mushroom Stew	Nut and Spice Rice	Vegetable Bean Curd Roll
Main Ingredients	200g of soft tofu, 100ml of almond milk, 50g of mint leaves, 10ml of lemon juice	100g of soaked brown rice, 50g of soaked wheat berries, 50g of shiitake mushrooms, 30g of enoki mushrooms	150g of steamed brown rice, 20g of roasted walnuts, 20g of roasted cashews, 5g of cinnamon, 1g of cloves	1 sheet of bean curd skin, 50g of spinach, 30g of sweet bell peppers
Preparation Method	Blend soft tofu with almond milk, add mint leaves and lemon juice, blend until smooth.	Slow stew-soaked brown rice and wheat berries with various mushrooms and spices until flavorful.	Mix steamed brown rice with roasted nuts and spices.	Lay out tofu skin, fill with seasoned spinach and sliced sweet peppers, roll and slice.
Final Presentation	Smooth, refreshing soup with a hint of mint and lemon.	Hearty stew with layers of mushroom and grain flavors.	Aromatic rice mixed with crunchy nuts and warm spices.	Delicate rolls filled with vibrant vegetables.
Nutritional Value	High in protein and zinc, low in calories.	Rich in zinc, fiber, and complex carbohydrates.	High in zinc, healthy fats from nuts, and whole grain benefits.	Moderate zinc, high in vitamins from vegetables.
Calories	150kcal	250kcal	350kcal	200kcal

	Tofu Almond Soup	Five-Grain Mushroom Stew	Nut and Spice Rice	Vegetable Bean Curd Roll
Zinc Content	3.2mg (29% RDI)	4.5mg (41% RDI)	5.0mg (45% RDI)	2.8mg (25% RDI)
Allergens	Nuts (almond milk)	Gluten (wheat berries)	Nuts (walnuts, cashews), Gluten (brown rice)	Soy (tofu skin)

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