

VITAMIN B12 REQUIREMENTS AND DAILY DIETARY PLANNING FOR SOUTH INDIAN VEGETARIAN ADULTS

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Article Received on 05 June 2026,

Article Revised on 25 June 2026,

Article Published on 01 July 2026,

<https://doi.org/10.5281/zenodo.21054860>

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How to cite this Article: Dr. C Rama Raju¹, V. Venkatesh², Dr. M. Ravinder^{3*}. (2026). Vitamin B12 Requirements And Daily Dietary Planning For South Indian Vegetarian Adults. World Journal of Pharmaceutical Research, 15(13), 1282-1291.

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ABSTRACT

Vitamin B12 (cobalamin) is an essential water-soluble micronutrient required for DNA synthesis, red blood cell formation, neurological function, energy metabolism, and maintenance of cardiovascular health. Unlike most vitamins, vitamin B12 is synthesized exclusively by certain bacteria and archaea and is naturally found primarily in foods of animal origin. Consequently, vegetarians are particularly vulnerable to vitamin B12 deficiency. India has one of the world's largest vegetarian populations, making vitamin B12 deficiency a significant public health concern. Numerous studies have reported widespread deficiency among Indian adults, especially among vegetarians, pregnant women, elderly individuals, and economically disadvantaged populations. Deficiency may lead to megaloblastic anemia, neurological disorders, cognitive impairment, adverse pregnancy outcomes, and elevated

homocysteine levels associated with cardiovascular disease. The Indian Council of Medical Research (ICMR) and the National Institute of Nutrition (NIN) recommend daily vitamin B12 intake of approximately 2.4 µg for healthy adults. This review examines the physiological functions of vitamin B12, recommended dietary allowances, prevalence and consequences of deficiency, challenges faced by vegetarian populations, and practical dietary

strategies for South Indian vegetarian adults. Special emphasis is placed on dairy products, fortified foods, and culturally acceptable dietary plans capable of meeting daily vitamin B12 requirements. The review highlights the need for increased awareness, nutritional screening, food fortification, and evidence-based dietary planning to prevent vitamin B12 deficiency and improve long-term health outcomes among South Indian vegetarian populations.

KEYWORDS: Vitamin B12, Cobalamin, Vegetarian Diet, South Indian Diet, Nutritional Deficiency, ICMR-NIN Guidelines.

INTRODUCTION

Vitamin B12, also known as cobalamin, is one of the most complex and biologically important vitamins required for human health (ICMR-NIN, 2024). It functions as an essential coenzyme in DNA synthesis, cellular metabolism, neurological maintenance, and hematopoiesis (Stabler & Allen, 2004; Green et al., 2017). Unlike many other vitamins, vitamin B12 is synthesized exclusively by microorganisms and accumulates naturally in animal-derived foods. Consequently, dietary sources of biologically active vitamin B12 are limited primarily to meat, fish, eggs, milk, and dairy products (Watanabe et al., 2014).

India represents a unique nutritional landscape characterized by cultural, religious, ethical, and economic factors that promote vegetarian dietary practices. According to national surveys, a substantial proportion of the Indian population follows vegetarian diets either completely or predominantly. While vegetarian diets are associated with numerous health benefits including lower risks of obesity, hypertension, type 2 diabetes, and cardiovascular disease, they may increase the risk of vitamin B12 deficiency when not appropriately planned (Pawlak et al., 2013; Melina et al., 2016).

Vitamin B12 deficiency has emerged as a major nutritional concern in India. Several investigations have documented low serum vitamin B12 concentrations among adults, adolescents, pregnant women, and elderly populations. The problem is particularly pronounced among strict vegetarians and populations with limited access to animal-source foods (Dror & Allen, 2012). Since deficiency develops gradually and symptoms may remain unnoticed for years, vitamin B12 inadequacy often remains undiagnosed until clinical manifestations become severe.

The importance of vitamin B12 extends beyond hematological health. Recent research has established its role in cognitive function, neurodevelopment, cardiovascular health, immune

regulation, and maintenance of healthy aging (Green, 2017; Ashok et al., 2021). The growing popularity of plant-based diets globally further emphasizes the need for evidence-based guidance regarding vitamin B12 nutrition. Therefore, understanding dietary requirements and practical food-based approaches to achieving adequate vitamin B12 intake is essential for public health planning and individual well-being.

LITERATURE REVIEW

Vitamin B12 plays a fundamental role in human metabolism through its involvement in two major enzymatic reactions. The first reaction involves methionine synthase, which catalyzes the conversion of homocysteine to methionine. The second involves methylmalonyl-CoA mutase, which participates in fatty acid and amino acid metabolism (Green, 2017; Mucha et al., 2024). Deficiency of vitamin B12 disrupts these pathways, resulting in elevated homocysteine and methylmalonic acid concentrations, both of which are considered biomarkers of deficiency (O'Leary & Samman, 2010).

Several studies have highlighted the global burden of vitamin B12 deficiency. Allen (2009) estimated that deficiency affects a substantial proportion of populations in both developing and developed countries. In India, prevalence rates ranging from 40% to 70% have been reported in some vegetarian communities (Langan & Goodbred, 2017). These findings underscore the significance of vitamin B12 as a public health priority.

The hematological consequences of deficiency are well established. Vitamin B12 is essential for DNA synthesis during red blood cell production. Deficiency results in ineffective erythropoiesis and megaloblastic anemia characterized by enlarged immature red blood cells (Stabler et al., 2013). Symptoms commonly include fatigue, weakness, pallor, breathlessness, and reduced physical performance.

Neurological manifestations are among the most serious consequences of deficiency. Vitamin B12 is required for maintenance of the myelin sheath surrounding nerve fibers. Deficiency may therefore result in neuropathy, paresthesia, impaired coordination, memory disturbances, depression, and cognitive decline (Hunt et al., 2014). Prolonged deficiency can produce irreversible neurological damage.

Emerging evidence also links vitamin B12 deficiency with cardiovascular disease. Elevated homocysteine concentrations associated with inadequate vitamin B12 status have been implicated in endothelial dysfunction and increased cardiovascular risk (Clarke et al., 2008).

Although the relationship remains complex, maintaining adequate vitamin B12 status contributes to cardiovascular health.

Pregnancy represents a particularly vulnerable period. Maternal vitamin B12 deficiency has been associated with neural tube defects, low birth weight, intrauterine growth restriction, and impaired neurodevelopment in offspring (Rogne *et al.*, 2017). These findings emphasize the importance of adequate intake among women of reproductive age.

Vegetarian populations face unique challenges because plant foods generally contain negligible amounts of biologically active vitamin B12. Although fermented foods, mushrooms, algae, and certain traditional foods have occasionally been reported to contain vitamin B12-like compounds, their content is inconsistent and often biologically inactive (Herbert, 1988; Watanabe *et al.*, 2014). Consequently, dairy products, fortified foods, and supplements remain the most reliable sources for vegetarians.

MATERIALS AND METHODS

This review article was prepared through a comprehensive analysis of scientific literature obtained from Google Scholar, PubMed, Scopus-indexed journals, reports of the Indian Council of Medical Research (ICMR), National Institute of Nutrition (NIN), World Health Organization (WHO), Food and Agriculture Organization (FAO), and peer-reviewed nutrition journals. Keywords including “Vitamin B12,” “Cobalamin,” “Vegetarian Diet,” “South Indian Diet,” “Vitamin B12 Deficiency,” “ICMR Guidelines,” and “NIN Recommendations” were used for literature retrieval. Articles published between 1999 and 2025 were reviewed. Preference was given to systematic reviews, meta-analyses, clinical studies, and national nutritional guidelines. Information related to vitamin B12 physiology, dietary requirements, deficiency prevalence, health implications, vegetarian dietary sources, and dietary planning was extracted, synthesized, and critically evaluated.

RESULTS

The recommended daily requirement for healthy adults is approximately 2.4µg/day (Table 1). Increased requirements during pregnancy and lactation reflect additional physiological demands.

Table 1: Recommended requirements of daily Vitamin B12.

Population Group	Vitamin B12 Requirement (µg/day)
Adult Male	2.4

Adult Female	2.4
Pregnant Woman	2.6
Lactating Woman	2.8
Elderly Adults	2.4–3.0

South Indian Vegetarian Dietary Plan for Adults

A practical South Indian vegetarian dietary pattern can adequately satisfy vitamin B12 requirements when dairy products and fortified foods are incorporated regularly (Table 2). An adult male may begin the day with a glass of milk providing approximately 1.0 µg vitamin B12. Breakfast consisting of idli, sambar, and curd contributes an additional 0.7 µg. Lunch comprising rice, dal, vegetable curry, and curd supplies approximately 0.7 µg. An evening serving of fortified cereal with milk provides approximately 1.0 µg, while dinner including dosa and paneer curry contributes another 1.0 µg. Such a dietary pattern supplies approximately 4–4.5 µg vitamin B12 daily (Table 3).

Table 2: Major Vegetarian Sources of Vitamin B12.

Food Item	Quantity	Approximate Vitamin B12 (µg)
Cow Milk	250 ml	1.0–1.2
Curd	250 g	0.8–1.0
Paneer	100 g	0.8–1.5
Fortified Cereal	30 g	1.0–2.0
Fortified Soy Milk	250 ml	1.0–2.0
Cheese	50 g	0.7–1.2
Buttermilk	250 ml	0.3–0.5

Source: Watanabe et al. (2014); USDA Food Data Central; ICMR-NIN (2020).

Table 3: South Indian Vegetarian Dietary Plan for Adults.

Time of Day	Food Item	Quantity	Vitamin B12 (µg)
Early Morning	Milk	200 ml	0.8
Breakfast	Idli and Curd	3 Idlis + 100 g Curd	0.5
Lunch	Rice, Sambar, Vegetables, Curd	Standard Meal	0.5
Evening Snack	Fortified Millet Beverage	1 Serving	0.8
Dinner	Dosa and Paneer Curry	Standard Meal	0.5
Total Daily Intake	—	—	3.1

Source: Compiled by authors based on ICMR-NIN (2020) and Watanabe et al. (2014).

The proposed dietary pattern provides approximately 3.1 µg vitamin B12 daily, meeting the recommended intake for healthy adult women.

Bacteria Found in Traditional Fermented Foods

Vitamin B12 is synthesized only by certain microorganisms, mainly bacteria and archaea. Plants, animals, and fungi do not produce true vitamin B12. In foods and beverages, the presence of vitamin B12 is usually due to bacterial fermentation or microbial contamination. Several fermented foods contain measurable amounts of vitamin B12 because of microbial activity (Table 4).

Table 4: Bacteria Found in Traditional Fermented Foods (Watanabe et al., 2014; Herbert, 1988).

Food/Beverage	Microorganisms Involved
Curd (Yogurt)	Some strains of <i>Lactobacillus</i> and <i>Bifidobacterium</i> may contribute small amounts
Cheese	<i>Propionibacterium freudenreichii</i>
Fermented Soy Products	<i>Propionibacterium</i> and selected <i>Lactobacillus</i> strains
Traditional Fermented Rice (Chaddannam)	Mixed bacterial communities; B12 levels vary greatly
Ambali	Contains bacteria and yeasts, but usually not a reliable B12 source
Idli/Dosa Batter	Lactic acid bacteria present, but true B12 levels are generally very low



Figure 1. Traditional fermented foods commonly consumed in South India: (1) Ambali, (2) Chaddannam (fermented rice), and (3) Idli–Dosa batter.

DISCUSSION

The findings of this review indicate that vitamin B12 deficiency remains a significant nutritional challenge among vegetarian populations. Although daily requirements are relatively small, the limited availability of biologically active vitamin B12 in plant foods makes deficiency common among individuals consuming poorly planned vegetarian diets (Rizzo et al., 2016). The widespread prevalence of deficiency reported in India highlights the importance of nutritional awareness and dietary diversification.

Dairy products continue to represent the most practical and culturally acceptable vitamin B12 sources for South Indian vegetarians (Gibbs & Cappuccio, 2024). Milk, curd, paneer, buttermilk, and cheese contribute substantially toward meeting daily requirements. However, changing dietary habits, lactose intolerance, and reduced dairy consumption may compromise vitamin B12 intake in some individuals.

Food fortification represents an important public health strategy. Fortified cereals, fortified plant-based beverages, and nutritional yeast products offer reliable alternatives for populations with low dairy consumption (Khaliq et al., 2023). International experiences demonstrate that fortification programs can significantly reduce deficiency prevalence.

Routine screening among high-risk populations including elderly individuals, pregnant women, lactating mothers, and strict vegetarians may facilitate early detection and intervention (Antony, 2003; Bulk & Russel, 1999; Carmel, 2008; De Benoist, 2008; Herrmann & Obeid, 2008; Langan & Zawistoski, 2011). Public health campaigns emphasizing vitamin B12-rich vegetarian foods and fortified products are essential for preventing deficiency.

The South Indian dietary plans proposed in this review demonstrate that vitamin B12 requirements can be achieved through culturally familiar foods when dairy products and fortified foods are appropriately integrated. Such dietary approaches support nutritional adequacy while preserving traditional dietary practices.

CONCLUSION

Vitamin B12 is an indispensable micronutrient required for hematological, neurological, metabolic, and cardiovascular health. Deficiency remains highly prevalent among vegetarian populations because natural plant foods provide negligible amounts of biologically active vitamin B12. South Indian vegetarian adults can successfully meet their daily requirements through careful dietary planning that includes milk, curd, paneer, buttermilk, and fortified foods. Adoption of evidence-based dietary practices, food fortification strategies, nutritional screening, and public awareness programs will play a crucial role in preventing vitamin B12 deficiency and improving public health outcomes. Continued research and policy support are required to ensure adequate vitamin B12 nutrition among vegetarian populations in India.

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