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Review Article

Mint (Mentha): A Herb and Used as a Functional Ingredient

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Abstract

Health never goes out of trend. There is increased interest in alternative medicines particularly those obtained from plants. Functional foods have the ability to prevent or lessen the severity of symptoms of disease. The world is gaining its interest in treatment through natural sources like foods and medicinal plants. Herbal medicines have already been utilized by various cultures around the world for several therapies including chronic pain, malaria, heart conditions, warts, skin diseases and bowel disorders. The need for functional foods is anticipated to increase as a result of three factors: changing laws, increased health care expenses, and scientific discoveries. Mint is a member of the *Lamiaceae* family. Mint is an excellent source of vitamins, minerals, phenolic compounds, dietary fiber and antioxidants. Mint is a mysterious herb because of its many unknown aspects through which it promotes good health that should be revealed. Mint is a rich source of Iron. Alkaloids, steroids, and tannins are among phytoconstituents found in mint essential oils that prevent the absorption of sugars and flavonoids.

Keywords: Mint; Herb; Functional Food; Fortification; Iron Fortification.

INTRODUCTION

Food is a necessary component of life and is influenced by a wide range of environmental factors. Globally, the production of food, food products, and their consumption increase greenhouse gas emissions by 25–35% (Ghoulem *et al.*, 2019). Processing procedures that take place in the mouth and are connected to sensory observations include complex multiple sets like bolus lubrication, particle size reduction, alteration, and temperature adjustments. There are several food classifications, such as liquids, partial solids, and solids, for each class's various oral management stages (Li *et al.*, 2020).

Food systems, mostly in Africa and South Asia are still unable to halt chronic malnutrition on a large scale. In high-income countries, large populations experience food insecurity. Malnutrition and hunger are widespread because they have intricated underlying causes and are closely related to scarcity. It is expected that socio-demographic factors will have a significant impact on the extent, complexity, regional, and geological diversity of the effects of climate change on crops as well as food systems. Climate change may have an impact on farm revenues, increased food, uniformity, food quality, and food security, according to successive statistical evaluations and combined valuation models (Nechifor *et al.*, 2021).

Human health is significantly concerned with the development and improvement in food merchandise. Important elements are delivered through food products that are very necessary for human health. Different categories of food products including solids, semi solids and liquid provide different nutrients along with vitamins and minerals. Due to the worst economic landscape, the worth of life as a result of income and expenditure has been worsening over time. But it's now a major problem for illnesses that are induced by a certain behavior. Unhealthy food consumption is associated with the development of several nutritional deficits and metabolic disorders (Rai *et al.*, 2019; Elizabeth *et al.*, 2020; Pagliai *et al.*, 2021).

"You are what you eat" is an often-used phrase. Due to our complicated genetic makeup, eating patterns can be handed down throughout generations. Malnutrition, diabetes, hypertension, malignancies, osteoporosis, asthma, and tooth decay are the major lifestyle-related illnesses that were brought on by escalating automation and urbanization(Norman *et al.*, 2021). These issues are involved in all industrialized nations, including the United States, Japan, and Canada. Additionally, developing nations are rapidly adopting western culture. Due to their benefits for improving health, designer and functional meals are gaining popularity. Such meals go well beyond providing basic nourishment by including components that are concerned with health and disease prevention (Keats *et al.*, 2021).

Mankind is in a state of anarchy due to acute malnutrition. Numerous ailments and diseases are brought on by mineral deficiencies, particularly those involving iron (Fe), iodine (I), calcium (Ca), and zinc (Zn). The most exposed populations are young children in preschool and pregnant women. Micronutrient deprivation is a global health problem. The most cost-effective dietary treatments, primarily fortification and micronutrient mediators, have been discovered (Peña-Rosas *et al.*, 2019).

Together with their bioavailability, micronutrients play a crucial role in fortification. Advantages can only be gained if these modifications are frequently used and encompass good working environment and an expanded distribution network. Technical challenges also reduce the effectiveness of such supplements. When nutrients are added to meals, they must be examined for a number of things, such as their toxicity, interactions with other nutrients, impact on the texture and flavor of food, average shelf life, quality of the product, and bioavailability. Women and children are especially susceptible to micronutrient deficiency due to an increased demand for reproduction and growth, respectively (Shubham *et al.*, 2020). Therefore, intervention programs are much needed to improve the well-being of the massive people. Fortification of food is the most effective way to combat the lack of minerals, among many other predictable approaches. The strategic approach of food fortification is also highly economical (Patel *et al.*, 2022). Both in wealthy and underdeveloped nations, enough research have been done on it. Since more than a century ago, both developed and developing nations have employed fortification of dietary staples with micro- and macronutrients to treat micro- and macronutrient inadequacies (Nechifor *et al.*, 2021).

2.1. Functional foods

The tremendous powers of food have been influenced by long-standing cultural factors. The ability of specific foods to prevent or lessen the severity of symptoms resulting from what is now universally recognised as malnourishment has been demonstrated in a number of historical publications. Incredibly, it becomes obvious that certain food ingredients that are not strictly necessary for human existence may instead severely decrease quality of life by affecting one or even multiple physiological processes when researchers uncover previously unknown nutritional requirements. It is more likely that specific qualities, such as interactions with other diet items, a consumer's physiological functions, behavioural patterns, and biological characteristics, will determine a meal's capacity to affect these processe (Figueroa *et al.*, 2021).

A growing number of people throughout the world are becoming aware that the food they consume not only influences their academic performance but also raises their risk of contracting a number of ailments. It is reasonable to assume that in the expected future, consumer demand for these physiologically potent substances and health-promoting foods will rise (Patel *et al.*, 2022).

Due to public interest in the idea that some foods may benefit health, the term "functional food" was first used. According to the Food and Nutrition Board of the National Academy of Sciences, a functional food is one that has elements that may be nutritious. "Any changed food or food item that may deliver a health benefit in addition to that of the regular nutrients it comprises" is included in this. Despite the fact that the term "functional food" is growing in popularity, the scientific and health communities have not fully embraced it. The distinctions between what counts as a functioning meal and what does not are frequently the focus of consultations. Many believe that classifying food as "good" or "poor" is incorrect and unsound from a scientific perspective. Many dietitians hold the dogmatic idea that only diets, not actual foods, can be categorised as being healthy or unhealthy(Wu *et al.*, 2020). The presence of food that isn't functional is unknown. In the inclusive framework, all foods must be recognised as "functioning." Yet, some meals may be primarily beneficial in moderating specific physiological processes in a way that improves life quality or reduces the risk of contracting a disease (Granato *et al.*, 2020).

The idea that particular meals or their components may provide some specific health benefits has blurred the line between food and drugs. A medication is anything that is thought to be used for the diagnosis, treatment, equitability, or prevention of any ailment in terms of symptoms. Also, rather than being considered as a way to confirm that people are eating more nutritious meals or as a simple publicity stunt, the promotion of higher intake of functional foods and the bioactive components that go along with them should be seen as a road towards better nutrition. Regardless of whether functional foods continue to be popular, it is crucial that consumers' confidence in the food system is not undermined. It is inappropriate to promote both healthy and unhealthy foods (Sarkar, 2019).

2.1.1. Need of functional foods

The need for functional foods is anticipated to increase as a result of three factors: changing laws, increased health care expenses, and scientific discoveries. Globally, the cost of healthcare as a percentage of GDP is rising (the gross national product). Many people think that unhealthily eating contributes to both poor health and additional medical costs. Nutritional variables are thought to play a role in illnesses including some types of cancer and coronary heart disease, which are among the main causes of death (Ajeeshkumar *et al.*, 2021).

It would be ridiculous to believe that specific foods could be utilized as "natural cures" for different diseases, but it would also be strange to disregard evidence suggesting that making bad dietary decisions can aggravate hazardous conditions. The assumption that meals and the components that make them up occasionally provide medicinal benefits is one likely explanation for why people use supplements more frequently. A lot of people who seem to be in good health use supplements frequently, which is predisposed by a number of characteristics like age, sex, and previous health problems (Meléndez-Martínez *et al.*, 2021).

2.1.2. Global Trends of Functional foods

Japan promoted functional diets for young children as part of a nationwide study initiative that was funded by the Japanese government and held to help contain the cost of healthcare. The desire and curiosity of consumers to eat healthful foods has now been established, and they have started to adhere to diet plans. This movement is expanding daily as a result of people's increased interest in foods containing active substances, particularly those that quickly improve their health. Due of their biological physiognomies, functional foods satisfy the body's basic needs while appearing to be outdated food products (Gok and Ulu, 2019).

Nutrition classification and education act was proven in 1990 in United States and it was first time entirely imposed in 1994. There are more than 400 functional foods and nutraceutical objects in the marketplace. They are usually derived from plant kingdom and show many health encouraging functions that is why they are consumed for the cure of many contagious diseases and syndromes. Because of extra health care cost, trust of people on healthy diet, limitation and obligatory laws, enhancements in science, technology and zero side effects are the key factors that are convincing the public to consume functional foods (Mu *et al.*, 2019).

Functional foods are attaining reputation in confectionary and dairy segments but the bakery sector is still under developed in terms of functional foods. Consumers are being provided with functional foods in satisfactory manner through different stuffs. Innovation in functional foods in bakery and confectionary was made by Unilever when they developed white bread containing the vitamin B1, B6, fiber, zinc, iron, inulin and starch from wheat like present in brown bread (Daliu *et al.*, 2019).

2.1.3. Positive effect of functional foods

Functional foods have abundant health benefits. They are often linked with good health and permanency. This perception has expanded the marketplace for functional food items which are making functional foods accessible to consumers who are health conscious. The overview of functional food constituents in diet looks very tempting and attractive to consumers. Furthermore, a study directed by Stark and Madar, (2002) determined that consumers select functional foods allowing for them psychologically improved and disease preventive. Functional foods are not only the foods which contain polyphenolic compounds (Daliu *et al.*, 2019).

Secondary metabolites of polyphenolic compounds are those elements that can capture free radicals by analyzing them through an internal antioxidant. Antioxidants are known to reduce the risk of cardiovascular disease, neurological illnesses, immune system problems, cataracts, and mental issues. They also have anti-inflammatory and anticancer properties. Previous studies have exposed that these health-promoting ingredients in functional meals combine to defend against oxidative stress. Oxidative stress is a method that results in the production of additional sensitive oxygen species, which are accountable for the breakdown of macromolecules like lipids, proteins, and DNA. In the body, oxidative damage is caused by oxidants such hydrogen peroxide, superoxide anion and hydroxyl ions. These by products which are formed during regular metabolic reactions are mutagens and they cause oxidative stress with aging (Angeli *et al.*, 2020).

2.1.4. Negative effects of functional foods

Nutraceuticals and innovative foods are frequently combined with functional foods. Novel foods are fresh and unconventional. Compared to the foods that are now available on the market, they are unique. In addition to nutraceutics, the availability of functional meals is suggested to get through sensory obstacles like unpleasant taste and mouth feel that are frequently associated with phytochemicals that are commonly approved (Shegelman *et al.*, 2020).

Sharpness and bitterness are unpleasant aspects of food that are connected both directly and indirectly to polyphenolic chemicals and some functional diets. The degree of bitterness and sharpness of foods is related to their molecular masses. This is the main reason why products fail after being familiarized to the market. This may be changed by properly identifying the intended consumers, but doing so is a time-consuming and expensive process. Hit and trial approach, which is difficult, is typically used to increase optimization (Galanakis, 2021).

Plants have been regarded as a diverse source of natural ingredients for enhancing health for the past ten years. The WHO has endorsed the encouragement of these items because conventional management is primarily neither quantitative nor within reach (Borsellino *et al.*, 2020).

Abundant features of plants, organic components and natural processes are beneficial for guaranteeing bodily physiological functions as well as being utilized to cure a variety of illnesses, according to previous studies. Alkaloids, tannins, phenolic acids and flavonoids are the most important of these bioactive plant elements. Due to the realization that they may contain a considerable amount of beneficial ingredients as compared to their conventionally produced counterparts, consumers' desire for organic foods has considerably expanded (Firouz *et al.*, 2021).

The ingestion of sweetened fruit drinks and soft drinks has increased steadily over the past few decades, especially among children and teenagers. Due to their quick and rapid growth and development needs, adolescents have higher nutrient requirements than elderly people. Additionally, their unhealthy and unrestrained eating patterns may result in inadequate and unnecessary nutrient consumption (Daliu *et al.*, 2019; Firouz *et al.*, 2021).

2.1.5. Functional food products

Customers' demand for organic foods has grown tremendously as a result of the widespread knowledge that they may contain more beneficial ingredients than their conventional counterparts. High consumption of sugar-sweetened beverages is directly and significantly correlated with lower intake of high-fiber foods, increased energy intake, and fleshiness. Even while soft drink consumption is not the main factor of obesity, it is recognized as having a substantial impact on school children of practically all ages. To stop this dangerous usage, a remedy is urgently needed. A range of phytosterols, phenolic acids, flavonoids, and carotenoids found in many aromatic plants have antioxidant and cancer- preventive qualities. One of the most popular single ingredient herbal teas is peppermint (*Mentha piperita*) (Wani *et al.*, 2022).

Due to the growing knowledge that organic foods may include more healthful nutrients than their conventional equivalents, consumer demand for them has increased significantly. Low intake of foods high in fibre, increased calorie intake, and fleshiness are all directly and strongly associated with high consumption of sugar-sweetened beverages. Whilst soft drink consumption is not the primary cause of obesity, it is acknowledged to have a significant effect on schoolchildren of almost all ages (Salehi *et al.*, 2018). A solution is urgently required to stop this risky usage. Many aromatic plants contain a variety of phytosterols, phenolic acids, flavonoids, and carotenoids that have antioxidant and cancer-preventing properties. Peppermint (*Mentha piperita*) tea is one of the most often consumed single-ingredient herbal beverages (Valancius *et al.*, 2008).

To prepare peppermint tea, use the leaves of the peppermint plant. Traditional native and indigenous medicines commonly contain peppermint essential oil. *Mentha piperita L.* is the scientific name for the genus of plants that includes peppermint. It is also known as "nana," which refers to a plant that is widely used as a seasoning, antiseptic, antibiotic, stimulant, and carminative agent in the cosmetic and pharmaceutical industries worldwide. Foods of a plant-based origin are the best providers of antioxidants and other phenolic compounds. They also supply several essential minerals needed for human nutrition (Dalgıç *et al.*, 2012).

2.2. Mint

The popular term for mint is pudina. It belongs to the *Lamiaceae* family and the *Mentha* class. In muddy places, vast clumps of moist spots, and along the sides of rivers, mint flourishes. Mint has a potent flavour and gastrointestinal aftertaste (Taneja and Chandra, 2012). Alkaloids, steroids, and tannins are among phytoconstituents found in mint essential oils that prevent the absorption of sugars and flavonoids. Gram-positive and Gram-negative germs are eliminated by the phytochemicals, full phenolic content, and in vitro antibacterial action of mint (Tsai *et al.*, 2013).

On the contrary hand, mint is frequently ingested as a fundamental ingredient in many herbal beverages. It supports maintaining health in a variety of ways. Linalool oxide, bornyl acetate, and carrone are the other three antioxidants found in mint. Moreover, *S. aureus* and *E. coli* are also effectively inhibited by the antibacterial properties of mint species. Pharmaceutical goods use the substantial oils and bioactive substances of mint. effects of mint oil specifically on the respiratory system. Several epidemiological studies have indicated its modulatory effect in irritable bowel syndrome. It is believed that mint can stop recurrent dyspepsia. Moreover, the antioxidants in peppermint guard against flatulence, bile duct enteritis, gastritis, gallbladder spasms, and gastrointestinal colic (Tsai *et al.*, 2013).

In industrialized and now numerous emerging countries, mint varieties are utilized as aromatic and therapeutic elements in cosmetics, pharmaceuticals, meals, and beverages. Mint varieties are prevalent around the world. According to Hayes *et al*., (2007), peppermint is the most commonly utilized food ingredient because of the aroma potentials of iso-menthol, menthol and menthone ester. The Mediterranean, European and Indian civilizations employ spearmint, which is essentially a home garden mint, as a flavoring agent in tea, beverages and ready to eat meats. There are new procedures that can lessen the loss of bioactive substances caused by prolonged extraction periods. Among them, microwave- sponsored extraction is developing into a respectable choice in several disciplines, particularly in studies on the extractions from medicinal plants. Due to their antibacterial, antioxidant, anti-inflammatory and anti-allergic qualities, Mentha species non-volatile components have positive benefits on human health (Kadam *et al.*, 2011).

Furthermore, we may say that *Mentha piperita* is a gifted plant that may offer low-cost substitute strategy for the use in Medicine and in food industry. Kadam *et al*., (2011) studied the effects of different conditions and particle sizes on solid-solvent extraction of the total phenolics and flavonoids which is also referred to as antioxidants from peppermint leaves.

The overall phenolic content of extracts is linearly correlated with their antioxidant activity. Polyphenols are abundant in medicinal and aromatic herbs including winter savoury, oregano, and rosemary. By using mostly microwave- or ultrasound-assisted removal, Dimitrios *et al*., (2018) attempted to recover these highly valued chemicals. The kind of solvent is critical to quantitative extraction and ethanol in water at a concentration of 60 to 80 percent appears to be the most promising choice for the majority of phenolic groups (Moetamedipoor *et al.*, 2022).

Shabnam *et al*., (2018) evaluated the efficiency of removing antioxidant phenolic components from peppermint extracts using various organic solvents (80% acetone, 80% ethanol, 80% methanol), along with sterile water. Their flavonoid and phenol content in total, antioxidant activity, and concentration of various phenolic components were all analyzed. High-performance liquid chromatography was used to measure the amount of phenolic chemicals (HPLC). For the extraction of all of the phenolic components from mint (28.19 mg GA/g freeze dried crude extract), 80% acetone was found to be the most effective solvent (80% ethanol was the best solvent). According to HPLC results, the amount of phenolic compounds varies and is dependent on the kind of solvents utilized (Alameen *et al.*, 2023).

From the specific Mentha species, 47 hydrophilic and nearly 17 lipophilic chemicals were identified and measured. Additionally, eight carotenoids and eleven phenolic compounds were found, and their composition differed among the several Mentha species (Herro and Jacob, 2010). The many Mentha species showed a variety of antioxidant effects. Among the nine Mentha species, horse mint in particular demonstrated the strongest antioxidant properties (hydrogen peroxide and reducing power assay) (Benkert *et al.*, 2022).

The notion of mint as a useful food was first enthused by how herbs and spices were really employed in diets. Functional foods are not specifically explained, but there are various circumstances in which the idea is implemented, including scientific research, technological advancement, dietary standards and food marketing. Functional foods are described as "items that provide benefits beyond basic nutrition" from a scientific perspective. This definition is based on several conceptions of food (as an identifiable unit of application as opposed to medications), thoughts of benefits (which entail the requirement for scientific evidence), and the notion of "basic nourishment" (an awareness open to understanding). Basic nutrition may really represent the degree of knowledge and performance that now prevails in various cultures. So, fulfilling vitamin and mineral requirements which have recommended reference values could be considered to be basic nutrition. The prevailing idea is that these nutrients are necessary to preserve healthy bodily functions. On the other hand, current research on food ingredients goes beyond the ideas of avoiding medical inadequacies and preserving homeostasis. However, they include a growing understanding of how food ingredients work in concert with the body to maintain health and prevent anomalies and evident diseases (Ilić *et al.*, 2022).

Table 2.1: Proximate composition of mint

Citation	Moisture (%)	Fiber (%)	Protein (%)	Ash (%)	Fat (%)	Iron (mg/100g)
(Nayak *et al*., 2011)	4.97	16.19	22.23	15.32	2.14	11.87
(Sangwan *et al*., 2012)	2.48	7.78	18.85	11.23	0.62	8.30
(Salve *et al*., 2020)	4.20	16.20	13.62	9.70	2.40	10.15

2.2.1. Therapeutic effect of mint

Mint leaves have diaphoretic, stimulative, antiseptic, anti-asthmatic, antispasmodic, and stimulating properties. Mint is a fragrant and medicinal plant that can be used in its leaves. In addition to helping with nasal and throat conditions, it also helps with the flu, infections, malaise, poor absorption, motion sickness, food poisoning, stings, hitches, and ear discomfort. It is abundant in minerals including calcium, phosphorus, and iron. Because mint has a high-water content (between 78 and 82%), it is typically dried before being sold in order to inhibit the growth of microorganisms and prevent decomposition, which typically results from biochemical reactions. Moreover, drying results in a significant reduction in weight and volume, which lowers the cost of packaging, storing, and transporting the product (Soleimani *et al.*, 2022).

Hussain *et al*., (2010) categorized peppermint as mordant, antiseptic, antiemetic, carminative and pain-relieving. The mint leaf extract contains anti-oxidant, anti-oncogenic, and anti-allergic characteristics. In general, peppermint oil is used to treat a variety of illnesses, including cough, edoema, bronchitis, and sore throat and oral mucosa. Also, a great deal of digestive issues like gas, bloating, diarrhoea, dyspepsia, vomiting, nausea, and colic in young children are treated with mint. Moreover, it alleviates gas production, anorexia, morning sickness, and muscle cramps. Mint is also used to treat a wide range of conditions, including irritable bowel syndrome, Crohn's disease, ulcerative colitis, gallbladder and liver issues, menstrual cramps, annoyances, migraines, and many others. Moreover, blood sugar levels, some unstable sulphur compounds, and arsenic-induced noxiousness can all be greatly decreased by the plant extract (Yassin *et al.*, 2020).

Mentha piperita, often known as peppermint, has a rather long history of safe use in flavouring and medicinal formulations. Among the peppermint's powerful and beneficial constituents are menthyl esters, dimethyl sulphide, cadinene, amyl alcohol, acetaldehyde, pinene, pugelone, phellandrene, and limone. Traditional medicine has a reputation for using mint to successfully cure ailments like parasitosis, headaches, stomach cramps, and dysmenorrhea. Mint has been discovered to be one of the amazing therapeutic agents when utilised as a stabilising agent for the flu and inflammation-inducing disorders of the oropharynx, cavities, and of hepatobiliary and gastrointestinal origin. Peppermint has gained popularity as a flavouring ingredient and is frequently used in pharmaceuticals and other items, especially in confectioneries. complementary in addition to (Asghari *et al.*, 2018).

Mint is a very beneficial and significant plant that has been utilized extensively in foods, medications, and cosmetics since ancient times. Mint has been used for therapeutic purposes to regain health and strength since ancient times, when it was also used to perfume baths. Mint was utilized back then to restore the brilliance of discolored and dull teeth. Due to the mint's energizing scent and flavour, its extracted oil is still used in toothpaste, chewing gum, and candy today. Mint is useful in providing us with a calming flavour. Also, mint sells soaps that have certain alluring scents. Fresh mint leaves in the form of sliced leaves can be added to the soup to complement the soup's bitter and sweet tart flavors of tomatoes. You can avoid heat strokes in the blazing summer by consuming yoghurt that has been spiked with mint paste or sipping a cold beverage made from sugarcane and mint leaves. In several nations, mint leaves are frequently utilized as tea flavorings (Deyab *et al.*, 2018).

2.2.2. Mint as a functional ingredient

As a condiment and salad dressing known as chutney, mint is frequently used. They grind various spices, including fennel seeds, black salt, black pepper, and chillies, along with the mint, into a paste that includes onion, garlic, ginger, tomato, raw mango, and other vegetables. In pharmaceutical therapies and as a spice, Mentha piperita, popularly known as peppermint, has a reasonably long history of safe use. Among the peppermint's powerful and beneficial constituents are menthyl esters, dimethyl sulphide, cadinene, amyl alcohol, acetaldehyde, pinene, pugelone, phellandrene, and limone. The mint has isolated amounts of several different compounds with potential health benefits, including alpha- and beta-thujone, alpha-pinene, terpinolene, sabinene, gamma-terpinene, fenchone, citronellol, and ocimene. In traditional medicines, mint has a reputation for providing relief. This liquid is the essential oil and better known as peppermint oil, with menthol as its principal constituent. Traditionally, the flowering parts of *Mentha pulegium* (pennyroyal) have the antimicrobial reputation in fighting against tuberculosis, sinusitis and foodborne illnesses. The same were also used as antitussive, diuretic and carminative agents (Karousou *et al.*, 2007).

Mint leaves have been used for a very long time in a variety of contexts, primarily in the enjoyment of food and its connection to wellbeing. Communicating the benefits of food diversity in balanced ways remains a problem, especially when compared to the criteria used to survey pharmaceutical professionals. Medicines are mixes that are normally ingested in a well-kept environment and have low atomic weights. Food is taken in combinations, portions that are rather large and unmeasured, and in highly circulating environments. The simple test doesn't require a proof of whether food and its components, including mint and its flavour, have beneficial benefits on health. By employing methodological and purposeful approaches, we demonstrate what these benefits are and what actions are done to find them (Kowalczyk *et al.*, 2021).

Mint meets the requirements of a supplement in numerous ways. The emphasis of such supplements in this augmentation is on their role in the diet rather than their usage as drugs. This post would involve discovering the only bioactive compounds to help uncover objective advantages. Afterwards, study would be conducted to see if the benefits noted for the specified combination might be accepted for the food itself or a meal based on the food. The traditional usage of food in various civilizations provides numerous insights regarding this development. For instance, several dishes in traditional Thai cuisine have a cultural history of sustaining health depending on their blend of herbs, spices, and other foods. Due to the emphasis on the targeted nutrients in Western countries, it may be preferable for dietary management principles to make reference to meals rather than specific foods. The real difficulty therefore arises in communicating the benefits and giving them the scientific support for these benefits (Lemyze *et al.*, 2020).

By analyzing their properties as consumables, we can better understand how mint functions nutritionally. Similar with most foods, their inclusion in the diet is probably going to have the effect of enhancing perceptions of the aspects of wellness that food most strongly promotes, as well as methodological breakthroughs addressing the verification basis for their specific impacts. These developments through evidence-based frameworks are well underway to support food-related health claims. Guidelines are now required to promote the consumption of foods rich in bioactive components, such as herbs and spices. We should anticipate a growing corpus of technical research indicating the benefits of herbs and spices in preserving general health and preventing disease in the future (Lothe *et al.*, 2021).

Table 2.2: Utilization of mint in different products

Citation	Product	Supplementation	Results
(Karousou *et al.*, 2007)	Yogurt	Mint leaves extract	The phenolic and iron content of thick yogurt was significantly improved with appreciable change in sensory properties
(Deyab *et al.*, 2018)	Lemonade beverage	Mint herbal extract	Mint herbal extract addition to lemonade allowed the production of beverages which were preferred by consumers for their sensory properties
(Karousou *et al.*, 2007)	Orange juice	Mint paste	Incorporation of orange juice with 15% of mint paste recorded the best values for sensory evaluation as well as for zinc and iron contents
(Lothe *et al.*, 2021)	Yogurt	Mint extract	Addition of mint extract contributed in increasing taste, texture and flavor and exhibit more antioxidant properties
(Maas *et al.*, 2020)	Yogurt	Mint	Addition of mint reduced the yellowness and increased the overall sensory scores. It also masks the fishy flavor.

2.3. Mineral deficiency

Around 2 billion individuals worldwide experience micronutrient insufficiency, which is preventable and linked to illnesses that pose a serious risk to their lives (Maas *et al.*, 2020). Even though they are just slightly necessary for human health, micronutrients have a remarkable impact on it (micrograms or milligrammes per day). If these drugs are consumed in ludicrous quantities nutritionally, the brain, immune system, reproductive system, and energy metabolism may all suffer the repercussions. The consequences of these deficiencies include learning difficulties, reduced employment potential, ill health, and even death (Moetamedipoor *et al.*, 2022).

Almost 24 percent of Pakistanis are currently experiencing starvation due to the country's horrifyingly high malnutrition rate. 37.5 million Pakistanis are undernourished, according to a report by the Food and Agriculture Organization of the United Nations (FAO, 2008). According to the fifth review on the state of global nutrition by the United Nations Standing Committee on Nutrition (SCN), only three kinds of malnutrition: protein deficiency, iodine insufficiency and iron deficiency account for three to four percent of Pakistan's annual gross domestic product (GDP) loss (USSCN, 2008).

Vitamin and mineral deficiency are a widespread issue in both rich and developing nations. Nowadays, about half of the world's population experiences malnutrition or is at risk of lacking in vitamins, minerals, and other micronutrients. Consuming enough micronutrients is essential for both physical and mental growth. Since micronutrients are essential for many metabolic functions, a deficiency in them can result in a range of health problems (Yousuf *et al.*, 2021).

2.3.1. Iron deficiency

A state of very low haemoglobin content is known as iron deficiency. Iron is a crucial element for all living things, including humans. Iron is vital to life because it can function equally well as an electron donor and acceptor. Heme is a prosthetic group that is typically found in proteins and enzymes that contain iron. Heme is involved in a number of natural oxidations as well as transportation networks. Some essential proteins having functioning iron include catalase, cytochrome, and haemoglobin. Heme proteins, notably myoglobin, cytochrome P450, and haemoglobin are the most major bioinorganic iron compounds. These compounds are necessary for the movement of gases, the production of enzymes, and the transfer of electrons.

Ferritin and rubredoxin are significant metalloproteins that have iron as an ion cofactor. The iron-containing enzymes catalase, lipoxygenases, and IRE-BP are some of the most important ones (Beutler *et al.*, 2010).

Millions of individuals throughout the world suffer from iron deficiency, namely from iron deficiency anemia (IDA), which continues to be one of the most serious and critical nutritional deficiencies in existence today (Breymann *et al.*, 2001). According to Cook *et al*., (2003), the majority of these individuals reside in underdeveloped nations, although this issue also affects people in industrialized nations. According to a study by Fernando and Viteri from 2003, 11% of people in the industrialized world are anemic. Another research done in the United States revealed that around 15% of babies in developed nations do not receive enough dietary iron (Byrnes *et al.*, 2011). As a result, it is more widespread in emerging nations than in less industrialized ones. According to several studies, nutritional anemia affects 20 to 50 percent of people in underdeveloped nations and 2 to 28 percent of people in wealthy nations (Chang *et al.*, 2005; Saini *et al.*, 2016). In Bangladesh, workers account for 69% of GDP, while 64.89% of the working force is anemic, which results in a 0.89 percent decline in GDP owing to lost productivity (Khambalia *et al.*, 2006).

Similar to many other poor nations, Pakistan is battling iron deficiency anemia (IDA), a serious public health issue that is most prevalent among school-age children, pregnant women, and nursing mothers. According to the National Nutrition Survey, women made up 48.7% of the population while children under the age of five made up 29%. In NWFP, anemia was observed in 50.1% of infants and young children aged between six months and five years (Kotwal *et al.*, 2013).

It may be argued that the primary cause of IDA in children in Pakistan is under nutrition. According to the findings of a research on the nutritional condition of male and female school-aged children in and around Faisalabad, Pakistan, between the ages of 6 and 12, 36.1% of the children were undeveloped, 45.3% were malnourished, and 25.2% were underweight for their height. Those in cities have better conditions than children in rural areas. Children in urban areas were stunted in 33 percent of cases, underfed in 32.3 percent, and wasted in 32.7 percent. Children in rural areas had an underweight rate of 40.9 percent, a malnutrition rate of 64.7 percent, and a waste rate of 33.3 percent. Rural females were the most affected and malnourished, with 61.7 percent undersized, 83 percent underweight and 67.23 percent futile (Martínez-Pastor and Puig, 2020).

Iron deficiency is partially brought on by vegetarian diets since they have low levels of iron with significantly decreased bioavailability. According to several investigations, the type of food itself is a significant factor in decreased iron absorption. They claimed that diets low in ascorbic acid and meat might cause an iron deficiency due to the very restricted availability of both nutrients. The Nation Nutritional Survey 2001-2002 provided results that were verified in Pakistan. The survey found that critical nutrients are not consumed to the recommended daily intake by moms or children under the age of five. It has recommended iron supplements for ladies and iron-fortified wheat flour for the public (Saini *et al.*, 2016).

Fatigue, lethargy, and a general lack of energy are common anemia symptoms. Physically speaking, these are clear indicators of an iron deficiency. All types of cells contain iron, which is essential to many biological processes. Therefore, iron deficiency has a variety of detrimental health impacts, including anemia, impaired perceptive function and increased maternal and infant death (Sanchez-Gonzalez *et al.*, 2016). Iron malnutrition is not the primary cause of anaemia, although it is typically the most common one in areas where anemia is common.

A lack of iron is linked to changes in several metabolic systems. With IDA, the concentration or activity of several iron-containing enzymes in the liver and skeletal muscles decreases. In iron-deficient anemic people and rats, the levels of the catecholamines adrenaline and norepinephrine, the main regulators of glucose production, is abnormal (Santhakumar *et al.*, 2023).

It is clear from the name that iron deficiency anaemia is caused by a lack of iron. When you don't get enough iron, your body can't generate enough of the components that allow red blood cells to carry oxygen. As a result, iron deficiency anaemia may cause you to feel exhausted and out of breath.

2.3.2. Iron Deficiency and Pregnancy

Pregnant women and young children are the demographic groups most prone to experience an iron deficit. In both industrialised and developing nations, anaemia during pregnancy impacted a substantial percentage of women. According to the WHO, anaemia during pregnancy affected between 35 and 75 percent (or an average of 56 percent) of pregnant women in undeveloped countries and 18 percent of those in industrialised countries. In Africa and Asia, maternal mortality due to iron deficiency anaemia accounts for 20% and 23% of societal costs, respectively. It was found that prenatal morbidity and mortality were increasing in developing countries. According to surveys, many anaemic moms died during giving delivery (Zhang *et al.*, 2012).

The need for iron rises throughout the second trimester of pregnancy and stays elevated for the duration of the pregnancy (Martínez-Pastor and Puig, 2020). As a result, there is a considerable risk of iron deficiency during pregnancy. The fear that the risk of maternal mortality and morbidity may increase is one of the main concerns regarding the harmful effects of IDA on pregnant women. Although the evidence is still lacking, it is probable that low maternal haemoglobin is associated with greater neonatal or perinatal death. Overall, the data is insufficient to establish a causal relationship between iron deficiency and unfavorable pregnancy outcomes (Sanchez-Gonzalez *et al.*, 2016).

There is compelling evidence linking IDA in the first few years of infancy to problems with behaviour as well as poor motor and cognitive development. Studies repeatedly demonstrate that kids who don't get enough iron as babies continue to have delayed cognitive and motor development as well as subpar academic performance as they get older.

2.3.3. Fatigue due to Iron Deficiency

Employees that are anaemic are less productive, have less stamina for work, and are more fatigued since IDA reduces physical stamina. Children with IDA grow more slowly, perform worse on cognitive tests, and have lowered infection resistance. Moreover, their cerebral and psychomotor development has been stunted. Research carried out in labs and on the ground confirmed and recommended that IDA has a sizable potential impact on work production. Many countries have shown a direct link between iron deficiency and the productivity of agricultural workers. Since it is difficult to assess the social and economic effects of IDA and iron deficiency, more field study is necessary. When anaemic people received iron therapy, their labour productivity increased by 5% overall for blue-collar jobs and by 17% for physically demanding work (Rai *et al.*, 2019).

2.3.4. Deficiency and infectious diseases

Together with other elements, iron is crucial for nearly all disease-causing bacteria or pathogens, but it is also required for the host in order to enhance a powerful immune response. Since both iron deficiency and infectious diseases are common problems, the effects of iron shortage and supplementation on the immune system are of great interest. Several researches have demonstrated that an iron shortage increases the likelihood of developing infectious diseases, although other study results have called this conclusion into question. Yet, the information is scant, vague, and oblique. On the other hand, it is asserted that, in specific malaria-endemic regions, a lack of iron can offer protection from infection (Salehi *et al.*, 2018).

Girls between the ages of 10 and 19 who were adolescents in 1980 in Egypt experienced anemia. The prevalence of anemia was 46.6 percent overall, with mild, modest and severe anemia accounting for 82.6, 16.45, and 0.446 percent of cases, respectively. The mean haemoglobin level was 11.958 g/dl (Angulo-Kinzler *et al.*, 2002). IDA is a significant problem for both industrialized and developing nations. The relationship between a number of factors, including the discrepancy between the iron which is needed by the body and the amount that is absorbed by the body, results in iron deficiency anemia. Limited levels of iron in the diet, coupled with its low bioavailability, as well as the presence of inhibitors are dietary variables that can lead to IDA. IDA can also result from a given life span having insufficient dietary iron of a certain kind. Based on the mean corpuscular volume, anemia might be microcytic, normocytic or macrocytic. When a kid is 6 to 36 months old and has risk factors for iron insufficiency anemia, they can get oral iron therapy to treat mild microcytic anemia. It is necessary to mark out gastrointestinal blood failure in patients whose anemia is severe or resistant to iron treatment. Hemolytic, bone marrow, and chronic illnesses are all potential causes of normocytic anemia. Based on bone marrow function as assessed by the reticulocyte calculation, normocytic anemia is evaluated. A patient who has a high reticulocyte count should be checked for hemolysis or blood loss. Reticulocyte counts below normally indicate a problem with the bone marrow. Iron and vitamin levels are frequently examined during anemia testing. Any morphology of anemia patients can benefit from additional information provided by a marginal smear (Caruso *et al.*, 2022).

Depending on the location, anemia in pregnancy occurs more frequently and has multiple causes. Anemia in pregnancy can be caused by a number of diseases, including acute and chronic infections, hemoglobin production problems and nutritional deficiencies such as lack of iron, vitamin B12 or folic acid. Anemia in pregnancy is most frequently caused by dietary iron deficiencies. Maternal anemia has been associated with higher chances of both adverse maternal and newborn outcomes, regardless of the cause (Cirovic and Cirovic, 2022b).

Heart failure patients frequently have iron deficiency anemia, which is linked to severe symptoms and unfavorable outcomes in this population. Over the past several years, erythropoietin stimulating medications have undergone extensive research and have come up with positive results for anemia and heart failure patients. Additionally, questions have been raised about the safety of erythropoietin-stimulating medications in people with chronic renal disease, therefore information on safety in people with heart failure will likely be provided by the findings of a large mortality test. Patients with heart failure and anemia have a far more mature therapy option in iron replacement or supplements (Cirovic and Cirovic, 2022a).

Anemia affects quality of life and the entire situation noticeably negatively among cancer patients, where it is rather frequent. Iron deficiency (ID) is commonly a major and possibly curable contributor to the etiology, which is complicated and typically multivariate. Malnutrition, bleeding (for instance, in gastrointestinal malignancies or after surgery), medicines, and iron seizure into macrophages with subsequent iron-restricted erythropoiesis can all contribute to iron deficit in cancer patients. Absolute and functional iron shortage is both possible, without a doubt. While there is widespread agreement over the laboratory diagnosis of absolute iron insufficiency, a common definition of functional iron deficiency is still missing (Crooks *et al.*, 2013).

Approximately 1.62 billion people worldwide, or 24.8 percent of the world's population, suffer from anemia. Fe-deficiency anemia in children can result in gastrointestinal illnesses, weight loss, and recurrent respiratory infections. Numerous anomalies, including respiratory problems, exhaustion, a lack of physical activity, sluggish learning in both adults and children, and a reduction in immunity, are brought on by iron deficiency. According to a WHO report, anemia is one of the major public health problems and affects more than 50% of the population. Children are highly anemic, and over half (53.7%) of the population is anemic (Fischer *et al.*, 2014; Suselo *et al.*, 2023).

It has been determined that the most prevalent form of child malnutrition in Pakistan is nutritional anemia. Anemia prevalence decreased to 53.7% in 2018 but remained high when it was at 50.9 percent from 2001 to 2011 and then soared to 61.9 percent. Teenage females are more likely to be anemic than boys (56.6%), however just 0.9% of adolescent girls are severely anemic. Anemia affects roughly 41.7 percent of women of reproductive age (WRA), with urban areas having a somewhat lower prevalence (40.2 percent) than rural areas (44.3 percent) (Hutchinson *et al.*, 2008).

In America, 5% of women and 2% of men are anaemic due to a Fe deficiency. Iron, a trace element, is necessary for many cellular metabolic processes. The average adult's body has 3–4 g of iron. Iron is typically absorbed at a rate of 12 mg per day; however, the average western diet only contains 7 mg of iron per 1000 kcal. The majority of the iron in the human diet is heme and non-heme (Sunarno *et al.*, 2012). Heme iron is the kind of iron that is obtained from and readily absorbed by meat. Iron deficiency anemia is a disorder in which there is a reduction in haemoglobin concentration in the blood due to an iron deficit (Krouma, 2023).

Non-heme dietary iron is defined as iron present in various vegetables, beans, and grains that is not well absorbed. Non-heme iron can be found as ferrous (Fe+3) or ferric (Fe+2). Food fortification has been deemed the most efficient and secures method for supplying low-iron diets. It is important to include in food fortification items that are consumed and accessible locally. For a fortified meal to be successful in the community for the prevention of anemia in underdeveloped nations, it must employ carriers that are available and legally applied. Who may consume more iron than they require, fortification of mass is intended to increase the bioavailable Fe intake with the goal of curing anemia in humans (Li *et al.*, 2023; Mohammed *et al.*, 2023).

2.4. Interventions strategies

Supplementation, dietary diversification, illness prevention, and food fortification are the four main strategies for combating malnutrition. All of these techniques can be applied to alleviate micronutrient deficits. Food fortification is the most common and useful of these.

2.4.1. Mineral Fortification

According to the Codex Alimentarius commission, fortification is defined as "adding one or more essential nutrients to a food, whether or not they are normally present in food, for the prevention or correction of a verified deficiency of one or more nutrients in the population or specific groups of population" (Adetola *et al.*, 2019).

Food fortification is a scientifically, technically, and economically effective technique to enhance the population's consumption of micronutrients. In industrialised countries, food fortification is believed to have had a major impact on the nutritional health and welfare of the populace. Throughout the first half of the nineteenth century, the concept of improving everyday foods was developed (Vatandoust *et al.*, 2023). Margarine was fortified with vitamin A in Denmark in 1918. Salt had previously been iodized in Switzerland towards the beginning of the nineteenth century. The success of salt iodization was largely due to how simple and affordable it was to use. Iodine deficiency was a public health problem in many nations at the time, and UNICEF and WHO supported widespread salt iodization as the primary solution (Raouche *et al.*, 2009; Affonfere *et al.*, 2022).

Food fortification, along with other dietary strategies and supplements, is a crucial tool for preventing and managing micronutrient hunger. The number of intermediaries depends on regional circumstances, local expertise, resources that are promised, and infrastructure. Fortification is preferred over other intermediaries because it requires fewer significant dietary changes from individuals who consume the product (Silva *et al.*, 2022). The World Bank claims that food fortification is the most economical type of medical intervention and the solution to lowering micronutrient deficits in developed countries (World Bank, 1993). Many additional researches concur with Bothwell and MacPhail that food fortification is the most effective strategy for IDA control. One vitamin is added to an appropriate food carrier in place of the unusual technique once used in food fortification programmes. Fortifying food with two or more micronutrients at once is a practical way to treat multiple deficits at once (Baldelli *et al.*, 2023).

While the general populace eats some of the foods utilised in iron fortification programmes, like wheat flour, salt, and sugar. Other meals can be manipulated to target vulnerable groups, such as infants and kids. For example, it has been demonstrated that adding iron to infant formula can lower the incidence of iron deficiency in neonates. Food served in school lunch programmes is a fantastic potential medium for targeted iron fortification campaigns.

2.5. Choice of Fortificant

For proper immune system functioning, good body metabolism, and mental and physical growth, nearly forty different vitamins and minerals are required. They have a number of benefits, including as boosting immunity, serving as an antioxidant, and being anti-carcinogenic. Because they are so important, micronutrients need to be a part of our meals. Even though our body only requires a very small number of them, when they are lacking or absent, major problems result (Hurrell, 2021).

Food can be fortified using a variety of fortificants with different qualities. One of the largest challenges is locating chemicals that are stable, readily and correctly absorbed, and do not alter the flavour or appearance of food vehicles. Non-Heme sources of iron, such as ferrous sulphate, elemental iron, ferrous fumarate, and others, are widely used for fortification. Iron fortifications are technically difficult because iron reacts with meal components quickly (Moslehi *et al.*, 2022). The organoleptic qualities of the fortified product or the meals that contain the fortified food must be preserved while selecting an iron supplement. In order to avoid iron overload, it's also important to remember things like avoiding hot, humid surroundings while keeping iron, dispersing iron throughout meals, and leaving it out when combining and storing.

A fortificant substance is often chosen as a balance between reasonable cost, diet bioavailability, and the acceptance of any sensory modifications. In order to achieve the required fortification, fortificants must not separate from the food matrix or generate undesirable sensory issues (such as colour, flavour, odour, or texture). They must also be stable within the predetermined ranges (Kaur *et al.*, 2022).

It is important to thoroughly evaluate the probability or potential for the interactions between additional micronutrients, the food carriers and new nutrients. Food affordability must not be impacted by the expense of fortification. The target population's micronutrient status must be improved by the fortificant, which must be able to be sufficiently well absorbed from the food vehicle. The issue of safety is equally crucial. To be successful, fortification must be consumed at a level that is consistent with a balanced diet (Mattar *et al.*, 2022).

The micronutrient iron interacts with food components the strongest and creates unfavourable organoleptic changes, making it exceedingly challenging to add to food. The most challenging iron additives are therefore those with the highest bioavailability. The major consideration when selecting a good iron compound for food fortification is to pick one that has the highest relative bioavailability (RBV) in contrast to ferrous sulphate without adversely affecting the meal's sensory attributes (such as flavour, colour, or texture). Expense is often another another important consideration (Hurrell, 2021).

Iron fortificants can be divided into three broad types. The most preferred alternative is water-soluble iron complexes since they have the highest relative bioavailabilities. Moreover, they are very soluble in stomach secretions. These compounds, however, adversely affect the organoleptic qualities of food, particularly its flavour and colour. A different family of iron fortificants consists of iron compounds that are hardly or barely soluble in water but soluble in weak acids. These fortificants are rather well absorbed from meals because they are soluble in the gastric acids produced in the stomach. These chemicals have less of an impact on the sensory qualities of food when compared to water-soluble chemicals (Kaur *et al.*, 2022).

Compounds that are weakly soluble in diluted acid and insoluble in water make up the third category of iron fortificants. Although the amount of iron absorbed from these fortificants is quite low, they have a far smaller impact on the sensory qualities of food and are also less expensive than the more soluble compounds. If a water-insoluble iron fortificant is required, it should preferably have an absorption ability comparable to at least 50% than that of ferrous sulphate (tested in rat/human) and two times they would need to be supplied to make up for the lower absorption rate (Makkar *et al.*, 2022).

Ferrous sulphate is a great example of an iron fortifier because it has the highest relative bioavailability (100%) of any water-soluble iron component. Spaghetti, bread, and infant formula have all been successfully fortified with it in the past. The flour can also be combined with wheat flour if very briefly held in storage. However, it can hasten the oxidation of fats and increase rancidity in cereal flours stored for extended periods of time, and it might provide an undesirable hue to salts, chocolate products, and infant food. It frequently adds a metallic flavour to liquid dishes and can cause the peptides in soy and fish sauce to precipitate (Ohanenye *et al.*, 2021; Vatandoust and Diosady, 2022).

CONCLUSION

Ingredients in functional foods have health benefits that go beyond their nutritional value but their excessive use can impose adverse effect on human health. Natural antioxidants derived from diverse plants, spices, and oil seeds have increasingly replaced synthetic antioxidants in processed foods in recent years. Mint leaves include a wide spectrum of vitamins, minerals, phenols, fibre and antioxidants that have both therapeutic and nutritional benefits. Also, mint leaves offer amazing medical advantages. The considerable phytochemical profile of mint leaves accounts for these health advantages. The leaves of the mint plant can protect you from a number of ailments, including diabetes, cancer, and cardiovascular disease. Daily incorporation of mint leaves in diet can provide various health benefits and protection against various diseases. The creation of functional foods, which are sold to consumers due to their health advantages, contributes to enhancing the nutritional quality of food. The development of novel products and suggestions for their nutritional content present new challenges for scientists today.

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