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Chili Pepper as a Functional Food: Relevance to Lesotho

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Abstract

Purpose: Although the use of chili peppers as functional foods in Lesotho is not well documented, their production and consumption have a rich historical background. Functional foods are those that serve as therapeutic agents in addition to nutrition. Previous research supports the many health benefits of consuming chili peppers, including their potential to mitigate the risk of cancer, cardiac arrhythmias, rheumatism, and chest colds. Nevertheless, these concepts have yet to translate into tangible alterations in policies and implementation strategies. Therefore, this review aims to identify potential topics for future research on Chili peppers, food, and therapeutic food product development; to improve the population's health and well-being

Methodology: This paper presents a literature analysis of existing data on chili peppers as functional foods, specifically emphasizing their applicability to Lesotho, a developing country.

Findings: Based on the analysis of the reviewed research, it can be inferred that those who regularly incorporate chili peppers into their diet exhibit a decreased risk of death from non-communicable diseases compared to those who do not.

Unique Contribution to Theory, Practice and Policy: The data presented in this review supports the classification of chili pepper as a functional food while also emphasizing the importance of investigating the effectiveness, safety, quality, development, and possible hazards of chili peppers, particularly in developing nations like Lesotho. The present study has great potential to provide novel global perspectives on the associations between chili peppers, non-communicable diseases (NCDs), and mortality to guide future research. Hence, future research endeavors must thoroughly examine the distinct impacts of chili peppers through more clinical studies. Moreover, the present review and further research will contribute to revising Lesotho's dietary guidelines and advancing functional food products, such as herbal supplements derived from chili peppers.

Keywords: *Functional Foods, Chili peppers, Chronic Diseases, Developing countries, Capsaicin*

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INTRODUCTION

The significance and exploration of chili peppers' impact on human health have gained prominence on a global scale. Considerable attention has been dedicated to examining the preventive and therapeutic attributes of chili peppers in relation to many health conditions including their potential to mitigate the risk of cancer, cardiac arrhythmias, rheumatism, and chest colds, and numerous other disorders worldwide (Xiang et al., 2022). Previous research supports the use of chili peppers as functional foods (Ao et al., 2022; Azlan et al., 2022). Functional foods are those that serve as therapeutic agents in addition to nutrition (Shetty & Sarkar, 2020).

Chili peppers include a variety of species belonging to the nightshade family, characterized by their intense spiciness and pungency (Alonso-Villegas et al., 2023). These peppers are closely related to bell peppers and tomatoes (Barboza et al., 2022). Chili peppers, which are indigenous to the Americans, are cultivated in many warm regions worldwide (Ramírez-Aragón et al., 2022). Several cultivars of the predominant chili pepper are derived from the asexual reproduction of *Capsicum annum*, including cayenne, jalapeño, serrano, and Thai chili peppers (Barboza et al., 2022). Several pungent chili peppers are derived from *Capsicum chinense* varieties, such as the habanero, Carolina reaper, and ghost chili pepper (Encyclopedia Britannica, 2020; Kondo et al., 2021).

Chili peppers are primarily used as culinary condiments and can be consumed in fresh and dried forms. They are utilized in chili powder production and serve as flavoring agents in dishes such as soups, hot curry, and other piquant sauces (Ramírez-Aragón et al., 2022). Hot peppers derive their pungency from capsaicin, a compound known for its acrid fumes and burning taste (Yang et al., 2020). Capsaicin exhibits a high concentration within the interior parts of the fruit, rendering it the principal bioactive phytochemical in chili peppers. This element is responsible for chili peppers' distinctive and piquant flavor and has many advantageous effects on human health (Xiang et al., 2022). Capsaicin, an extract derived from chili peppers, has analgesic properties (Chang et al., 2023). Therefore, it acts as a selective neuropeptide-releasing agent for the primary sensory peripheral neurons (Yang et al., 2020).

Historically, various communities in Lesotho and other regions of Southern Africa have used chili peppers for purposes beyond their nutritional value. Ezekiel et al., (2019), indicate that chili peppers are a vital component in most Sub-Saharan African diets owing to their associated health benefits, including disease prevention. Currently, recommendations are warranted to support the consumption of foods rich in bioactive components, such as herbs and spices (Banwo et al., 2021). As chili pepper fruits ripen, they get more metabolites like capsaicinoids, organic acids, ascorbic acid, citric acid, malic acid, and phenolics (De Sá Mendes & Gonçalves, 2020). This process of ripening is vital for the accumulation of bioactive compounds.

Given the widespread consumption of capsaicin as a food additive and its current therapeutic applications (Xiang et al., 2022), it is crucial to accurately evaluate any potential health benefits and adverse effects of this compound from a public health perspective. Chili pepper (genus *Capsicum*) consumption in Lesotho has not been adequately studied. Therefore, it is vital to examine the consumption of genus *Capsicum* in Lesotho, as previous research has suggested that exposure to high levels of capsaicin can lead to histological and biochemical alterations, such as erosion of the stomach mucosa and hepatic necrosis (Chang et al., 2023). However, there is conflicting evidence regarding the mutagenic properties of capsaicin. Therefore, it is necessary to conduct further research to broaden the comprehension of the potential health

implications of Chili peppers. Engaging in such an endeavor may facilitate the utilization of chili peppers to enhance the overall health and well-being of the nation's population.

The present study comprehensively examines the literature on chili pepper as a functional food. An assessment of chili pepper's significance in Lesotho's context is conducted to identify potential study topics pertaining to Lesotho's food, chili peppers, and therapeutic food product development.

The Proposed Mechanism of Action

Caterina et al., (1997) identify the capsaicin receptor as the transient receptor potential vanilloid subtype 1 (TRPV1). The above-mentioned receptor resides in several anatomical locations, including the brain, sensory neurons, dorsal root ganglia, bladder, stomach, and blood arteries (Du et al., 2019). Activation of capsaicin has been shown to possess the ability to induce desensitization of the vanilloid receptor, sometimes referred to as VR1 (Chang et al., 2023). According to (Gregor et al., 2019), the TRPV1 receptor is a potential therapeutic target for cardiometabolic conditions such as obesity, hypertension, dyslipidemia, diabetes, and atherosclerosis. Capsaicin potentially plays a vital role in preventing cardiometabolic disorders via activating TRPV1 in different target organs or tissues (Chang et al., 2023). Due to its activation, as mentioned earlier, TRPV1 is a promising target for the therapeutic intervention of cardiometabolic diseases and several human ailments, including hereditary pain insensitivity and chronic pain syndromes. However, the correlation between the amount of capsaicin consumed in one's diet and its impact on cardiometabolic protection has yet to be determined, and there is considerable ambiguity over the recommended daily intake (Szallasi, 2022)

Nutritional Value of Chili Peppers

Chili peppers are incredibly high in vitamins and minerals. Herbazest, (2022) asserts that chili peppers provide a diverse range of essential components necessary to maintain optimal health. They function as a commendable reservoir of vitamin C (ascorbic acid), provide significant quantities of vitamin B6 (pyridoxine), and include noteworthy amounts of copper and vitamin K (phylloquinone); in addition to modest levels of various other vitamins and minerals (U.S. Department of Agriculture(USDA), 2019). Chili peppers are recognized as significant contributors to the presence of carotenoids, which serve as precursors for vitamin A and ascorbic acid (Lü et al., 2010). At maturity, they exhibit significant concentrations of carotenoids and L-ascorbic acid, with a recommended daily allowance (RDA) of 0.33–336 RE/100 g for provitamin A and 124–338% of vitamin C activity (Lü et al., 2010).

Ascorbic acid has potent antioxidant capabilities against free radicals (Moreno-Ramírez et al., 2018). According to Azlan et al., (2022), chili pepper fruits that are fully mature and have strong pungency contain a significant amount of vitamin C. The research conducted by Shaimaa & Mahmoud, (2015) screened phytochemicals and antioxidants in several Egyptian chili varieties. The findings of this study revealed that fresh chili peppers exhibit a high vitamin C content. This study also revealed a positive correlation between elevated levels of vitamin C and maturation progression (Shaimaa & Mahmoud, 2015)

Table 1: Nutrient Composition per 100 G of Red, Uncooked Chili Peppers (*Capsicum Annuum*)

Principle	Nutrient Value	Percent of RDA
Energy	40 Kcal	2%
Carbohydrates	8.81 g	7%
Protein	1.87 g	3%
Total Fat	0.44 g	2%
Cholesterol	0 mg	0%
Dietary Fiber	1.5 g	3%
Vitamins		
Folates	23 µg	6%
Niacin	1.244 mg	8%
Pantothenic acid	0.201 mg	4%
Pyridoxine	0.506 mg	39%
Riboflavin	0.086 mg	6.5%
Thiamin	0.72 mg	6%
Vitamin A	952 IU	32%
Vitamin C	143.7 mg	240%
Vitamin E	0.69 mg	4.5%
Vitamin K	14 µg	11.5%
Electrolytes		
Sodium	9 mg	0.5%
Potassium	322 mg	7%
Minerals		
Calcium	14 mg	1.5 %
Copper	0.129 mg	14%
Iron	1.03 mg	13%
Magnesium	23 mg	6%
Manganese	0.187 mg	8%
Phosphorus	43 mg	6%
Selenium	0.5 µg	1%
Zinc	0.26 mg	2%
Phyto-nutrients		
Carotene-β	534 µg	--
Carotene-α	36 µg	--
Cryptoxanthin-β	40 µg	--
Lutein-zeaxanthin	709 µg	--

(Source: USDA National Nutrient Database, 2019)

The nutritional information of chili peppers, as shown in Table 1, was derived from the (U.S. Department of Agriculture (USDA), 2019).

Global Perspective of Chili Pepper as a Functional Food

The proliferation of scientific advancements and the growing fascination with the potential physiological advantages of chili peppers and their constituent compounds have given rise to various health-related assertions and structure-function claims, particularly concerning non-communicable illnesses. In a study conducted by (Lv et al., 2015), the objective was to investigate the correlations between habitual consumption of chili peppers and mortality rates

related to specific causes in ten distinct regions throughout China. The findings of this study revealed a significant negative correlation between the consumption of chili-based foods and overall mortality rates, as well as mortality rates attributed explicitly to cancer, ischemic heart disease, and respiratory disease. Nevertheless, this study's reliance on observations makes it unfeasible to establish a causal relationship. To establish the generalizability of these results, conducting further prospective investigations with other groups is essential. The increased availability of data will contribute to the revision of dietary guidelines and facilitate the advancement of chili pepper as a functional food.

Regular consumption of chili peppers may be vital in preventing cardiovascular diseases. Bonaccio et al., (2019) report that regular consumption of chili peppers was associated with a decreased risk of ischemic heart disease (HR:0.56; 95% CI:0.35 to 0.87) and cerebrovascular (HR:0.39; 95% CI:0.20 to 0.75) mortality. This study further supports the notion that chili peppers can be considered functional foods. The results of this study demonstrate both validity and significance. This research had a high level of quality and included a substantial sample size. A separate investigation conducted in the Asian region examined the correlation between the intake of chili peppers and cancer occurrence in 23 studies that specifically focused on chili peppers as a dietary component. The assortment of chili peppers encompassed several types: peppers, Hungarian hot peppers, red and green chili peppers, and chilies. In this study, the consumption of chili peppers has shown a consistently significant correlation with cancer occurrence, with more than 200 cases and high-quality studies (Bonaccio et al., 2019).

Nevertheless, a study conducted by (Chen et al., 2017) found no statistically significant correlation between the intake of chili peppers at the highest level and the risk of cancer in women. This lack of association is evident across many cancer types, including gastric, gallbladder, and other forms of cancer. It is important to note that the study included a tiny sample size of less than 200 cases and focused on hospital-based research and poor-quality papers.

A growing body of evidence indicates a correlation between microbial infections and chronic illnesses. Research has confirmed that microorganisms can potentially initiate chronic human illnesses (Ganguly, 2019). Additionally, previous studies have shown that chili peppers possess antimicrobial properties comparable to certain modern antibiotics (Baumann, 2015). Notably, capsaicin in chili peppers has demonstrated significant antimicrobial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Klebsiella pneumoniae*, and *Escherichia coli* (Nithya et al., 2011; Omolo, 2014). These findings suggest that chili peppers serve as an untapped resource for identifying natural products that can be incorporated into food to enhance food safety and potentially treat human diseases.

Capsaicin in chili peppers has also been associated with weight reduction. Based on the research conducted by Bertao et al., (2016), the results of a longitudinal study spanning three years and including a sample of 1983 individuals aged 19 to 70 years indicated that those with higher total antioxidant capacity scores saw a decrease in weight and abdominal circumference. Multiple studies have demonstrated the anti-obesity properties of red chili pepper via various mechanisms, such as thermogenesis, satiety, fat oxidation (Azlan et al., 2022), and increased energy expenditure (Varghese et al., 2017). Additionally, a Malaysian study by Huei et al., (2020) that investigated the anti-obesity properties of local chilies varieties suggests that chili peppers exhibit anti-obesity properties.

Chili peppers have additional health benefits, including the potential to mitigate the development of hypertension. A research investigation conducted by (Sun et al., 2016) examined the effects of combining isoflavones and capsaicin in hypertensive individuals with alopecia. The study found that this co-administration resulted in elevated levels of insulin-like growth factor 1 in the serum, leading to a notable decrease in systolic and diastolic blood pressure. Within the realm of scholarly investigations, a study by (Ao et al., 2022) revealed that fermented red chili pepper supplementation may play a vital role in improving systolic blood pressure (SBP) and diastolic blood pressure (DBP). However, there was no significant association between the consumption of red chili pepper and systolic blood pressure, diastolic blood pressure, and heart rate. Numerous experiments have been undertaken to explore the antihypertensive properties of red pepper, primarily focusing on animal models, such as mice and rats. However, further clinical research is necessary to establish the efficacy of this effect in humans.

Relevance to Lesotho

The prevalence of non-communicable diseases (NCDs) in Lesotho is substantial. Non-communicable diseases (NCDs) include a range of chronic ailments not attributable to infectious organisms, as defined by the World Health Organization (WHO), (2022). This category comprises disorders such as cardiovascular diseases, cancer, diabetes, and chronic respiratory diseases (WHO, 2022). Chronic diseases have common underlying etiological factors and have emerged as significant global contributors to premature morbidity and mortality (WHO, 2022). The incidence of chronic diseases in Lesotho may be attributed to many fundamental reasons, including significant discrepancies in food and nutrition distribution and a lack of physical activity. Lesotho accounted for 45.08% of the total recorded fatalities in 2019. The World Health Organization (WHO), (2018) also reported that non-communicable diseases (NCDs) account for 32% of all fatalities in Lesotho.

Research conducted in the sub-Saharan Africa region, specifically Lesotho, revealed a prevalence rate of 48% for hypertension (Mudie et al., 2019). The figures above highlight the increasing prevalence of non-communicable diseases (NCDs) in Lesotho. Emphasizing the prevention, early identification, and care of these illnesses is crucial in public health initiatives to mitigate their effects on the community. The most effective approach to tackling diseases involves prioritizing prevention efforts and strongly focusing on cultivating healthy settings at household and national levels. The suggested approach should include creating resilient, flexible, and appropriate food systems to enhance human and ecological well-being (Mahungu & Krawinkel, 2006).

The effect of nutrition on mitigating the risk of chronic disease is substantial. Based on the global disease burden projections, it is anticipated that in developing countries, the mortality rate resulting from non-communicable illnesses (NCDs) will be over three-quarters of all deaths by 2030 (WHO, 2018). Hence, non-communicable diseases (NCDs) will likely become a global health issue in these developing communities.

Chili peppers are central in Lesotho's culinary practices, acting as an essential component that offers notable health advantages to natives of Lesotho. As discussed in this review, chili peppers have a significant nutritional profile, characterized by a high content of vitamins, minerals, and antioxidants, extending beyond their conventional role as spices (Herbazest, 2022). Incorporation of chili peppers in Basotho traditional foods, such as herbal teas,

vegetables, beans, and meat stews (*sechu*), is a common practice because of its desirable taste and potential therapeutic attributes.

It has been suggested that the regular consumption of chili peppers may have potential benefits in preventing and managing chronic conditions such as arthritis, diabetes, obesity (Huei et al., 2020), hypertension (Ao et al., 2022), and cardiovascular diseases (Bonaccio et al., 2019). Considering the increasing incidence of non-communicable illnesses in Lesotho, incorporating chili peppers into Basotho's dietary patterns may provide substantial health benefits.

Conclusion

The production and use of chili peppers in Lesotho have a rich historical background, but more data is needed regarding their utilization as a functional food. The health advantages of chili peppers have been extensively established worldwide. Based on the analysis of the reviewed research, it can be inferred that those who regularly incorporate chili peppers into their diet exhibit a decreased risk of death from non-communicable illnesses compared with those who abstain from consuming chili peppers. Consequently, the data presented above support the classification of chili peppers as a functional food. However, it is crucial to study matters about possible safety hazards, effectiveness, quality, and development opportunities for local chili peppers, particularly in developing nations such as the mountain Kingdom of Lesotho. Hence, future research endeavors must thoroughly investigate the distinct effects of chili pepper through rigorous clinical trials. The present study has great potential to provide novel global perspectives on the associations between chili peppers, non-communicable diseases (NCDs), and mortality to guide future research. Moreover, further research on these issues will contribute to revising Lesotho's dietary guidelines and advancing functional food products, such as herbal supplements derived from chili pepper.

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