Chapter

Hot Pepper (*Capsicum annuum* L.): An Alternative Food to Reduce Micronutrient Deficiencies in Human

S.R. Krishna Motukuri and Nallamothu Jaswanthi

Abstract

Hot peppers are good source of bioactive compounds particularly phytochemicals, capsaicin, oleoresins, and rich organic micronutrients with potential health benefits. It plays an important role in diets and possesses micronutrients. Micronutrient dietary deficiency remains a massive problem in the world which may cause several chronic health diseases. More than 2 billion individuals are facing micronutrient deficiencies, viz., zinc, iodine, and iron, followed by vitamins. Among various approaches to overcome human nutrition deficiencies, a diet with fruits and vegetables that are rich in micronutrients is considered as the best solution. Hot pepper consumption worldwide is well known for its high nutritional content which in turn reduces human micronutrient deficiencies. Thus sufficient amounts of micronutrients can be provided by incorporating the nutrient-rich pepper in diet that could beneficially help in combating nutrient deficiencies. Thus, in the present chapter, an overview of the micronutrient deficiency is described, and the nutrition status of hot pepper that utilized in eradicating human micronutrient dietary deficiencies is also discussed.

Keywords: *Capsicum*, hot pepper, micronutrients, human dietary deficiency, advanced approaches

1. Introduction

Micronutrients (minerals and vitamins) are obtained from our diet; though required in small amounts, they are necessary for good growth and development [1]. Micronutrients, namely, iron, cobalt, manganese, boron, molybdenum, chlorine, nickel, zinc, copper, iodine, fluorine, and chromium, are essential for human health. Many studies showed that nutrition plays a vital role in providing the substances essential for the formation of the early brain structure and also supporting for its good functioning [2]. Micronutrients play a unique metabolic role as cofactors in the absorption and digestion of carbohydrates, proteins, amino acids, and lipids to release energy [3]. Micronutrients play a very important role in all the metabolic activities like cell signaling, motility, cell division, and cell differentiation and death and, in turn, regulate the tissue development [4].

Micronutrient deficiencies can badly affect the health of individuals, which influence the world's morbidity and mortality [5]. These deficiencies are referred

to as "hidden hunger" which affects about 2 billion people [6] and may lead to high rates of illness, obesity, underdevelopment, and even deaths in children of age below 5 years [7]. Among various vegetables and fruits that are rich in micronutrients, chilies have various essential nutrients, minerals, vitamins (A, C, E), and other important phytochemical compounds [8]. They also pose some human health benefits like preventing diseases such as obesity, heart diseases, and different cancers [9]. An alkaloid, namely, capsaicin, is present in pepper which has antimicrobial, anti-inflammatory, and anticancer effects on the digestive system and is used in relieving pain and also to lose weight [10]. Thus providing diet that is rich in pepper can be supportive in an ongoing quest to ease micronutrient deficiencies.

2. Micronutrient deficiency in humans

Some studies reveal the importance of micronutrients in pregnant women and generally given as supplements, which include vitamins, viz., A, cobalamin, pyridoxine, C, D, and E, iron, zinc, iodine, copper, and selenium. Micronutrient deficiencies may mimic radiation or some chemicals which damage the nucleic acids and lead to cancer [11]. Some studies reveal that these deficiencies are related with the danger of HIV infection progression and deaths [12]. Deficiency of vitamin A may cause low serum level of retinol which affects nearly 15% of pregnant women and which leads to night blindness in 8% of them [4]. The reduced form of vitamin C [ascorbic acid (AA)] is the principal chemical structure that appears as an important micronutrient that involves in various physiological functions. Ascorbic acid plays a vital role in reducing the antioxidants and enhances the production of ROS to prevent cancer [13]. Vitamin D is generally known as fat-soluble compound with antiproliferative effect and also involved in the development of bone and immune system [14]. Some studies reported that vitamin D metabolites help in protection against cancer [15].

Vitamin E deficiency can lead to enhanced peroxidation which leads to symptoms like walking difficulties and severe development of speech, reduced fat absorption syndrome, and lipoprotein abnormalities [16]. Deficiencies of iron may affect the growth and mental development and also decreases the capability to do physical work [3]. Some studies reported that the supplementation of zinc along with other micronutrients can reduce the severity of diarrhea diseases and respiratory infections [17]. These deficiencies occur in individuals who do not consume food that provides micronutrients sufficiently like fortified foods, fruits, and animal products. This is usually due to its excessive cost or may domestically unreachable. Among the various vegetables available, chili (*Capsicum annuum*), which are available to common man at affordable price and provide various vitamins like E, C, B6, B12, and provitamin A and some minerals, possibly will give rise to significantly enhanced nutrition [8].

3. Role of hot pepper in micronutrient deficiencies

To enhance the micronutrient status in humans, nutritionists suggest integrating foods, which are rich in micronutrients, in diet. Among various vegetables, chili fruits are rich in capsaicinoids, carotenoids, tocopherols, provitamin A, ascorbic acid, and several antioxidants. Chilies are also an excellent source of xanthophylls and vitamins B1 (thiamine), B3 (niacin), and P (citrin) [18]. Hot pepper contains proteins (1.9 g), sugars (5.3 g), fiber (1.5 g), fat (0.4 g), energy (8.8 g), ascorbic acid (240%), pyridoxine (39%), vitamin A (32%), copper (14%), iron (13%), potassium (7%), and magnesium (6%) [19]. Nutrient constituents and their composition present in chili species in different countries are represented in **Table 1**. Red sweet

So. no	Constituent	Name of the country	Fruit species	Composition	References
1	Vitamin C	United States	*C. Francisca*	122.0 mg/100 g DW	[20]
		Brazil	*C. chinense*	125 mg/100 g DW	[21]
		India	*Capsicum chinense Jacquin*	109.36 mg/100 g DW	[22]
		Ethiopia	*C. annuum*	84.011–89.011 mg/100 g DW	[23]
2	Capsaicin	Brazil	*C. chinense*	14.0 mg/g DW	[24]
		Central America	*C. annuum*	0.042 mg/g DW	[25]
		India	*C. frutescens*	4.45 mg/g DW	[26]
		Ethiopia	*C. annuum (Marako fana)*	5.5 mg/g DW	[27]
3	Crude protein	America	*C. annuum*	2.9 g/100 g DW	[28]
		India	*C. chinense*	17.5 g/100 g DW	[22]
		Ethiopia	*C. annum (Marako fana)*	118.09 g/100 g DW	[29]
		Brazil	*C. chinense*	0.08–4.5 g/100 g DW	[21]
4	Carbohydrates	America	*C. annuum*	3.0 g/100 g DW	[28]
		India	*C. chinense*	78.1 g/100 g DW	[22]
		Brazil	*C. chinense*	1.8–10.8 g/100 g DW	[21]
		Ethiopia	*C. annum (Marako fana)*	35.3 ± 0.6 g/100 g DW	[29]

Table 1.
Nutrient constituents and their composition in chili species in different countries.

pepper consists of twice the provitamin A than in carrot and double the amount of vitamin C of green pepper, and it also acts as antioxidant and anti-inflammatory phytonutrient [30]. Sweet pepper is fibrous in nature and is the sources of dietary fiber which could help in fighting blood cholesterol level and diabetes better from the body and bloodstream, respectively [31].

4. Medicinal uses of hot pepper

Capsaicin is a pungent alkaloid present in hot pepper species, and it is the principal capsaicinoid that accounts for about 71% of the pungent types, followed by dihydrocapsaicin [32]. Structures of capsaicin and dihydrocapsaicin are in **Figure 1**. The percentage of pungency varies among species by varying the capsaicin and dihydrocapsaicin contents which are due to influence of factors like the developmental stages of fruit and the environmental conditions [33]. Capsaicin possesses good medicinal properties like antimicrobial, anticancer, antidiabetic, and analgesic properties. Some studies reveal that fruits having higher amounts

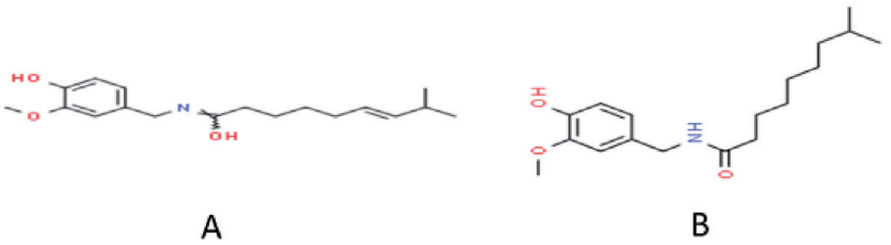

Figure 1.
(A) Capsaicin. (B) Dihydrocapsaicin.

of capsaicin show high antioxidant level [32]. Besides the nutritional benefits, it is also responsible for medical therapeutic and pharmacological uses [34]. Capsaicin has an important role in relieving sore throats, fever, and cold symptoms and also enhances the circulation of blood and strengthens the arteries, thus reducing the risk of heart attacks [3].

Capsaicin is also used as an anti-irritant balm for external use and as painkiller in some topical ointments, nasal sprays, and skin patches and also used in the form of cream for short-term relaxation of muscles and pains related to arthritis, back pain, and other stresses [35]. It also has an antidiabetic activity by enhancing the insulin secretion and releasing bound insulin. Capsaicin helps in producing heat within the body and consumes oxygen which simultaneously burns calories in the body and helps in losing weight [30]. Thus, incorporating pepper-rich food in everday diet can be useful in enduring pursuit of eliminating micronutrient deficiency. Hot pepper fruits were enriched with antioxidants which protect the human body from harmful effects of free radicals, and it develops resistance against different diseases.

5. Conclusion

Advanced technologies are being used to combat human micronutrient deficiency in developing countries, where poor people are mostly at this risk. In tropical countries, rural farmers traditionally cultivate wide range of vegetables; among them chili is grown globally, and India is the most important producer and exporter of hot pepper which consists of wide range of micro- and macronutrients. In this chapter, it has been concluded that the chilies are cost-effective vegetables that are significantly rich in essential micro- and macronutrients and also possess healthy components to support human health conditions. The presence of antioxidants and phytochemicals in chili increases its importance in controlling the diseases. Integrating hot pepper in our regular diet can be supportive to alleviate nutrient deficiency in humans.

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Conflict of interest

The authors declare that there is no conflict of interest on this book chapter.

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