# REAL VITAMIN B12 IN NORI AND ITS POTENTIAL GROWTH IN INDIA

A PROJECT WORK
SUBMITTED IN THE PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE AWARD OF THE DEGREE OF
MASTER OF SCIENCE
IN
**CHEMISTRY**

SUBMITTED BY:
**BHARTI (2K21/MSCCHE/10)**

Under the supervision of

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**CANDIDATE'S DECLARTION**

I , Bharti (2K21MSCCHE/10) hereby certify that the work which is being submitted in this major project report "Real vitamin b 12 in nori and its potential growth in India" in the partial fulfillment for the award of the degree of Master of Science (Chemistry) at Delhi Technological University is an authentic Record of my own work carried out by me under supervision of Dr. Anil Kumar(Department of Applied Chemistry and polymer Technology ,DTU ) .

I, further declare that the project report has not been submitted to any other Institute/university for the award of any degree or diploma or any other purpose whatsoever. Also it has not been directly copied from any source without giving proper reference.


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**Place: Delhi**

**Date: 23/05/23**

# ACKNOWLEDGEMENT.

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I appreciate everyone who has supported my research and made this thesis possible.

Bharti Gahlot

# Dedication

I would like to dedicate my work to my adoring parents, my brother and close friends, who inspired me throughout my learning journey, and every person dedicated to science and the betterment of society.

***Thank you***

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# CERTIFICATE

I/We hereby certify that the Project Dissertation titled " Real vit -b12 in Nori(purple laver ) and its potential growth in India" which is submitted by Bharti (2K21/MSCCHE/10) , Department of Applied Chemistry, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the Master of Science, is a record of the project work carried out by the student under my supervision. To the best of my/our knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

**Place: Delhi** **Prof. Dr Anil kumar**

**(Supervisor)**

**Date: 23/05/2023**


# ABSTRACT

As a substantial marine crop, Porphyra sp. (nori) is widely cultivated. One of the many minerals present in dried nori is vitamin B12, which is the only vitamin absent from diets manufactured from plants. Vegetarian diets are deficient in iron and vitamin B12, which can cause severe anaemia. Nori also has a lot of iron incomparison to other plant-based foods. Since nori has several bioactive compounds with different pharmacological effects, eating it is healthy for human health. Dried Porphyra sp. (nori) contains a variety of minerals, including vitamin B12 (B12), bioactive chemicals coenzyme forms (49%OH-B12, 33%CH3-B12, and 18% AdoB12), and pseudo vitamin B12, which is inactive in human bodies. From nutritional sources consisting of plants, .Only vitamin B12 is absent from dietary sources derived from plants. As a result, pure vegans are more susceptible to developing a B12 deficiency than non-vegetarians. The greatest B12 supplement for vegetarians available right now is nori. All of the Korean laundry products examined, as determined by a silica gel 60 thin layer chromatography-bioautogram examination, contained genuine vitamin B12 and not inactive corrinoid. Korean purple laver products make great sources of vitamin B12. Using the microbiological vitamin B12 test technique, the vitamin B12 content of many Korean purple laver products was examined. Seaweed may be found in great quantities around the beaches of Gujarat, Lakshadweep, and the Andaman & Nicobar Islands. Many populations of seaweed that are crucial to the Indian economy may flourish luxuriantly thanks to the variety of coastal ecosystems that surround it. These resources provide a great deal of potential for the development of seaweed-based industries in India. Additionally, since half of Indian soil has been exhausted owing to soil degradation, alternative food sources must be found. Its cultivation in India might lead to the creation of more than 50 million new jobs. Finding a new alternative food supply is necessary since soil degradation has already exhausted half of India's soil. A new seaweed sector, a rise in GDP, better ocean productivity, reduced algal blooms, increased carbon sequestration, and other benefits from India's seaweed agriculture. The production of seaweed, often known as nori, has a promising future because of the numerous advantages it offers to the economy and ecology.

**Keywords**; Porphyra (sp.), bioactive , bioautogram, luxuriantly, coastlines

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# 1. Introduction

## 1.1 Origin and background

In many parts of the world, algae have long been used as sustenance for people. The main source of nourishment is algae. It contains far more nutrients and minerals than any other food source available today. Over 70 different types of marine algae are consumed, including spirulina, chlorella, laminarin, and sargassum. According to reports, the majority of the vitamin B12 included in seaweeds is an inactive analogue except Nori ,which means that mammals may not be able to absorb it. They are used as dietary supplements by astronauts. The only vitamin missing from food generated from plants is vitamin B12, which is present in dried nori in large amounts. Traditional Asian dishes include .

Foods contain a variety of vitamin B12 compounds with various upper ligands; methyl cobalamin and 59-deoxyadenosylcobalamin serve as coenzymes of methionine synthase, which is involved in the biosynthesis of methionine, and of methylmolonyl CoA mutase, which is involved in the metabolism of amino acids and odd-chain fatty acids in mammalian cells. All Korean laundry products examined included real vitamin B12 but not inactive corrinoid chemicals, according to silica gel 60 thin layer chromatography-bioautogram examination. These findings imply that Korean purple laver products would be great sources of vitamin B12 for people, particularly vegetarians. The microbiological vitamin B12 test technique was used to assess the vitamin B12 content of several Korean purple laver products. While dried purple laver had a significant quantity (133.8 g/100 g) of vitamin B12, seasoning and toasting it increased its absorption .

The coastlines of India and the Andaman & Nicobar Islands all have an abundance of seaweed. Asia has practiced the ancient practice of algae cultivation for many years. It is currently becoming more well-known around the world. Growing algae offers various advantages .The Indian coastline, with its unique coastal habitats, promotes the luxuriant growth of numerous algae populations, having significant economic relevance. India has the capacity to generate around 9.7 million tonnes of seaweed annually. Our effort include boosting nori (Porphyra sp.) production or cultivation in order to include these nutritious food items in our diet**.**

In many different ways, algae is used in the functional foods of the future. Algae provides a supply of vitamins that are unavailable from soy, and there is also one vitamin that is also unavailable from spinach. It is vitamin B12, which is frequently lacking in plant-based diets as it is mostly found in meat, fish, dairy, and eggs. Algae do not produce B12 on their own; instead, they take it from the water they are in. They can be found in both fresh and salt water, on soil and rock, as epiphytes or parasites on plants and animals, in hot springs in the desert, on permanent snow fields, etc., although they mostly live in fresh water.

Among seaweeds, dried lavers (nori) appear to be the most widely consumed, and it has been reported that they contain significant amounts of B12, which is measured using a radioisotope dilution assay (RIDA) with hog intrinsic factor and/or a Lactobacillus leichmannii ATCC 7830 microbiological method (IF). The B12 analogues inert for humans as well as intact B12 and both deoxyribosides and deoxynucleotides may substitute for B12 in L. leichmannii ATCC 7830 used to determine the amount of B12 in meals. The importance of vitamin B12 for maintaining healthy neurons, blood cells, and DNA cannot be overstated. This vitamin is naturally present in animal products (red meat , fish , eggs dairy products). Foods made from plants don't naturally contain this vitamin. Pernicious anaemia and other major health issues can result from a vitamin B12 deficiency.

Malnutrition and anaemia continue to be major health concerns in India, according to the most recent National Family Health Survey (NFHS-4), which was performed in 2015–16. Low haemoglobin concentration in the blood is what causes anaemia. Around

2 million people worldwide, or about one-third of the population, are anaemic. The world's highest rate of anaemia is seen in India. Nori is not only the source of b12 but also contain large amount of essential nutrients required for healthy body and immune system.

Rats lacking in vitamin B12 were fed the lyophilized purple laver (Porphyra yezoensis), and the effects of feeding the laver on various vitamin B12 parameters wereexamined. The urine methylmalonic acid excretion of vitamin B12-deficient rats that were fed a meal containing dry purple laver (10 lg vitamin B12/ kg food) became undetectable after 20 days, and the levels of hepatic vitamin B12 (particularly coenzyme vitamin B12) dramatically increased. These findings suggest that rats can absorb vitamin B12 from purple lavers.

# 2. Methods Of Analysis

## 2.1 METHODS USED TO DETERMINE THE GENUINE VIT-B12 IN B12 COMPOUNDS

### 2.1.1 MATERIALS AND METHODS Materials

Sigma provided the B12, pepsin (P7012, from swine gastric mucosa), and pancreatine (P8096, from pig pancreas) (St. Louis, MO). Nissui provided a B12 test medium for Lactobacillus delbrueckii subspecies lactis (formerly L. leichmannii) ATCC7830 (Tokyo, Japan). Aluminum sheets for thin layer chromatography (TLC) on silica gel 60 were purchased from Merck (Darmstadt, Germany). The turbidity of L. delbrueckii test cultures was determined using an ultraviolet/visible spectrophotometer (460, JASCO Company, Tokyo, Japan) for the microbiological B12 assay. The highest purity commercially available reagents were employed for all other applications. Korean purple lavers (dried, seasoned, and toasted) test samples were obtained from neighbou`11`1rhood stores in Seoul, Korea. We bought dried Japanese purple lavers (Iwa-nori) at neighbourhood markets in Tottori and Kanazawa.

### 2.1.2. Extraction and Assay of Vitamin B12.

The samples were composed of two grammes of varied purple lavers. According to the procedure outlined in the Japanese Standard Tables of Food Composition, total B12 was extracted by boiling various B12 compounds with different R-ligands (such as coenzyme forms of B12) to cyanocobalamin (CN-B12), which was then measured using L. delbrueckii ATCC 7830. The quantity of genuine B12 was determined by subtracting the values of the alkali-resistant factor from the values of total B12 since L.delbrueckii ATCC 7830 may utilise both deoxyribosides and deoxyribonucleotides (known as an alkali-resistant factor) as well as B12.

### 2.1.3 Bioautography of Vitamin B12 Compounds with Vitamin B12 Dependent Escherichia coli 215 .

Bioautography of B12 compounds was done according to the method of the reference cited (8). After the B12 extracts preparedabove were partially purified with a Sep-Pak Plus C18 cartridge (Waters Corporation, Milford, MA), 0.5 µL of the purified B12 extracts and 2 µL of authentic B12 (cyanocobalamin, 10 µg/L) were spotted on the silica gel 60 TLC sheet and developed with 2-propanol/NH4OH (28%)/water (7:1:2 v/v) in the dark at room temperature(25 °C). The TLC sheet was dried before being covered with agar containing basal medium and precultured E. coli 215 and incubated at 30 °C for 20 hours. B12compounds were seen as red in a methanol solution of 2,3,5-triphenyltetrazolium salt on the gel plate.

### 2.1.4 Toasting Treatment.

A sheet of the dried Korean purple laver was toasted for a few minutes over a fire with a gas range until the laver's colour was changed from purple to green. The toasted laver sheet was left for 3 h at 25 °C. B12 was extracted from the dried laver sheets with or without the toasting treatment and analyzed with TLC-bioautography .

## 2.1.5 Analysis of Coenzyme Forms of Vitamin B12

By boiling the dried Korean purple laver in an 80% (v/v) ethanol solution, B12 components were recovered . The purple laver (2 g weight) received 100 millilitres of an 80% (v/v) ethanol solution before being heated at 98 °C for 30 minutes under reflux conditions and cooled to room temperature. For 10 minutes, the fluid was centrifuged at 10,000 g. The supernatant was dissolved in 20 mL of distilled water after being allowed to evaporate to dryness under decreased pressure. To get rid of the insoluble components, the solution was centrifuged at 10,000g for 10 minutes. After washing with 5 mL of a 75% (v/v) ethanol solution and equilibrating the Sep-Pak Plus C18 cartridge (Waters Corporation), a portion of the supernatant fraction was applied to it.

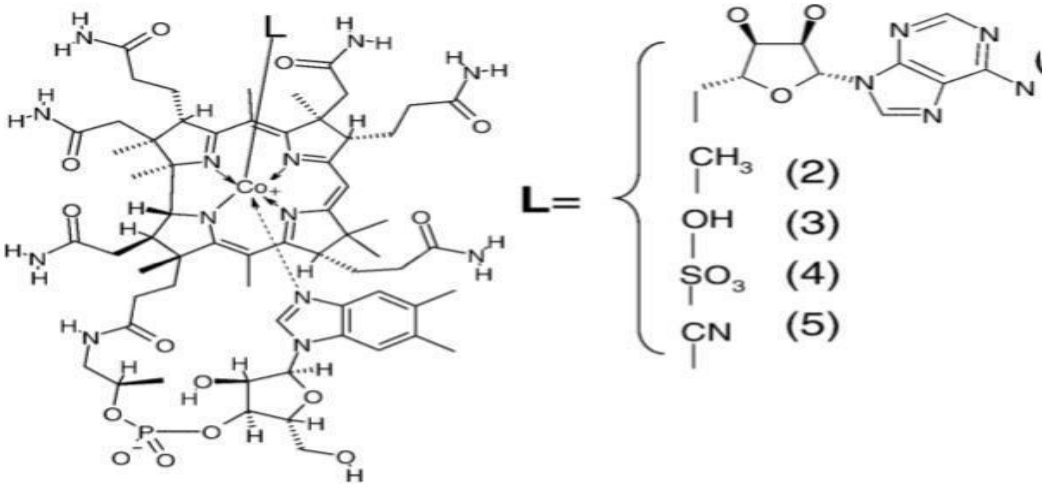


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Fig.1. Structural formula of vitamin B12 and partial structures of vitamin B12 compounds. The partial structures of vitamin B12 compounds show only those portions of the molecule that differ from vitamin B12. 1: 59-deoxyadenosylcobalamin; 2, methylcobalamin; 3, hydroxocobalamin; 4, sulfitocobalamin; 5, cyanocobalamin or vitamin B12

| | Energy (kcal) | Vegetable fiber (g) | Mineral | | | Vitamin | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Calcium (mg) | Potassium (mg) | Iron (mg) | A (μg) | B1 (mg) | B2 (mg) | C (mg) |
| Nori | 188 | 36 | 280 | 2,400 | 11.4 | 2,300 | 0.69 | 2.33 | 210 |
| Fresh Milk | 67 | 0 | 110 | 150 | Tr | 38 | 0.04 | 0.15 | 1 |
| Egg | 151 | 0 | 51 | 130 | 1.8 | 150 | 0.06 | 0.43 | 0 |
| Boiled spinach | 25 | 3.6 | 69 | 490 | 0.9 | 450 | 0.05 | 0.11 | 19 |
| Lemon fruit | 26 | Tr | 7 | 100 | 0.1 | 1 | 0.04 | 0.02 | 50 |
| Boiled soybeans | 180 | 7 | 70 | 570 | 2 | Tr | 0.22 | 0.09 | Tr |
| Pork | 263 | 0 | 4 | 310 | 0.3 | 6 | 0.69 | 0.15 | 1 |
| Cow lever | 132 | 0 | 5 | 300 | 4 | 1,100 | 0.22 | 3 | 30 |

**Table 1. Nori Nutrition and Comparison with Other Food Articles**

***Per serving 100g (Full size Nori 33 sheets)***

## 3.3 Reasons to Add Nori to Your Daily Diet

### 3.3.1. Source of vitamin C

Ten toasted Nori sheets have around 1.5 times the vitamin C as one mandarin orange. Vitamin C lowers melanin synthesis, prevents skin spots, and aids in the fading of blemishes. Another benefit is that habitual smokers lose vitamin C as a result of smoking. In general, vitamin C is not heat resistant, so heating food will usually destroy it. Nori's vitamin C, on the other hand, is heat-resistant and facilitates efficient vitamin C intake.

### *3.3.2* Dietary fiber cleans you out

Around one-third of nori is made up of dietary fibre, which is more than spinach possesses. Fibre is well known for helping to promote normal bowel function, which reduces the constipation that many women commonly suffered, lowers blood cholesterol, and protects against diabetes, colon cancer, and other geriatric disorders. The fibre in nori is said to be softer (more malleable) than the fibre in vegetables. This element reduces the likelihood that fibre will damage the intestinal or stomach wall. Additionally, it is claimed that softer fibre helps the gut flora produce vitamins and remove harmful amines and metals from the colon.

### *3.3.3* Nori for children

Nori contains 12 distinct vitamins. Two Nori sheets may provide the 500 ug of vitamin A that a child requires each day. Nori is suggested for your child who has trouble eating enough vegetables.

### *3.3.4* Vitamin B1 and B2 recover fatigue

The equivalent of one slice of pork shoulder loin (30 g) or around three sheets of nori corresponds to the daily need of vitamins B1 and B2 for an adult woman. Because vitamins B1 and B2 are efficient at turning carbohydrates into energy, taking all three of those vitamins should help you recover from weariness more quickly. We assume the Japanese "Onigiri" is a very unusual and well-planned creation (rice ball, carbohydrate with Nori, and vitamin B1/B2 close).

### *3.3.5* Iron for anaemia,

Frequently, spinach and liver are paired. We wish to offer a novel idea. The iron content of 5 sheets of nori is comparable to a piece of beef liver (about 40g), a bunch

of cooked spinach, 8 bottles of milk (1 200cc), and 1.7 eggs. Use liver, spinach, and nori as sources of iron.

### *3.3.6* Calcium reduces irritation

Nori is a rich source of minerals, especially calcium and iodine, which are usually deficient in modern society. Two Nori sheets have the same amount of calcium in them as 15 cc of milk and one-half of an egg. Calcium not only helps to maintain strong bones but also lessens inflammation and guards against osteoporosis. It is very recommended to consume adequate calcium for pregnant women and children.

### *3.3.7* Rich in EPA

Nori contains large amounts of beta-carotene and eicosapentaenoic acid (EPA). Beta-carotene is a well-known vitamin for avoiding cancer. Sardines and saury are examples of blue fish that contain EPA, a fatty acid. It is a vitamin that has gained a lot of attention recently since it reduces triglycerides and bad cholesterol, which cause obesity and help to develop lifestyle diseases..

### *3.3.8* Taurine protects against lifestyle disorders

Nori has a lot of taurine as well. Taurine lowers bad cholesterol. Less poor cholesterol should lower the risk of vascular disorders, myocardial infarction, heart failure, and cerebral thrombosis. In addition, it could help with hangovers, diabetes, endometriosis, and chronic hepatitis.

# 3. STATUS AND POTENTIOAL

## 3.1 RESOURCES AND POTENTIOAL IN INDIA

There are about 216 species of green algae in India, 434 species of red algae, 194 species of brown algae, and 844 species of seaweed that have been found in Indian oceans. For the manufacture of agar, the Red Algae Gelidiella acerosa, Gracilaria edulis,
G. crassa, G. foliifera, and G. verrucosa, and the Brown Algae Sargassum spp., Turbinaria spp., and Cystoseira trinodis are farmed. The issue is that there are now not enough seaweeds accessible to satisfy the raw material needs of the Indian seaweed businesses. Seaweed seed stock is typically gathered from the sea floor in shallow waters along Tamil Nadu's southeast coast. Seaweed farming is a highly lucrative enterprise employing straightforward, low-tech methods.

The coastlines of Gujarat, Lakshadweep, and the Andaman & Nicobar Islands all have an abundance of seaweed. Around Bombay, Ratnagiri, Goa, Karwar, Varkala, Vizhinjam, and Pulicat in Tamil Nadu, Andhra Pradesh, and Chilka in Orissa, there are rich seaweed beds. The various coastal environments throughout the Indian coastline enable the luxuriant growth of several populations of seaweed, which are significant economically. There is a lot of promise in those resources for the growth of seaweed-based enterprises in India. Large seaweed resources have been found in South India's coastal belts according to studies conducted by the Central Salt and Marine and Chemical Research Institute (CSMCRI), the Central Marine Fisheries Research Institute (CMFRI), and other research institutions.


Fig. 2. Seaweed Cultivation region in India.

### 3.2 CULTIVATION IN INDIA

In shallow coastal waters of maritime States, where Bamboo-Raft or Tube-Nets would be kept in clusters, would be chosen as the best location for seaweed farming. The location for developing seaweed farming will be determined and chosen by a committee made up of officials from the State Fisheries Department and the CSIR-Central Salt and Marine Chemicals Research Centre (CSMCRI), Bhavnagar, Gujarat. The Department of Fisheries of Coastal States would serve as the Implementing Agency, CSIR-

CSMCRI as the technological partner, and NFDB as the source of funding. The criteria used to choose suitable locations for seaweed cultivation include stable seawater with a salinity of at least 30 ppt, a sandy or rocky bottom with transparent water, ideal temperatures of 26 to 30 oC, and a minimum water depth of 1.0 m at low tide.

In the next five years, the Indian government intends to increase the country's seaweed output from 2,500 tonnes to 11,500 tonnes.

Since seaweed is not a part of our traditional culinary culture, it has taken years for nori product-based enterprises in India to increase their level of production.

In the instance of Japan, more than 600 km2 of the country's coastline are used to generate 350 ,000 tonnes of nori, which is equivalent to an estimated one billion dollars in revenue. Beneficiaries include coastal fishing families, particularly fishing women, their societies and SHGs, and farmers and business owners. The project will be carried out using a cluster approach, with certain beneficiaries included in each cluster.

The grantee will carry out the project with technical assistance from the State Government's Department of Fisheries.

Nori farming gives thousands of individuals an employment opportunity in addition to being an extra source of nourishment.

Governmental funding is also needed to build up the entire project employing new technologies at a higher level.

Agar-yielding red seaweeds like Gelidiella acerosa and Gracilaria edulis and algin-yielding brown seaweeds like Sargassum and Tubineria make up the majority of the seaweed business in India, which is mostly a cottage industry.

Currently, the majority of seaweed produced in India is utilised as a plant growth regulator, which lowers the need for fertilisers by around 13%. Additionally, they are utilised in several sectors, including the food, cosmetics, pharmaceutical, and neutraceutical industries. These materials made from seaweed are now being imported by Indian businesses from other nations. Seaweed farming, in contrast to other kinds of aquaculture, has little financial and technological requirements and offers significant economic prospects to underdeveloped coastal communities with few other alternatives for subsistence.

We must understand that modern agriculture is necessary for both the cultivation and processing of nori seaweed. Fortunately, despite its complexity, the biology of porphyria is now well known.

Nori grows swiftly; it only takes 45 days from seeding to the first harvest. After then, it is possible to practise numerous harvests from a single seeding, which is often done every 10 days. Nori seaweed is harvested using specially designed mechanical harvesters. The raw material is processed completely, mostly by highly automated equipment that accurately mimic the old-school hand processing methods.

The idea that it seems like the majority of farmers in rural areas are content with a certain minimal level of income can occasionally be challenging for profit-driven investors. Once that point is achieved, this majority frequently loses interest. Becauseof this, the remaining 20% of the workforce often provides 80% of the production. Once that point is

achieved, this majority frequently loses interest. This is the reason that the remaining 20% of motivated farmers, on average, provide 80% of the produce.

The overexploitation of raw materials that results in scarcity and poor quality raw materials, labour shortages during the paddy harvesting and transplanting season, a lack of technology to enhance the quality of processed products, and a lack of knowledge about new and alternative raw material sources are the main issues facing the seaweed industry. Despite the abundance of protected bays and lagoons ideal for mariculture, no significant attempts to produce seaweed on a wide scale have been attempted in India to far. Improved harvesting practises, the eradication of rival species, the construction of artificial habitats, and the sowing of cleared land are all necessary to boost productivity. Since dependable techniques for growing a variety of economically significant seed stocks and improving them have either previously been discovered or are now the subject of study The development of new products and methods for using seaweed might contribute to increasing the value of all fisheries exports while also ensuring the food and nutritional security of the Indian population. Porphyra (nori), in particular, has a crucial role to play in improving coastal fishing communities and serving as a significant source of foreign cash. The current situation calls for the training, encouragement, and promotion of the coastal fishermen population at suitable locations, with the help of the state governments, research facilities, seaweed industry, Marine Products Export Development Authority (MPEDA), and local NGOs. This will help them adopt commercially viable large-scale

culture technologies, and will also give them access to good marketing facilities through the appropriate channels.

## 3.4 Advantages and challenges

### 3.4.1 Advantages of Nori Cultivation:

Nutritional Value: Nori is a great source of important nutrients, such as dietary fibre, iodine, and minerals like iron and iodine, as well as vitamins like vitamins A, C, and B12. It also has a lot of healthy ingredients including antioxidants and is a fantastic source of protein.

Environmental Advantages: Compared to other agricultural practises, nori growing is thought to be environmentally beneficial. During photosynthesis, seaweeds take in carbon dioxide and expel oxygen, which helps to sequester carbon and possibly slow climate change. In addition, seaweed production uses less freshwater, less space, and no fertilisers, which eases the burden on terrestrial resources.

Rapid Growth: Nori has a 45–90 day harvest cycle that varies based on the species and environmental factors. The potential productivity and profitability of nori cultivation are increased by the opportunity to harvest the plant numerous times within a year due to its rapid development.

Economic Prospects: Nori cultivation offers coastal communities economic prospects. In areas with favourable coastal conditions for seaweed cultivation, it can be a source of revenue and employment.

### 3.4.2 Challenges of Nori Cultivation:

In India, farming algae is not without its challenges. involves pest and disease control: Nori farming suffers difficulties due to pests and disease outbreaks, just like any other crop. The health and productivity of seaweed can be impacted by pathogens like bacteria or viruses. To ensure successful cultivation, it is essential to put appropriate disease management practises and preventative measures into place.

Quality Control: It might be difficult to maintain consistent quality in nori production. The flavour, texture, and colour of seaweed that has been harvested can be influenced by elements like water quality, temperature, and nutrient availability. To guarantee that the product fulfils market requirements and consumer expectations, quality control mechanisms must be in place.

Techniques for Nori Harvesting and Processing: Specialised knowledge and abilities are needed for nori harvesting and processing. To prevent injuring the thalli (leaf-like structures) and guarantee a sustainable regrowth, seaweed must be collected carefully. Furthermore, the nori's quality and shelf life must be maintained through proper post-harvest processing, including washing, drying, and packaging.

Market need and Consumer Awareness: Although there is an increasing need for nori, market development and consumer awareness continue to be obstacles. It may take marketing and education initiatives to increase nori consumption in order to grow the market and promote it as a wholesome and adaptable food ingredient.

## 3.5 Future prospective

Seaweed farming, commonly known as nori cultivation, has a bright future because of the many economic and environmental advantages it offers. Here are some possible events that could affect nori cultivation:

Increased Demand and Consumption: As a healthy food source and essential component of sushi rolls and other cuisines, nori has grown in popularity all over the world. The increase of nori manufacturing is being driven by the rising demand for seaweed-based products to satisfy market demands.

Nori farming is regarded as a sustainable method of aquaculture because it doesn't require fertilisers, freshwater, or arable land. By offering home for a variety of marine animals, absorbing extra nutrients, and lowering ocean acidification, seaweed farming is essential to the restoration of coastal ecosystems. Nori and other seaweed farming will probably get more attention as sustainability becomes a top focus on a global scale.

Technological Developments: Technological developments are projected to increase the effectiveness and productivity of nori agriculture. Remote sensing, automated farming tools, and other technological advancements can help nori farms produce more nori while enhancing growing conditions and reducing environmental effect. These developments might also make it easier for seaweed farming to spread to new regions, particularly offshore ones.

Developing genetically improved nori strains with better growth rates, disease resistance, and nutritional profiles is a current area of research. Nori's nutritional value and commercial viability may be improved through selective breeding or genetic modification, resulting in higher-quality goods and greater farmer profitability.

Applications with added value: In addition to being eaten as food, nori may find use in a number of different sectors. In addition to being a biofuel feedstock, it can also be used to make bioplastics, animal feed, medicines, cosmetics, and fertilisers.

Investigating these value-added uses can boost the nori industry's overall economic viability by generating new revenue streams.

Geographic Expansion: At the moment, nori cultivation is mostly carried out in nations like Japan, China, and South Korea. The cultivation of nori, however, may spread to other geographical areas if demand rises, including coastal regions of neighbouring nations. This diversification can boost regional economies and lessen reliance on a small number of industry hubs.

Collaboration & Knowledge Sharing: For the future of nori farming, cooperation between academics, farmers, and policymakers is essential. Sharing best practises, information, and resources can help farmers develop sustainable and effective farming methods, overcome obstacles, and encourage nori growing to be practised widely around the world.

Alternative food source for future: In India, there is a severe problem with soil degradation, which results in a loss in soil productivity, a decline in vegetative cover, a qualitative and quantitative decline in soil and water resources, and air pollution. Due to the country's growing population, it has become significantly worse in recent decades, necessitating the cultivation of marginal regions to fulfil the rising food demand. People are forced to look for more land to produce food, fodder, and fibre as a result of poverty and the destruction of the environment. Deforestation and the loss of indigenous vegetation are the major factors contributing to degradation brought on by direct or indirect human action. Since nori does not need soil, water, or fresh land to flourish, it may be grown anywhere. They can be used in the future as a substitute for food.

Overall, due to rising demand, sustainable farming methods, modern technology, genetic developments, and creative uses, nori production seems to have a bright future. Nori farming is set to play a large part in the global food and agriculture

business as society becomes more aware of the benefits of seaweed and the need of sustainable food production.

# 4. Result and discussion

## 4.1 Identification of B12 Compounds in Various Korean Purple Laver Products.

We tried to purify B12 compounds to clarify whether Korean purple lavers contain true B12 or inactive corrinoid compound (pseudo-B12) which has been found in edible blue-green algae (cyanobacteria). since a substantial amount of algal purple pigment (phycoerythrin) may interfere with purification of B12 compounds. Therefore, each B12 extract of the purple lavers was analyzed with a B12-dependent E. coli 215 bioautogram after being separated by silica gel 60 TLC . The B12-activity found in each purple laver was given as a single spot, whose Rf value (0.56) was identical to that of authentic B12. The result indicated that Korean purple lavers contain true B12, but not pseudo-B12 inactive for humans.

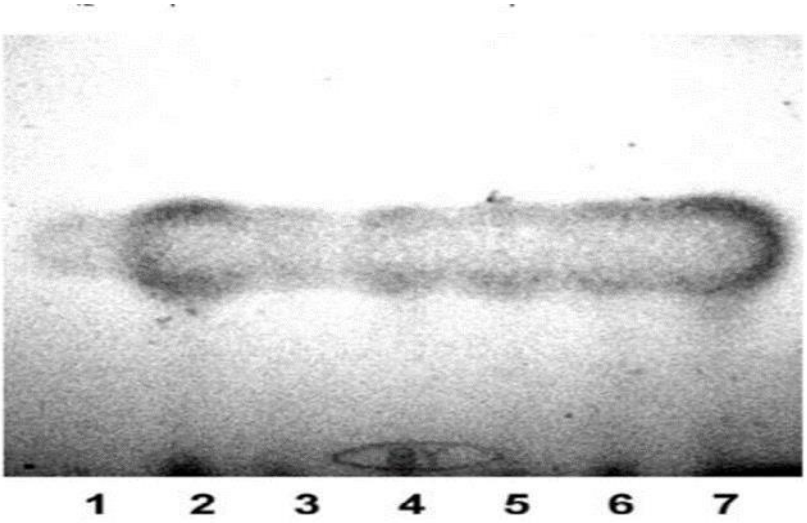
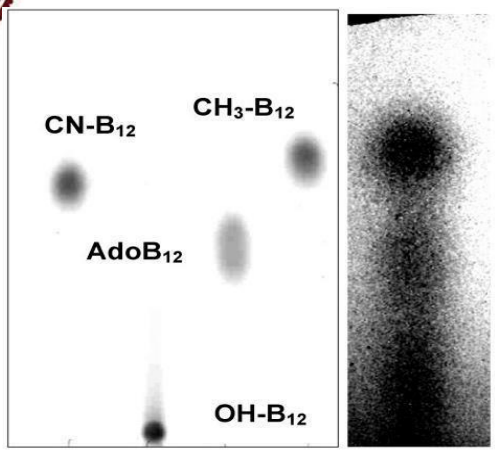



Fig.3. E. coli 215 bioautogram after silica gel 60 TLC of the B12 extracts of selected purple laver products and authentic B12: 1, authentic B12; 2, Korean dried laver ; 3, Korean seasoned and toasted laver ; 4, Korean seasoned and toasted laver ; 5, Korean seasoned and toasted laver ; 6, Japanese dried laver ; 7, Japanese dried laver .

**4.2 Occurrence of Coenzyme Forms of B12 in Dried Korean Purple Laver.**

The coenzyme forms of B12 were extracted with 80% (v/v) ethanol and analyzed by the TLC-bioautogram method. The B12 compounds found in the dried purple laver were separated as three spots, whose Rf values were identical to those of authentic hydroxocobalamin (OH-B12), 5'-deoxyad-enosylcobalamin (AdoB12), and methylcobalamin (CH3- b12 ) respectively (Figure 4). The area of each B12 spot in the Korean purple laver was calculated to be about 49% OH-B12, 33% CH3- B12, and 18% AdoB12, indicating that half of the B12 found in the Korean purple laver was the coenzyme forms (CH3-B12 and AdoB12). It has been reported that most (~80%) of the B12 found in commercially available dried Japanese purple laver sheets is recovered in OH-B12 .

(A) , Authentic b12 compounds; (B) ,B12 compounds were extracted from the lavers and then analysed with the E.coli 215 bioautogram analysis .




**(A)** **(B)**

Fig. 4. Occurrence of coenzyme forms of B12 in dried Korean purple laver: A, authentic B12 compounds; B, B12 compounds were extracted from the lavers and then analyzed with the E. coli 215 bio autogram analysis.

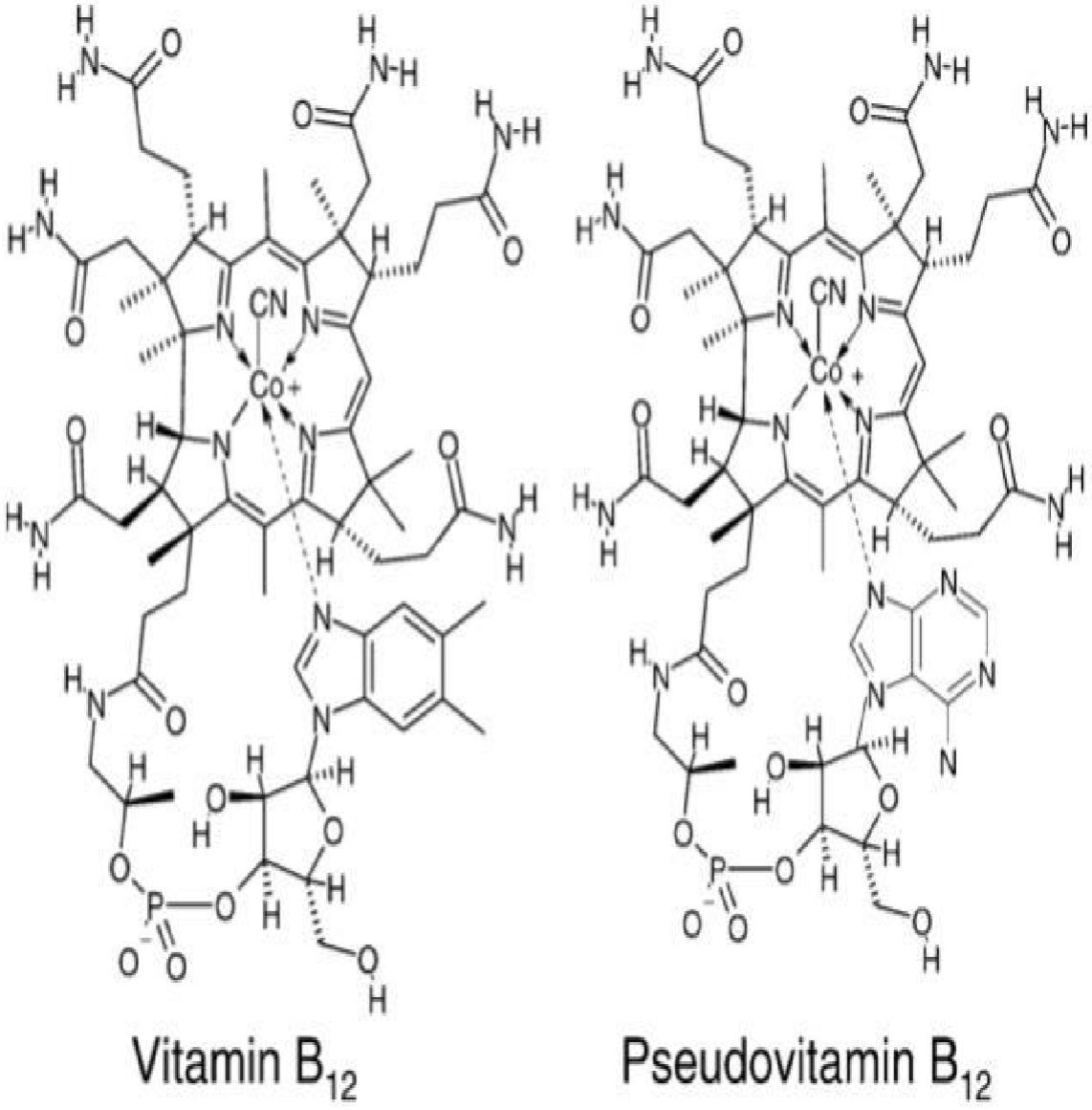



Fig. 5. Structural formula of vitamin B12 and pseudovitamin B12 (7-adeninyl cyanocobamide)

## 4. Summary

Demand for nori has been rising on a global basis. Seaweed has a lot of fibre, vitamins, and minerals. Many types of seaweed are anti-inflammatory and anti-microbial. The findings of the aforementioned trials demonstrate that Purple laver contains authentic B12 but not fake B12. The Rf value for purple lavatory is (0.56), which is identical to that of genuine B12. claiming that the sole plant-based source of vitamin B12 is nori. According to estimates, if cultivation were to occur in 5% of India's EEZ, it could: produce 6.6 billion litres of bioethanol; create a new seaweed industry; increase ocean productivity; lessen algal blooms; increase carbon sequestration; and employ close to 50 million people.

Even while nori farming is still in its early stages in India, if it is effective, it could have a number of advantages. It might help restore the marine ecosystem, give coastal people a new source of income, and diversify farming methods throughout the nation. In India, farming algae is not without its challenges. concerns labour shortages throughout the paddy harvesting and transplanting seasons. lack of financial stability brought on by bad conditions and low pay. inadequate technological advancements to improve processed commodities. Ignorance of new and alternate sources of raw materials. Risky due to the need to collect seaweed from depths more than 25 to 30 feet. Lack of awareness of the benefits of a healthier diet among the populace prevents many from making the switch.

It's crucial to remember that these benefits and difficulties might change based on the particular setting and region where nori is grown. Nevertheless, current studies and advancements in seaweed farming methods seek to overcome these obstacles and raise nori cultivation's productivity and sustainability.

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# THANK YOU

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