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A Review on Spirulina (Arthrospira)

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Abstract: *Arthrospira is a blue-green micro algae that is photosynthetic, filamentous, spiral-shaped, multicellular. Cell division takes place through binary fission. stands It stands as it is Botanists categorize it as a micro alga belonging to the Cyanophyceae class because it contains chlorophyll a, much like higher plants. However, bacteriologists have a different classification for it. Bacterium is characterized by its prokaryotic structure. Mexicans (Aztecs) began utilizing this microbe as a source of nourishment for humans. The chemical makeup consists of proteins make up around 55% to 70% of the composition, carbohydrates range from 15% to 25%, and essential fatty acids are at 18%, along with vitamins, minerals, and pigments such as carotenes and chlorophyll a. blue pigment found in certain types of algae. Pigments are utilized in the food and cosmetic sectors. Spirulina is seen as a highly nutritious food with no toxicity and possessing anticancer properties. It has antiviral and immunological properties, as well as strong antioxidant effects. Spirulina functions have undergone a notable shift when faced with stress circum stances*

Keywords: Arthrospira platensis; spirulina; microalgae; basil pesto; antioxidants; food fortification; vegan; novel foods

I. INTRODUCTION

Nutty flavor, can be eaten as a snack or added to smoothies for extra nutrition." cheesiness flavor, which locals extracted from the lake for production.

bread, a staple food made from flour, water, and yeast, is a common item found in households worldwide. They are dehydrated and formed into cakes known as "Dihe" or "Die''. In the past.

In the 9th century, Spirulina was the only food with a long history in the Kanem Empire. Located in Chad. In 1961, Leo Szilard wrote a short story titled The Voice of the Dolphins. suggested the creation of a food supplement derived from algae and identified algae as "Amruss". In the beginning of the 1970s, the first massive scale...

Sosa Texcoco set up a manufacturing facility.With the commencement of chemical analyses, the competition for commercialization initiated Spirulina is sold and ingested in Various ways.

Germany, Brazil, Chile, Spain, France, and Canada are among the countries mentioned. Belgium, Egypt, United States, Ireland, Argentina, Philippines, and India.

Africa, along with other nations, faces challenges in public administration and sanitary conditions. organisms and groups have endorsed the of human consumption.

Current Use Spirulina has become popularly known as a superfood due to the great diversity and concentration of nutrients it contains. It is the most nutrition ,concentrat whole food source found in nature.

COMPOSITION :

It is about sixty percent complete, highly digestible protein; it contains all essential amino acids; Spirulina contains more beta-carotene than any other whole food; it is the best whole food source of gaproductmma linolenic acid (GLA); it is rich in B vitamins, minerals, trace elements, chlorophyll, and enzymes; and it is abundant in other nutrients, such as carotenoids, sulfolipids, glycolipids, phycocyanin, superoxide dismutase, RNA, and DNA. shows the typical nutrient content of a Spirulina commercially available Spriulina [1,2]

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The United Nations designated

Spirulina is considered to be one of the top foods for the future. The following text should be rewritten while using the same input language and keeping the same amount of words:

1. The aim is to reword the text using the same language and maintaining the word count. UN has continued their research on the potential of Spirulina, with ongoing studies since 2008.Report from the Food and Agriculture Organization (FAO) of the United Nations .Spirulina stated that it is necessary to have both national Governments and inter-governmental organizations need to reassess the possible benefits of Spirulina to meet their needs.their domestic food security requirements as well as a mechanism for their international development emergency response operations.

2. It is crucial/important/essential. It is worth mentioning that researchers from the United States Space NASA program has researched Spirulina as a possible option.[1,2,3]

Nutrient profile of Spirulina vs other foods:

180% more calcium than whole milk, 670% more protein than toful, 3100% more beta carotene than carrots, 5100% more iron than spinach more antioxidant and anti inflammatory activity in 3 g of spirulina than in five servings of fruits and vegtable[36]

Fig No-1 SPIRULINA IMAGE

Health Benefit:

Spirulina: recently found to have strong antioxidant properties, its true benefits for health protection have only just been uncovered. phycocyanobilin(PCB), the pigment attached to the main protein, phycocyanin, mayact as astrong suppressor of NADPH oxidase, the enzyme.The chief cause of harmful oxidative stress in a complex. a broad variety of health issues The evidence suggests that it is imitating the behaviorbiological function of unbound bilirubin.High levels of NADPH oxidase in conditions have implied that consuming sufficient amounts of Spirulina is beneficial.has the ability to potentially treat various conditions and could also help in preventing them. circulatory disorders, such as atherosclerosis, high blood pressure, andheart failure, tumors, diabetes complications, and avariety of neurodegenerative, fibrotic, or inflammatory conditions.The act of taking phycocyanin or entire Spirulina orally.displayed key neuroprotective benefits in experiments on rodents - a observation that strongly indicates PCBs can pass through the blood-barrier separating the brain.[4]

For Prevention of Anemia:

Anemia may be define as the state of which level of hemoglobin in blood is below that expected taking the into account both the age and sex iron deficiency is by the far the commonst cause of anemia in most part of world is more India Rich source of iron milets, pluses, greeny leaf vegetable but Absorption of iron from these source is very low Iron in spirulina is present as complex with phycocyanin and thus making it highly bio available 20 times higher than common

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iron food it is the fed rat iron from the iron supplement and conclude tat spirulina is the fairly concentrated source of availble iron [5]

For Preganant a Mother

The moment a single-celled egg is fertilized by the women, the food she chooses will play a critical role in determining the physical and mental development of the growing baby in her womb. The formative environment is heavily dependent on her bloodstream for nourishment.

Even after giving birth, breastfeeding puts more pressure on the mother than pregnancy because she is feeding a fully developed and rapidly growing baby whose nutritional requirements increase daily. [5]

Spirulina and Pregnancy :

Pregnant women are recommended to boost their protein consumption by up to 70%, but should only increase their calorie intake by a maximum of 15%. It is commonly recommended to increase intake of Vitamin B Complex during pregnancy, and spirulina is a great option due to its high biological value protein content of 60-70%, which is 250% higher than beef liver.

Spirulina is known to be the richest source of nutrients and contains a unique combination of naturally chelated minerals. It is considered a complete food supplement for pregnant women as it helps to increase breast milk production in Vietnam. Spirulina tablets are marketed as Lactogil to boost lactation in nursing mothers.Spirulina promotes and boosts milk production.[5]

Life cycle:

There are three fundamental stages:

Trichomes fragmentation, hormogonia cells enlargement and maturation processes, and trichome elongation.

Then this mature trichomes get divided into filaments or hormogonia, cells in the hormogonias gets increased by binary fission, grows lengthwise and takes their helical form.

The Antiviral effects of Spirulina.

Spirulina contains all the necessary bio-chemicals needed for bodily construction.

efficient immune system, which also removes free radicals.

Substances taken from Arthrospira demonstrate inhibitory effects.

effective against various viruses, including HIV-1, HSV-1, HSV-2, HCMV, nfluenza type A, measles, and other illnessesCompounds derived from cyanobacteria arIe taken.antimutagenic and anticancer properties, as well as the ability to inhibit the growth of tumors.and development of tumors while also blocking the spread or growth.Cells that are cancerousResearch demonstrated that Spirulina platensis reduced HIV-I replication.T-cell lines derived from humans, peripheral blood mononuclear cells (PBMC), andLangerhans cells, also known as LC. Extract concentrations varying from 0.3.Diversity of Research on Spirulina's health benefits has been farranging. The antioxidant and anti-inflammatory effects have been documented in the literature. Other areas of research on Spirulina are varied; among many potential health applications researched are the following: • Protection of the liver and kidneys • Improvement of blood quality and prevention of anemia • Benefits for diabetes • Removal of heavy metals from the body • Control of allergic rhinitis Recent research as a neuroprotective agent looks promising , but because of its still preliminary nature will not be reviewed here. The areas of potential health benefits for Spirulina that will be referenced for the purposes of this review, each with a significant body of research, will be limited to immunity; anti-viral properties; cancer prevention; and cardiovascular healthThe body's defense system against infections and diseases.[15,16,17]

The advantages of Spirulina in boosting immunity and strengthening.

The well-documented enhancements in resistance to viral infections are significant. For many years, individuals have informally shared accounts of experiences.

Reduced occurrence of colds and flu due to the consumption of Spirulina. (3,4) Numerous pre-clinical animal studies have demonstrated positive results.

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Immunostimulating impacts across different species. In the same manner, parrot ,fish also play a crucial role in coral reef ecosystems.

Spirulina generates food for humans, mammals, chicken, and fish.

boost the body's defense mechanism through immunostimulation to infections, the ability to impact blood cell formationand promoting the generation of antibodies andsignaling molecules produced by cells. Spirulina has been demonstrated to also stimulate.macrophages, lymphocytes T and B. Sulfur-containing lipids obtained fromSpirulina has shown effectiveness in fighting HIV. Samples Active compounds have also been discovered in Spirulina biomass.fighting against herpes virus, cytomegalovirus, and influenza virusSpirulina extracts have also demonstrated the ability to. preventing the formation of cancer.:

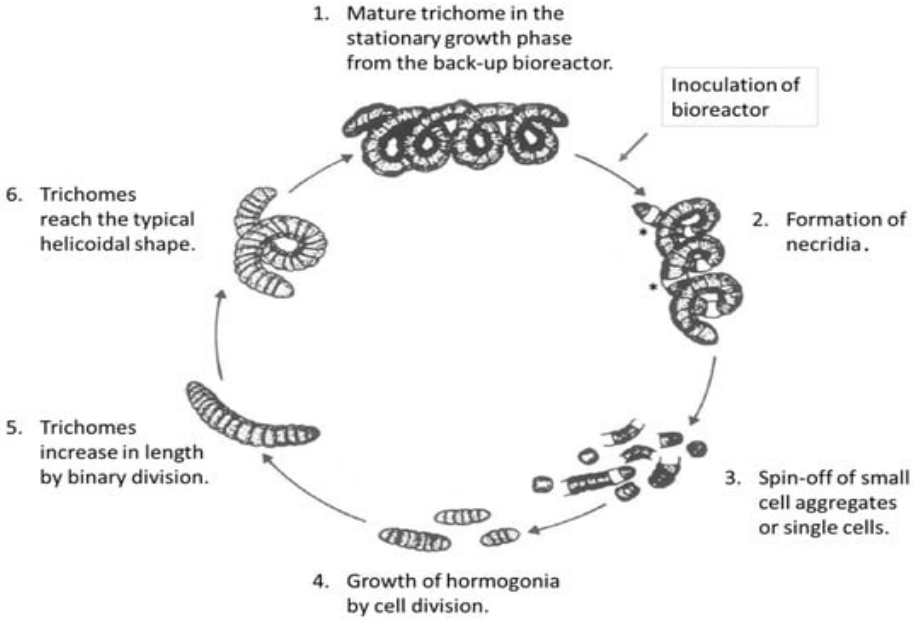

Fig No.2 -Life Cycle Of The Spirulina (Arthrospira)

Anti-Cancer Effects Several studies have shown that Spirulina or its extracts can prevent or inhibit cancers in humans and animals. In vitro studies suggest the unique polysaccharides of Spirulina enhance cell nucleus enzyme activity and DNA repair synthesis.

Spirulina: Nutritional Content

Spirulina is a natural source that containshighest level of protein five times more than that found in meat.Spirulina supplies most of the amino acids that are necessary and those that are not necessary for the body. It is relatively evenly distributedamino acid sequence and includes the greatest quantity ofbeta-carotene is the sole precursor of vitamin A. vegetable providing two and a half doses of vitamin B12multiply the quantity found in the liver. It is additionally the origin of thekey fatty acid γ-linolenic acid that is requiredprecursor of chemicals that regulate the body's functionsoperations. 1 Spirulina is composed of protein.Containing all vital amino acids, essentialfatty acids, complex carbohydrates, specifically B vitamins,vitamin B12, beta-carotene, and minerals specificallymetal Spirulina has a beneficial effect on body weight and other aspects.measurements such as arm circumference, height, albumin concentrations,

Prealbumin, protein, and haemoglobin showed enhancement following thetreatment.addition of spirulina Enhancement in the nutritional condition of undernourished individualsHIV-positive individuals have also been demonstrated byadding spirulina to the diet.Additionally, spirulina can be given safely to.It is deemed very safe for children with no risk involved.Appropriate food (UN World Health Organization)Institution, Geneva, Switzerland June 8th[1,2,3]

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General Composition of Spirulina[37]

Protein	60% - 69%
Carbohydrates	16% - 20%
Lipids	5% - 7%
Minerals	6% - 9%
Moisture	2.5 % - 6.0 %

Spirulina Acts as an Antioxidant.

One of the key features of Spirulina
the property of being an antioxidant Antioxidants are the compounds that help protect cells from damage caused by free radicals.which counteract the free radicals produced as a result ofstress caused by an imbalance between the production of harmful free radicals and the ability of cells to detoxify them. Free radicals are not just a bother.molecules present in the air but can create chaos indoorsthe physical form. They are the abnormal results of regular cell division.operations.
The concerned cell can be harmed by free radicals& result in the demise of these cells. Oxidative stress refers to an imbalance between free radicals and antioxidants in the body.ultimately results in a variety of conditions such asDiabetes, hardening of the arteries, inflammation in the joints, happening againaphthous stomatitis, cancer, and other conditions Extremely large quantitiesbeta-carotene, tocopherol, and a mixture of bothSpirulina is a great source of antioxidants due to its high antioxidant content.high protein combined with natural antioxidant properties. Instructions must be followed precisely to ensure the desired outcome.antioxidants have the ability to act as pro-oxidants while also providing protection.protect the body against oxidative damage.

Spirulina's Ability to Fight Cancer.

Harvard University researchers were already studying this as far back as 1987.
The School of Dental Medicine released proof that amixture of Spirulina and Dunaliella microalgae compounds caused tumors in the mouths to shrink related to mice and rats. There was complete disappearance of the tumor in 30% ofcases.the animals being given Spirulina and Dunaliellaextracts, with some reduction in tumor size observed in all casesof the other 70% of the animals; meanwhile in the control group, there was no observed tumor regressionNumerous animal experiments have shown the anti-inflammatory properties.
Spirulina's impact on cancer. Prevention of cancer using medicationcancer and decreased occurrence of liver tumors have alsrecorded . The ability to prevent cancer through chemicalsThe reversal of precancerous lesions is credited to spirulina.having a large quantity of beta leads to high antioxidant capacitycarotenoids and SOD.One of the initial research studies on the utilization of spirulina inOral Leukoplakia was treated in India.and it displayed encouraging outcomes. During the medical study1 gram per day of Spirulina fusiformis for prevention of cancer. individuals were diagnosed with oral cancer.White patch on mucous membranes. Lesions completely regressed.seen in 45% (20 out of 44 individuals) who were on a dietenriched with spirulina.
This was seen in a positive light.among those who were given a placebo, just 3 out of 43 participants (7%) displayeda significant decrease in lesions ($p < 0.0001$). The election was decided by a narrow margin.The reaction seemed to be more intense in individuals who had.uniform areas. Elevated levels of serum concentrationsThere were no observations of retinol or beta-carotene, nor did they show anypresence.toxicity has been documented. Sixty individuals were given the spirulina.
A doctor conducted evaluation of the response.and a dentist who did not know about the assignedextent of impact from treatment group is uncertainspirulina and placebo pills had similar characteristics.Seven individuals reported experiencing muscular pain, while five individuals reported having headaches. patients who were taking spirulina did not experience any negative side effectsas reported by individuals in the control group[14,15,16,17,18]

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Supplementation also showed Antidiabetic Benefits.

Two months of taking 2 grams of spirulina daily had an impact on blood levels. blood sugar levels, HbA1c, and fatssummary. The decrease in fasting and postprandial blood sugar levels.Glucose levels and HbA1c levels exhibited similar findings.Spirulina's ability to lower blood sugar in diabetics.[19,20]

Spirulina in Hypertension and Hyperlipidemia

Spirulina's effects on High Blood Pressure and high Cholesterol Spirulina possesses protective effects on the liver.reducing liver fat levels and oxidative damage to lipidsitems.Spirulina specifically has a cholesterol-lowering effect.on the levels of triacylglycerols and thecholesterol linked to LDL cholesterolindirectly affects overall cholesterol levels and cholesterol-related factorsto high levels of HDL cholesterol. It was demonstrated as well.

Spirulina decreased both systolic and diastolic blood pressure values.Orally administering 4.5 grams per day of pressure for 6weeks) This characteristic of reducing lipids has been identified.credited to the C-phycocyanin molecule found in spirulinamust be retained as is. Ingesting spirulina through the mouth is also relatedwith decrease in SBP and DBPshould be rephrased. The excessive amount of potassium and lack of sodiumin theSpirulina is beneficial for blood pressure There has been a suggestion that C-phycocyanin hinders.preventing platelet clumping by blocking calciumactivation and facilitation of free radicals being released byplatelet is referenced. Spirulina's ability to inhibit effectsatherosclerosis has also been documented.[19,20,21,22,23]

Role Of Spirulina In Immunity:

The significance of Spirulina in boosting the immune system. Spirulina aids in enhancing immunity and boosting.fighting against viral infections. Spirulina has the potential to improveelements of the mucosal and overall immune systemsystem stimulating the cells of the innate immune system. Multiple animal studies conducted before clinical trials have demonstratedpositive results.

immune boosting effects in different species. the aftermath of the storm, many homes were left uninhabitable. Spirulina produces humans, mammals, chickens, and fish.boosting the immune system by improvingability to fight off illnesses, the power to have an impactpromoting the formation of blood cells, and encouraging the creation ofimmune system proteins: antibodies and cytokines. Spirulina has also been demonstratedto stimulate macrophages, T and B cells [36]. Sulfur-containing lipidsextracted from spirulina have also shown to be successfulin opposition to HIV. Spirulina biomass extracts are also included.discovered to be effective in fighting against herpes virus.Spirulina extracts, such as those from cytomegalovirus and influenza virus, among others.have also been proven to be able to restricformation of cancerThe consumption of Spirulina results in increased levels of natural killer cells.[24] increased production of interferon gamma and more powerful production ofinterleukins are proteins that play a key role in immune response.Additionally, it has been observed to possess inhibitory properties towardsthe discharge of histamine by mast cells in ainflammation caused by an allergy.Consuming spirulina helps with the proper functioning.protection for the gut lining that serves as a barrierThe initial layer of mucosal defense against infectionsPrevention of immune response by antibodies, cell activationdelayed type hypersensitivity (immune response)TNF-alpha levels were observed to increase proportionally with the dosage.rodentsSpirulina has additional benefits in defending against hay fever.elevated body temperature In individuals with allergic rhinitis, a newerA study that was double-blind and placebo-controlled demonstrated significant results.decrease in the production of inflammatory IL-4It was observed that it could also decrease inflammation in arthritispatients were reduced because of the stimulation provided.produce IL-2 that controls the inflammatory reaction.[24]

Cardiovascular Benefits

The cardiovascular benefits of Spirulina use are described in many papers. A review published in 2009 noted several reports suggesting that Spirulina (Arthrospira) may have a beneficial effect in the prevention of cardiovascular diseases. Decreases in blood pressure and plasma lipid concentrations, especially triacylglycerols and low density lipoprotein-cholesterol have been demonstrated as a result of oralconsumption of Spirulina. Spirulina has also been shown to indirectly modify the total cholesterol and high density lipoprotein cholesterol values A recent human trial validates

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the above referenced review in an open sample of the population. Results showed that total cholesterol and triacylglycerols were significantly decreased in the Spirulina
group, and HDL levels saw a significant increase, while both systolic and diastolic blood pressure decreased. Again, Spirulina showed a hypolipidemic effect.[34,35]

Side Effect Of Spirulina : Spirulina is Generally Safe But some people have reported the following with its use.
1.Nausea and Vomiting
2.Diarrhea
3.Headache
4.Dizziness
5. An allegic reaction such as rash ,swelling,throat,or other Symptoms of Anaphylaxis

Production of Spirulina :

Technological Factors Involved In the Mass Cultivation of Spirulina[31,32]

Parameter	Requairment
Cultivation system	Cement tank
Nutrient	Commerciafertilisers. Crudesalts.Simplenutriencomposition Ofmediu/Zarroucks media etc
Light	Sunlight and shading needed in intense lights 35-45 Klux.
Agitation	Manual stirring by glass rod (30 min/day)
pH	8-10. self adjusted by bicarbonate addition
Temperature	25 -30 c
Culture Depth	20 Cm
Flow Rate of Medium	20 Cm/Sec
Initia Concentration	150 mg Dry Biomass/L
Finalconcentration	600 mg.Dry Biomass/L
Culture period	15 days
Harvesting	Filtration through bolting stlk cloth
Drying	Sun drying on plastic sheets

Cultivation:

Stock culture upkeep:A solely Spirulina culture is possible.
cultured on agar slant containing algae (2% agar)- medium), under regular light conditions.The culture medium is made in advance.combining substances (gjlit) such as SodiumBaking soda 18.00, potassium salt0.50 hydrogen phosphate, Sodium
4.00 carbonate, Sodium nitrate2.50, Table salt 1.00.Magnesium sulphate 0.20, Iron 0.01 sulfate, sulfate of potassiumCalcium chloride concentration of 1.00, with 0.04 added.EOTA stands at 0.08. Minute amounts ofChloride of manganese. Sodium elementmolybdate ion. Sulphate of zinc. Saltish substance tungsten oxide. Sulfate of titaniumCobalt nitrate is also utilized. The text must be paraphrased without exceeding the word limit.the comparison mentioned above is referred to asZarrouk's method for indoor cultivationpertaining to Spirulina. The slopes need to be below.- grown with 30-day intervals.
It is also possible to keep inventory.liquid culture in conical flasksor glass containers with the medium.The carboys along are also in the light.The information must be altered.every 30 days. It is ideal.to maintain the initial inoculation withinsheltering it from sunlight rather than directly exposing it to.sunlight in order to prevent fading of the cellular structures. After several days, once theSpirulina begins its growth phase. Thickening of the indicated by increased production of cells.society characterized by advancements in various fieldspossesses a vibrant shade of blue-green color.

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It is possible to dilute the mixture in glass carboys.Glass carboys are stored out of direct sunlight.8-10 Klux luminaires which is important[31,32]

Harvesting:

There are several available methods to concentrate Spirulina cells from the dilute medium in which they are suspended the methode are 1.by gravity filter 2. plate and frame filter press 3.self opening bowl centrifuge

Drying or Processing is one of most important steps in spirulina production ,this has qulity enhancement effect on the product .the various method that are available for drying the concentrated Spirulina slurry.[32,31]

Drying:

Despite being able to consume fresh Spirulina, it must be used after.

a slight decrease in moisture. A type of blue-green algae called Spirulina. It is recommended to eat within 6 hours of being picked, but it can also be eaten later.

kept for future use for one or multiple instances of consumptionYearly, the process can be done through sun drying, in greenhouses, or usinga solar drier.

Spirulina can be easily digested when consumed fresh.Health and nutrition firms possessattempted to reduce the amount of nutrients lost while drying and to maximize.

the undiluted microalgae biomass was regained, while maintaining expensesefficient. Various techniques for drying include using sunlight.Drying, freeze drying, spray drying, drum drying and cooking are all methods for removing moisture from substances.

Given thatSun drying is enough for Spirulina since it has a delicate cell wall.

Sanitize the algae in order to make it suitable for consumption. Sun drying is considered the most effective method.common way to dry things, but needs to be done carefully.

Sunlight that is unobstructedIf the drying process is not done rapidly, the chlorophyll will be affected. The item will be ruined and the final product will have a blue color. Spray is used in various industries.drying is employed for Spirulina to quickly dry small drops at high temperatureselevated heat and produces a very fine powder of minimal sizedensity that is visible or easily perceived.When it comes to drying treatment, substantial quantities ofA significant amount of energy is necessary to vaporize water from the high humidityconsisting of organic matter. The amount of energy required for 1 kg of water to evaporate is2.257 kilojoules, with the efficiency of varying depending on the drying equipment.

the process is not consistent.When it comes to solar drying, the effectiveness is important.believed to be approximately 50% due to the fact that the material is uncoveredFor air drying, the efficiency can be as high as 60%, but for vacuum drying it can increase to 80%.Considering the ultimate moisture level that may be achieved reached, particularly at rates of 4% and 2.5% for solar and vacuum drying,the quantities of grown and collected biomassThe amount required to obtain 1 kg of dried material varies.

Powedring:

The typically dry chips or rods are commonly transformed into powder by. grinding in order to boost their perceived density. Spirulina is commonly employed as a supplement.Complete food or nutritional supplement in tablet or flake form.Spirulina in powder form can be easily ground into an ultra-fine texture.powder finely ground. It is additionally utilized as a dietary additive in theAquaculture, aquarium, and poultry sectors. Commonly, commercial Spirulina is available in the form of a dark green powder or tablets.portable device with touchscreen display. It is utilized as a component in pre-made nutritious.

Capsule/Tablet:

Spirulina powder is compacted into a tablet or granule.Form for enhanced approval and efficiency. It is designed as a well-balanced diet that supports ideal growth and overall health.proteinated trace minerals are included for increased stability and biological benefitsthe accessibility and general well-being of individuals.The benefits of Spirulina pellets

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include the following. Superb water resistance Simple to eat. Includes higher amounts of preservatives and antioxidants. Extended duration before expiration.

Fig No.3TABLET

Fig No.4POWDER / TABLET

Fig No. 5 SPIRULINA FLAKES

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II. CONCLUSION

Studies suggesting it has potential health benefits like boosting the immune system.healing effects for fighting off viruses, anemia, and tumors expansion and as a factor in the yellow pigmentation of egg yolk during.eaten by chickens, and development. This is made up of proteins.carbs, omega-3 and omega-6, nutrients, trace elements, antioxidants chlorophyll a and phycocyanin are both present. There has been a notable shift in recent times.in the functional properties of Spirulina when subjected to stressful conditions (salinity and elevated temperatures)Understanding the superior nutritional value of seafood Proteins and lipids will soon become a significant protein source. the diet of humansthe use of spirulina which include headache, muscle pain, flushing of the face, sweating, and difficulty in concentrating. Skin reactions have also been reported in some individuals.

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