Culinary and herbal resources as nutritional supplements against malnutrition-associated immunity deficiency: the vegetarian review

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Abstract

Background: Malnutrition may be due to undernutrition and/or overnutrition and is responsible for morbidity and mortality. Fulfilling nutrition requirements of all human age groups is necessary for maintenance of health and quality of life. Nutritional supplements, or daily diet, must include a sufficient amount of macronutrient (carbohydrate, protein, and fat), micronutrients (vitamins and minerals), and nonessential dietary components such as fiber.

Main body: There is a bidirectional relationship that exists between nutrition, infection, and immunity; children are dying due to malnutrition that weakens their immunity and makes them more susceptible to pathogen attack. Culinary and herbal resources containing macro- and micronutrients are required to achieve nutritional deficiencies.

Conclusion: In this review, we have documented different culinary herbs that have been used as prime herbal nutritional source and these herbs might be helpful in malnutrition and boosting immunity. The review contains the description of nutritional levels and their distribution to different age group people. This review gives insight to herbal products that boost immunity to fight against infections by restoring micronutrients.

Keywords: Malnutrition, Culinary herbs, Immunity, Nutrition, Phytoconstituents

Background

Malnutrition has become a leading public health problem globally, more in southern Asian and African countries [1]. The prime cause of malnutrition in developing countries is prevalence of bacterial and parasitic diseases [2]. It has been estimated that 300,000 deaths occur annually due to malnutrition and is indirectly related to half of all deaths in young children [3, 4]. Malnutrition, more specifically to protein-energy, and micronutrient deficiencies, are major health burdens in developing countries. It is one of the most important risk factor for illness and death worldwide. Malnutrition exists in all countries, irrespective of the economic status of the country, where people are lacking nutritious diet [5]. According to Global Nutrition Report 2018, India is a shelter of 46.6 million stunted children as the world's third highest country having malnourished children. The mortality in below 5-year-old children in India is mostly due to undernutrition [6]. India is faced with serious problems of malnutrition that affect socioeconomic progress. One-third of the children are malnourished [7].

Deficiencies of protein, carbohydrates, fat, and micronutrients such as iodine, iron, vitamin A, and zinc are nutritional deficiencies [8]. Poverty is the major cause of malnutrition in developing countries. Severity of malnutrition depends on several factors: education level, sanitation, economy, political situation, climate, food...
production, cultural eating traditions, prevalence of infectious diseases, nutrition awareness programs, and quality of health services [9, 10]. Improper breastfeeding of infants and children leads to malnutrition. The first 6 months of life is crucial for proper nutrition [11]. Breastfeeding provides immunity to the infant and protects against infection due to presence antibodies and lymphocytes (T and B), numerous cytokines, and growth factors to stimulate an infant’s immune system [12, 13].

Malnutrition occurs due to improper diet and infection that results to energy and nutrient losses through anorexia, vomiting, and diarrhea. Microbial attack causes contamination of the gut that impairs digestion and nutrient uptake and results in sepsis from bacterial translocation to the intestine [14]. The indicative measures of malnutrition are frailty, impairment of organ functions, cognitive impairment, poor performance, stress and depression, etc. [15]. It can be characterized as physical and mental exhaustion, low basal metabolic rate (BMR), small height (wasting), and rigid skin. India has the highest number of malnourished children in comparison to other developing countries and high rate of mortality due to malnutrition each year [16]. One other cause of malnutrition in developing countries is more consumption of Western diet by the people that is also responsible for the deficient nutrition level in their bodies [17].

Deficiency of nutrition in diets requires proper understanding of processes and determinants that are influencing diets. Thus, there is a need for a large intervention including nutrient-rich food, coverage of immunization, supplements distribution, primary care to children, proper checkup of geriatric patients, and proper sanitation in community which are necessary across different sectors. There may be a rational approach to investigate the dietary supplement effects including all nutrients present in the current government recommended dietary allowance. The solution to malnutrition and other forms of hunger needs to be focused on ensuring the sufficient supply of nutritious and high-quality food.

Main text
Status of child nutrition
The United Nations International Children’s Emergency Fund (UNICEF) has defined nutrition status among children and investigated roles of food care—health determinants, i.e., quantities of food available at a national level and varieties of food, women’s education and equality of gender, and access to safe drinking water and sanitation. One-third of the women in India are malnourished during pregnancy and give birth to malnourished babies [18]. In 2017, the death of malnourished children below 5 years old was accounting for 68.2% in India. A projection for global malnutrition 2030 target was set according to the study of National Nutrition Mission (NNM) conducted in different states of India in 2017. The malnourished data in this study indicated 21.4% low birthweight, 15.7% child wasting, 39.3% child stunting, 59.7% anemia, 32.7% child underweight, and 11.5% child overweight [19].

The influence of income and quality of governance in countries affects nutritional levels. The conceptual framework indicates (Fig. 1) causes of child malnutrition and death [20]; this framework is a hierarchical relationship between immediate, underlying, and basic determinants of child nutritional status. Factors such as dietary intake and health status are immediate determinants that manifest themselves at the level of the individual child. Inadequate dietary intake may lead to enhanced susceptibility to pathogens; disease caused reduced appetite and inhibition of absorption of nutrients present in food [21]. Underlying determinants manifest themselves at household food security (having enough food for living an active healthy life), care for mother and children (care for women that affects children’s nutritional wellbeing is care and support during pregnancy and lactation), and home environment and services (children’s exposure to pathogens and the use of preventative and curative health care). Basic determinants manifest political, economic, social, environmental, and cultural context in which children’s nutritional status is determined [22].

Effects of aging on nutritional level
The maintenance of healthy life for all age groups depends on diet and nutrition. Obtaining proper nutrition has significant effects for wellbeing, decreasing and delaying risk of diseases, maintaining functional independence, and continuing independent living [23]. Aging leads to physiological and pathological changes in the body that makes it difficult to meet the nutritional requirements for the body (Table 1). Cumulative effects of all these changes lead to malnutrition of elderly people. Aging, combined with arthritis, depression, stroke, respiratory disease, renal diseases, and dementia, creates loss of appetite, inability to swallow properly, alteration in food intake, and unbalanced nutrient in the body [24, 25]. Older persons are more prone to malnutrition that causes energy loss, poor wound healing, and vulnerability to infections increasing the risk factor of morbidity and mortality [26, 27].

Malnutrition and infection
Malnutrition and infection operate synergistically (Fig. 2). Infection interferes with substrate utilization, reduces nutrient absorption, and promotes tissue breakdown. Weight loss is an indication of malnutrition [28]. Signs for nutritional deficiency in children are stunting.
Immune dysfunction as a cause and consequence of malnutrition

Malnutrition leads to suppression of immune and inflammatory systems with weakened responses to infection or injury. Severe acute malnutrition management that fails to consider these complex metabolic and physiological changes results in severe, or fatal, complications [14]. Poor diet, lack of exercise, environmental toxicity, and age progression causes variable effects on the human immune system (Fig. 3). It has been reported that long-term usage of herbal nutrients, or nutraceuticals, may reverse these immune-affecting variables [29].

**Culinary herbs**

Culinary herbs and spices (dried) include any part of plant (root, leaves, bark, berry, seed, stigma, or flower) that are frequently used while cooking to enhance the aroma or flavor of foods [30]. These herbs contain several nutritional contents along with their flavoring property [31]. They also have been used for several medicinal purposes to diseases including cardiovascular, neurodegenerative, diabetes, cancer, and many more [32]. The use of herbs and spices as functional food extends their importance beyond basic nutrition. Herbs and spices are generally used in the concentration of 0.5–10% in food preparation [33]. Peppermint leaves are most widely used in herbal teas. It is a folk medicine used for dyspepsia, enteritis, gastritis, and intestinal colic. The total phenolic content (TPC) of peppermint leaves is 19–23% along with present of Ca, Mg, Mn, Fe, Zn, Cu, I, Cr, and Se [34]. Several culinary herbs containing rich nutrients are *Melissa officinalis* (Lemon balm leaves), *Hyssopus officinalis* (Hyssop leaves), *Agastache foeniculum* (Anise hyssop), *Capsicum annuum* (Red pepper), *Juniperus communis* (Juniper berries), etc. Table 2 shows the list of culinary herbs and spices used in cooking that are rich in nutritional contents.

**Phytoconstituents and biological activity of culinary herbs**

Oregano possesses carvacrol, thymol, linalool, *p-*cyeme, and *y-*terpinene as active constituents that gives

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**Table 1 Effects of changes on aging**

| Change                      | Effect on older people (age 60 and above) |
|-----------------------------|------------------------------------------|
| Decreased sense of taste    | Reduced appetite                         |
| Decreased sense of smell    | Reduced appetite                         |
| Loss of vision and hearing  | Decreased ability to purchase and prepare food |
| Oral health/dental problems | Difficulty chewing, inflammation, poor quality diet |
| Altered energy need         | Diet lacking in essential nutrients      |
| Decreased physical activity | Progressive depletion of BMI and loss of appetite |
| Muscle loss                 | Decreased functional ability             |
| Social isolation            | Decreased appetite                       |
| Financial and environmental | Limited access to food, poor quality diet |
antimicrobial, anti-inflammatory, immunomodulatory, antidiabetic, anticancer, and antioxidant activities; prevents lipid peroxidation; suppress nitric oxide activity; and DNA protection against damage from free radicals [35]. *Salvia officinalis* contains ellagic acid, quercetin, rosmarinic acid, camphor, borneol, cineole, and thujone as phytoconstituents. It helps in cognition enhancement, reduction of throat pain, analgesic, antihyperlipidemic, antinociceptive, anti-inflammatory, and antioxidant activities [65]. *Mentha piperita* contains menthyl acetate, menthone, and menthol as major phytoconstituents. Other active constituents of mentha leaves are methofuran, neomenthol, isomenthone, isorhoifolin, leutolin-7-O-glucoside, and 1,8-cineole. It possesses antioxidant, antimicrobial, insecticidal, and anti-inflammatory activities [66]. *Thymus vulgaris* possess active constituents

**Table:**

| Poor diet        | PROGRESSIVE IMMUNE DYSFUNCTION | Hypertension |
|------------------|-------------------------------|--------------|
| No exercise      |                               | Heart attacks|
| Hectic lifestyle | Stress                        | Diabetes     |
| Inoculations     | Acute recurrent infection     | Cancer       |
|                  | Allergies                     | Arthritis    |
|                  | Chronic infections            | Asthma       |
| Negative thoughts| Stress headaches              |              |
|                  | Colds                         |              |
|                  | Hay fever                     |              |
|                  | Candida                       |              |
| Environmental toxicity | Onset of fatigue | Viral and bacterial infections |
|                   | Urinary tract infections      |              |
|                   | Food and chemical allergy     |              |
|                   | Viral and bacterial infections|              |
| Age of onset      | 15-25                        |              |
| (Approx.)         | 10-35                         |              |
|                   | 25-45                         |              |
|                   | 35-45                         |              |
|                   | 45-60                         |              |

**Fig. 2** The vicious cycle of malnutrition and infection

**Fig. 3** Factors affecting human immune system
### Table 2 Culinary herbs and spices in daily use

| Culinary herb       | Biological sources         | Consumption (mg/day) | Nutritional value                                                                 | References |
|---------------------|----------------------------|----------------------|-----------------------------------------------------------------------------------|------------|
| Oregano             | Origanum vulgare           | 200                  | One teaspoon of dried oregano contains: energy (5 calories), fiber (0.08 g), calcium (29 mg), iron (0.66 mg), magnesium (5 mg), manganese (0.09 mg), potassium (23 mg), vitamin E (0.03 mg), vitamin K (11.2 µg) | [35]       |
| Sage                | Salvia officinalis         | 300–600              | One teaspoon of dried oregano contains: energy (2 calories), magnesium (3 mg), phosphorous (1 mg), potassium (7 mg), folate (2 µg), beta-carotene (24 µg), vitamin A (41 IU), vitamin K (12 µg) | [36]       |
| Peppermint leaves   | Mentha piperita            | 300–600              | Two tablespoons of peppermint leaves contain: energy (2 calories), protein (0.12 g), carbohydrate (0.48 g), fat (0.03 g), fiber (0.30 g) and small amount of potassium, magnesium, calcium, phosphorus, vitamin C, iron, and vitamin A | [37]       |
| Garden Thyme        | Thymus vulgaris            | 1000–2000            | Per 100 g of Garden thyme contains: proteins (5.6 g), energy (101 calories), carbohydrate (24 g), total fat (1.7 g), saturated fat (467 mg), monounsaturated fat (81 mg), polyunsaturated fat (532 mg), Omega-3 fatty acids (447 mg), Omega-6 fatty acids (85 mg), vitamin A (4751 IU), vitamin C (160 mg), thiamin (48 µg), riboflavin (471 µg), niacin (1.8 mg), vitamin B6 (348 µg), folate (45 µg), pantothenic acid (409 µg), calcium (405 mg), iron (1.7 mg), magnesium (160 mg), phosphorus (106 mg), potassium (609 mg), sodium (9 mg), zinc (1.8 mg), copper (555 µg), manganese (1.7 mg) | [38]       |
| Sweet Marjoram      | Origanum majorana         | 1000                 | Per 100 g of Sweet marjoram contains: energy (271 kcal), carbohydrates (60.56 g), protein (12.66 g), total fat (7.04 g), dietary fiber (40.3 g), folates (274 µg), niacin (0.902 mg), pantothenic acid (0.209 mg), pyridoxine (1.190 mg), riboflavin (0.316 mg), thiamin (0.289 mg), vitamin A (8068 IU), vitamin C (51.4 mg), vitamin E (1.69 mg), vitamin K (621.7 µg), sodium (77 mg), potassium (1522 mg), calcium (1990 mg), copper (1.133 mg), iron (82.71 mg), magnesium (346 mg), manganese (5.433 mg), zinc (3.60 mg), carotene-β (4806 µg), cryptoxanthin-β (70 µg), lutein-zeaxanthin (1895 µg) | [39]       |
| Tansy leaves        | Tanacetum vulgare          | 100                  | The tansy plant contains volatile oils that comprise of 70% of thujone and significant amounts of camphor. It also contains other chemical constituents such as sesquiterpene lactones, bitter glycosides, terpenoids, flavonoids, resin, tannin, oxalic acid, and citric acid. It is a good source of vitamin C and minerals like calcium, magnesium, sodium, manganese, iron, silicon, and sulphur | [40, 41]   |
| Poppy seeds         | Papaver somniferum        | 100–150              | Per 100 g of poppy seed contains: energy (525 kcal), carbohydrates (28.13 g), sugars (2.99 g), dietary fiber (19.5 g), fat (41.56 g), protein (21.22 g), thiamine (0.854 mg), riboflavin (0.100 mg), niacin (0.896 mg), vitamin B6 (0.247 mg), folate (82 µg), choline (52.1 mg), vitamin C (1 mg), vitamin E (1.77 mg), calcium (1438 mg), iron (9.76 mg), magnesium (347 mg), manganese (2.285 mg), phosphorus (870 mg), potassium (719 mg), sodium (26 mg), zinc (7.0 mg) | [42, 43]   |
| Cardamom            | Elettaria cardamomum      | 250                  | Per 100 g of cardamom contains: energy (311 kcal), carbohydrates (68.47 g), protein (10.76 g), total fat (6.7 g), dietary fiber (28 g), niacin (1.102 mg), pyridoxine (0.230 mg), riboflavin (0.182 mg), thiamin (0.198 mg), vitamin C (21 mg), sodium (18 mg), potassium (1119 mg), calcium (383 mg), copper (0.383 mg), iron (13.97 mg), magnesium (229 mg), manganese (28 mg), phosphorus (178 mg), zinc (7.47 mg) | [44]       |
| Coriander           | Coriandrum sativum        | 600–1200             | Per 100 g of coriander contains: choline (12.8 mg), folate (62.00 µg), niacin (1.114 mg), pantothenic acid (0.570 mg), riboflavin (0.162 mg), thiamin (0.067 mg), vitamin A (674800 IU), α-carotene (36.00 µg), β-carotene (3930 µg), cryptoxanthin-β (202.00 µg), lutein + zeaxanthin (885.00 µg), vitamin B6 (0.149 mg), vitamin C (27.0 mg), vitamin E (2.50 mg), tocopherol-α (2.50 mg), vitamin (310.00 µg), calcium (67.00 mg), copper (0.225 mg), iron (1.77 mg), magnesium (26.00 mg), manganese (0.426 mg), phosphorus (4800 mg), potassium (521.00 mg), selenium (0.9 µg), sodium (46.00 mg), zinc (0.50 mg) | [45]       |
| Garlic              | Allium sativum            | 300–900              | Per 100 g of garlic contains: choline (23.2 mg), folate (3.0 µg), niacin (0.70 mg), pantothenic acid (0.596 mg), riboflavin (0.110 mg), thiamin (0.20 mg), vitamin A (9.0 IU), β-Carotene (5.0 µg), lutein + zeaxanthin (16.00 µg), vitamin B6 (1.235 mg), vitamin C (31.2 mg), vitamin E (0.08 mg), α-tocopherol (0.08 mg), vitamin K (1.7 µg), calcium (181.00 mg), copper (0.299 mg), iron (1.70 mg), magnesium (25.00 mg), manganese (1.672 mg), phosphorus (153.00 mg), potassium (401.00 mg), selenium (14.2 µg), sodium (17.00 mg), zinc (1.16 mg), protein (6.36 g), alanine (0.132 g), arginine (0.634 g), aspartic acid (0.489 g), | [46]       |
| Culinary herb   | Biological sources | Consumption (mg/day) | Nutritional value                                                                                             | References   |
|----------------|--------------------|----------------------|---------------------------------------------------------------------------------------------------------------|--------------|
| Vanilla planifolia | V. planifolia      | 600–1000             | Per 100 g of vanilla contains: niacin (0.425 mg), pantothenic acid (0.035 mg), riboflavin (0.095 mg), thiamin (0.011 mg), vitamin B6 (0.026 mg), calcium (11.00 mg), copper (0.072 mg), iron (0.12 mg), magnesium (12.00 mg), manganese (0.230 mg), phosphorus (6.00 mg), potassium (148.00 mg), sodium (9.00 mg), zinc (0.11 mg) | [47, 48]     |
| Parsley         | P. crispum         | 6000                 | Per 100 g of parsley contains: betaine (1.7 mg), choline (97.1 mg), folate (180.00 μg), niacin (9.943 mg), pantothenic acid (1.062 mg), riboflavin (2.383 mg), thiamin (0.196 mg), vitamin A (97.00 μg), α-carotene (17.00 μg), β-carotene (115.00 μg), cryptoxanthin-β (400.00 μg), lutein + zeaxanthin (2428.00 μg), vitamin B9 (0.900 mg), vitamin C (125.00 mg), vitamin E (8.96 mg), α-Tocopherol (8.96 mg), β-Tocopherol (0.02 mg), γ-Tocopherol (1.53 mg), vitamin K (1359.5 μg), calcium (1140.00 mg), copper (0.780 mg), iron (22.04 mg), magnesium (400.00 mg), manganese (9.810 mg), phosphorus (436.00 mg), potassium (2683.00 mg), selenium (14.1 μg), sodium (452.00 mg), zinc (5.44 mg), protein (26.63 g), alanine (1.778 g), arginine (1.756 g), aspartic acid (3.169 g), cysteine (0.298 g), glutamic acid (3.688 g), glycine (1.756 g), histidine (0.718 g), isoleucine (1.546 g), leucine (2.794 g), lysine (2.098 g), methionine (0.596 g), phenylalanine (1.712 g), proline (2.010 g), serine (1.159 g), threonine (1.193 g), tryptophan (0.475 g), tyrosine (1.159 g), valine (2.021 g) | [49, 50]     |
| Caraway seed    | C. carvi           | 100–150              | Per 100 g of caraway seeds contains: Choline (24.7 mg), folate (10.00 μg), niacin (3.606 mg), riboflavin (0.379 mg), thiamin (0.383 mg), vitamin A (1800 μg), α-carotene (8.00 μg), β-carotene (206.00 μg), Cryptoxanthin-β (16.00 μg), lutein + zeaxanthin (454.00 μg), lycopene (20.00 μg), vitamin B6 (0.360 mg), vitamin C (21.0 mg), vitamin E (2.50 mg), o-tocopherol (250.00 mg), calcium (689.00 mg), copper (0.910 mg), iron (16.23 mg), magnesium (258.00 mg), manganese (1.300 mg), phosphorus (568.00 mg), potassium (1351.00 mg), sodium (17.00 mg), zinc (5.50 mg), protein (19.77 g), alanine (0.914 g), arginine (1.252 g), aspartic acid (2.084 g), cysteine (0.329 g), glutamic acid (3.169 g), glycine (1.322 g), histidine (0.550 g), isoleucine (0.826 g), leucine (1.218 g), lysine (1.031 g), methionine (0.361 g), phenylalanine (0.867 g), proline (0.917 g), serine (0.946 g), threonine (0.756 g), tryptophan (0.244 g), tyrosine (0.642 g), valine (1.037 g) | [51]         |
| PiriPiri        | C. frutescens      | 1000–1200            | Per 100 g of piri piri contains: energy (76.3 calories), total fat (6.6 g), sodium (48.3 mg), potassium (119.8 mg) | [52]         |
| Cummin          | C. cyminum         | 300–600              | Per 100 g of cummin contains: choline (24.7 mg), folate (1000 μg), niacin (4.579 mg), riboflavin (0.327 mg), thiamin (0.628 mg), vitamin A (64.00 μg), α-carotene (762.00 μg), lutein + zeaxanthin (448.00 μg), vitamin B6 (0.435 mg), vitamin C (7.7 mg), vitamin E (3.33 mg), α-tocopherol (3.33 mg), vitamin K (5.4 μg), calcium (931.00 mg), copper (0.867 mg), iron (66.36 mg), magnesium (366.00 mg), manganese (3.333 mg), phosphorus (490.00 mg), potassium (17880.00 mg), sodium (5.2 μg), sodium (168.00 mg), zinc (4.80 mg), protein (17.81 g) | [53]         |
| Chives          | A. schoenoprasum   | 1500–2500            | Per 100 g of cummin contains: choline (5.2 mg), folate (10500 μg), niacin (0.647 mg), pantothenic acid (0.324 mg), riboflavin (0.115 mg), thiamin (0.078 mg), vitamin A (21800 μg), α-carotene (2612.00 μg), lutein + zeaxanthin (323.00 μg), vitamin C (58.1 mg) vitamin E (0.21 mg), α-tocopherol (0.21 mg), vitamin K (212.7 μg), calcium (920.00 mg), copper (0.157 mg), iron (1.60 mg), magnesium (42.00 mg), manganese (0.373 mg), phosphorus (58.00 mg), potassium (296.00 mg), sodium (9.00 μg), sodium (3.00 mg), zinc (0.56 mg), protein (3.27 g), alanine (0.148 g), arginine (0.237 g), aspartic acid (0.303 g), glutamic acid (0.677 g), glycine (0.162 g), histidine (0.057 g), isoleucine (0.139 g), leucine (0.195 g), lysine (0.163 g), methionine (0.036 g), phenylalanine (0.105 g), proline (0.216 g), serine (0.148 g), threonine (0.128 g), tryptophan (0.037 g), tyrosine (0.095 g), valine (0.145 g) | [54, 55]     |
Table 2  Culinary herbs and spices in daily use (Continued)

| Culinary herb | Biological sources | Consumption (mg/day) | Nutritional value | References |
|---------------|--------------------|----------------------|-------------------|------------|
| Mustard       | Brassica nigra     | 1500–2000            | One table spoon full of mustard contains: total fat (3.2 g), total omega-3 fatty acids (205 mg), total omega-6 fatty acids (285 mg), vitamin A (6.8 IU), vitamin C (0.3 mg), vitamin E (0.35mg), vitamin K (0.6 µg), thiamin (0.1 mg), niacin (0.9 mg), folate (8.4µg), choline (13.5mg), betaine (0.2mg), calcium (57.3 mg), iron (1.1 mg), magnesium (32.8 mg), phosphorus (92.5 mg), potassium (75.0 mg), sodium (0.6 mg), zinc (0.6 mg), manganese (0.2 mg), selenium (14.7 µg) | [56] |
| Turmeric      | Curcuma longa      | 500–000              | Per 100 g of curcuma contains: betaine (9.7 mg), choline (49.2 mg), folate (2000 µg), niacin (1.350 mg), pantothentic acid (0.542 mg), riboflavin (0.150 mg), thiamin (0.058 mg), vitamin B6 (0.107 mg), vitamin C (0.7 mg), vitamin E (4.43 mg), α-tocopherol (4.43 mg), β-tocopherol (0.01 mg), γ-tocopherol (0.72 mg), α-tocotrienol (0.12 mg), γ-tocotrienol (0.05 mg), vitamin K1(13.4 µg), calcium (168.00 mg), copper (1.300 mg), iron (55.00 mg), magnesium (208.00 mg), manganese (19.80 mg), phosphorus (299.00 mg), potassium (2080.00 mg), selenium (6.2 µg), sodium (27.00 mg), zinc (4.50 mg), protein (9.68 g), alanine (0.330 g), arginine (0.540 g), aspartic acid (1.860 g), cysteine (0.150 g), glutamic acid (1.140 g), glycine (0.470 g), histidine (0.150 g), isoleucine (0.470 g), leucine (0.810 g), lysine (0.380 g), methionine (0.140 g), phenylalanine (0.530 g), proline (0.480 g), serine (0.280 g), threonine (0.330 g), tryptophan (0.170 g), tyrosine (0.320 g), valine (0.660 g) | [57] |
| Nutmeg        | Myristica fragrans | 100–200              | Per 100 g of nutmeg contains: choline (88 mg), folate (76.00 µg), niacin (1.299 mg), riboflavin (0.057 mg), thiamin (0.136 mg), vitamin A (5.00 µg), β-carotene (28.00 µg), cryptoxanthin-β (66.00 µg), vitamin B6 (0.160 mg), vitamin C (3.0 mg), γ-tocopherol (0.53 mg), calcium (184.00 mg), copper (1.027 mg), iron (3.04 mg), magnesium (183.00 mg), manganese (2.900 mg), phosphorus (23.00 mg), potassium (350.00 mg), selenium (1.6 µg), sodium (16.00 mg), zinc (2.15 mg), protein (8.84 g) | [58, 59] |
| Dill          | Anethum graveolens | 100–250              | Per 100 g of dill contains: folate (10.00 µg), niacin (2.807 mg), riboflavin (0.284 mg), thiamin (0.388 mg), vitamin A (3.00 µg), vitamin B6 (0.250 mg), vitamin C (2.10 mg), calcium (1516.00 mg), copper (0.780 mg), iron (16.33 mg), magnesium (256.00 mg), manganese (1.833 mg), phosphorus (277.00 mg), potassium (1186.00 mg), selenium (12.1 µg), sodium (20.00 mg), zinc (5.20 mg), protein (15.98 g), arginine (1.263 g), histidine (0.320 g), isoleucine (0.767 g), leucine (0.925 g), lysine (1.038 g), methionine (0.143 g), phenylalanine (0.670 g), threonine (0.575 g), valine (1.120 g) | [60] |
| Ginger        | Zingiber officinale | 500–1500             | Per 100 g of ginger contains: betaine (3.4 mg), choline (41.2 mg), folate (13.00 µg), niacin (9.620 mg), pantothentic acid (0.477 mg), riboflavin (0.170 mg), thiamin (0.086 mg), vitamin A (2.00 µg), β-carotene (0.080 µg), vitamin B6 (0.626 mg), vitamin B12 (0.07 mg), vitamin C (0.7 mg), γ-tocopherol (3.01 mg), vitamin K (0.8 µg), calcium (114.00 mg), copper (0.480 mg), iron (19.80 mg), magnesium (214.00 mg), manganese (33.300 mg), phosphorus (168.00 mg), potassium (1320.00 mg), selenium (55.8 µg), sodium (27.00 mg), zinc (3.64 mg), protein (9.08 g), alanine (0.370 g), arginine (0.708 g), aspartic acid (1.387 g), cysteine (0.099 g), glutamic acid (0.790 g), glycine (0.497 g), histidine (0.199 g), isoleucine (0.341 g), leucine (0.513 g), lysine (0.241 g), methionine (0.089 g), phenylalanine (0.311 g), proline (0.334 g), serine (0.250 g), threonine (0.289 g), tryptophan (0.152 g), tyrosine (0.243 g), valine (0.411 g) | [61] |
| Bayberry leaves | Myrica pensylvanica | 450–1350            | Per 13 g of bayberry contains: energy (6 calories), protein (0.07 g), fat (0.03 g), carbohydrate (1.47 g), vitamin A (0.26 µg), vitamin E (0.04 µg), vitamin B1 (0.01 mg), niacin (0.04 mg), vitamin B6 (0.01 mg), folate (3.38 µg), pantothentic acid (0.03 µg), vitamin (0.52 mg), sodium (0.52 mg), potassium (15.6 mg), calcium (0.52 mg), phosphorus (0.65 mg), iron (0.05 mg), zinc (0.01 mg), manganese (0.03 mg) | [62] |
| Common basil  | Ocimum basilicum   | 300–600              | Per 42 g of common basil contains: protein (1.3 g), energy (9.8 calories), carbohydrates (1.1 g), dietary fiber (678 mg), sugar (127 mg), fats (271 mg), omega-3 fatty acids (1194 mg), omega-6 fatty acids (31 mg), vitamin A (2237 IU), vitamin C (7.6 mg), vitamin E (339 µg), vitamin K (176 µg), thiamin (14 µg), riboflavin (32 µg), niacin (382 µg), vitamin B6 (66 µg), folate (29 µg), pantothentic acid (89 µg), choline (4.8 mg), betaine (0.17 mg), calcium (75 mg), iron (1.3 mg), magnesium (27 mg), phosphorus (24 mg), potassium (125 mg), sodium (1.7 mg), zinc (343 µg), copper (163 µg), manganese (487 µg), selenium (0.13 µg) | [63, 64] |
Table 3  Herbal products containing nutrients for different health benefits

| Nutrients            | Health benefits                                                                                                                                  | Herb/Herbal product                                                                                                           | References |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------|
| Fat-soluble vitamins| Vitamin A  Acts as antioxidant, useful for growth, development, and eye sight vision, helps in prevention and treatment of cancers and skin disorders | Aamaranth, spinach, sweet potatoes, carrots, pumpkins, yellow maize, mangoes papayas                                               | [69]       |
|                     | Vitamin D  Useful for bones and teeth development, helps in absorption of calcium from the body                                                  | Solanum lycopersicum, S. tuberosum, Cucurbita pepo, S. glaucophyllum, Nicotiana glauca, Cestrum diumnum, Medicago sativa, Trisetum flavescens, Capsicum annum | [70]       |
|                     | Vitamin E  Acts as antioxidant, helps in formation of blood cells, lungs, muscles and nerve tissue, it also boosts immunity                         | Nuts, spinach, whole grains, olive oil, sunflower oil, coconut, maize, palm, soybean, wheatgerm                                     | [71]       |
|                     | Vitamin K  Helps in clotting of blood                                                                                                             | Kiwifruit, avocado, broccoli, green grapes, and lettuce                                                                        | [72]       |
| Water-soluble vitamins| Vitamin C Acts as antioxidant, maintains healthy bones, teeth and gums, helps in wound healing and cold                                             | Herbal teas and tinctures from rose hips, pine needles, and tree barks                                                          | [73]       |
|                     | Vitamin B1 Helps in conversion of food into energy, useful in neurologic functions                                                              | Whole grain cereals (e.g., brown rice and bran), nuts, dried beans, peas, and soybeans                                            | [74]       |
|                     | Vitamin B3 Helps in conversion of food into energy, useful in brain functions                                                                    | Peanuts, coffee, beans, barley, wheat, rice, potato, soybean, maize                                                          | [75]       |
|                     | Vitamin B6 Helpful in production of essential proteins and convert protein in to energy                                                         | Legumes, nuts, bananas, potatoes                                                                                                  | [76]       |
|                     | Vitamin B12 Helps in production of cells genetic material, aids in formation of red blood cells (RBCs), brain functions, and synthesis of amino acids, helps in metabolism of biomolecules | Boletus sp., Macrolepiota procera, Pleurotus s. treatus, Morchella conica, Craterellus cornucopioides, Cantharellus cibarius, Lentinula edodes, Hericium erinaceus | [77]       |
|                     | Folic acid Helps in production of cells genetic material, first trimester of pregnancy, helps in formation of RBCs, protects body from heart diseases | Leafy vegetables, legumes, citrus fruits                                                                                            | [76]       |
|                     | Pantothenic acid Helps in synthesis of cholesterol, acetylkholine steroids and fatty acids                                                       | whole grain cereals, broccoli                                                                                                    | [76]       |
| Minerals            | Calcium  Helps in strengthening bones and teeth, nerve conduction, functionality of muscle and glands                                             | Orange juice, spinach, soybean, carrots, potato                                                                                   | [78]       |
|                     | Iron     Helps in production of energy production, carrying oxygen to tissues                                                                     | Cereals, pulses, legumes, fruits, and St John’s wort (flowers and leaves), sage (leaves), chamomile (flowers), mint (leaves) and nettle (leaves) | [79, 80]  |
|                     | Magnesium Helps in nerve conduction and muscle function, formation of bone, prevention of premenstrual syndrome                                   | St John’s wort (flowers and leaves), sage (leaves), chamomile (flowers), mint (leaves) and nettle (leaves)                        | [80]       |
|                     | Phosphorous Strengthening strong bones and teeth, formation of cells genetic material, production and storage of energy                          | Margarine oil, corn oil, peanut oil, beans, lentils, rice, maize flour, cornflakes                                                 | [81]       |
| Trace elements      | Chromium Helps in conversion of fats and carbohydrate into energy along with insulin                                                            | Aniseed, basil, cinnamon, garlic, laurel, mint, mustard, nutmeg, onion, oregano, parsley, paprika, pepper, pepper, saffron, thyme, vanilla | [82]       |
|                     | Cobalt   Helps in production of vitamin B12                                                                                                     | legumes, spinach, cabbage, lettuce, beet greens, and figs.                                                                          | [83]       |
|                     | Copper   Helps in formation of hemoglobin and production of collagen, maintains heart functions, helps in energy production and iron absorption from body | Potentilla anserina, Mentha arvensis, Achillea millefolium, Camarum palustre, Lysimachia vulgaris, and Lycopus europaeus      | [84]       |
|                     | Iodine   Maintains thyroid gland functioning                                                                                                     | Fruit, berries, nuts, seeds, potatoes                                                                                            | [85]       |
|                     | Zinc     Aids in reproduction of cells, growth and development in children, helpful in wound healing, generation of                               | St John’s wort (flowers and leaves), sage (leaves), chamomile (flowers), mint (leaves) and nettle (leaves)                      | [80]       |
such as cavacrol and thymol [67]. The pharmacological activities of Thymus vulgaris include antioxidant, anti-inflammatory, immunostimulatory, and antimicrobial properties. It is also effective against different types of cancer cells such as glioblastoma, glioma, breast, leukemia, mastocytoma, hepatocellular, osteosarcoma, cervical, laryngeal, gastric, and neuroblastoma cells. Other activities of T. vulgaris include antihypertensive, antiatherosclerosis, antidiabetic, hepatoprotective, antianxiety, antiepilepsy, antiasthmatic, and antiobesity [68].

Origanum majorana contains p-cymene, terpinen-4-ol, sabinene, α-terpineol, and trans-sabinene hydrate. However, thymol and carvacrol is found most prominently. It has reported antioxidant, antianxiety, anticonvulsant, antidiabetic, antigout, antimutagenic, antiulcer, antibacterial, antifungal, antiprotozoal, insecticidal, and antiovicidal activities.

**Herbs containing nutrients against malnutrition**

Herbal products have been used as a valuable source of natural products for medicinal purposes and maintain the healthy human life since a long ago [30]. The lifestyles of human beings are being changing due to the increasing work, industrial age, longer work schedules, improper diets, low physical activity, and various psychological pressures that led to the incidence of obesity, diabetes, various cancers, and vascular diseases. Noticeably, the advancement in nutrition sciences, the herbal products, and medicinal herbs are gaining extensive attention in the public. People started eating more fruits, vegetables, dietary supplements, culinary herbs, phytotherapeutic substances, and other plant foods. The demand for phytonutrients has enhanced over the past few decades and they are being used by people to fulfill their nutrition [29]. Table 3 shows several herbs and herbal products containing different types of nutrition.

### Conclusion

Malnutrition is a state of imbalance in a person’s intake of energy and/or nutrition. It is a complex interplay between nutrition and socioeconomic status of the country. It has been seen that proper consumption of vitamins and other nutritious food may protect the body from several infections, maintains immunity, and also protects the body from age-related disorders. In certain cases of nutritional deficiencies especially with vitamin B12 and vitamin D, it has been assumed that only non-vegetarians have sufficient amount of this vitamin in their body; however, today we came to know that several herbal sources are available for vegetarians through which they can maintain the level of vitamins in their body. Several herbs, microalgae, sea-inhabiting plants, and other photosynthetic organisms are the rich sources of vitamins and nutrients. Thus, it can be used as natural form of nutritious food.

### Abbreviations

UNICEF: The United Nations International Children’s Emergency Fund; TPC: Total phenolic content; BMR: Basal metabolic rate

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Not applicable.

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**Table 3** Herbal products containing nutrients for different health benefits (Continued)

| Nutrients          | Health benefits                                      | Herb/Herbal product                                                                 | References |
|--------------------|------------------------------------------------------|-------------------------------------------------------------------------------------|------------|
| Vitamin-like compounds |                                                      |                                                                                     |            |
| Biotin             | Regulation of several metabolic functions           | Almonds, peanuts, walnuts, pecans, avocado, sweet potatoes and cauliflower          | [86]       |
| L-carnitine        | Helps in oxidation of fatty acids, excretion of organic acid and help in oxidative phosphorylation | Avocado and asparagus                                                               | [87]       |
| Choline            | Helps in treatment of fatty liver and disturbed fat metabolism | Wheat germ, bacon, dried soybeans, Mustard seed, tomato                            | [88]       |
| Vitamin F          | Helps in development of various membranes and synthesis of prostaglandins, leukotrienes, and fatty acids | Flaxseed, hemp oil, soya oil, canola oil, chia seeds, pumpkin seeds, sunflower seeds, leafy vegetables, walnuts, sesame seeds, and avocados | [89]       |
| Inositol           | Helps in transportation of amino acid, potassium, and sodium | High-bran cereals, fruit, nuts, and beans                                          | [90]       |

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Competing interests
The authors declare that they have no competing of interest.

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