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Diving into the Depths: Unveiling the Micro-Nutrient Marvels in Fish and Aquatic Environments

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Introduction

An organism needs nutrients in order to grow, thrive, and reproduce. It is necessary for protists, fungi, plants, and mammals to get certain nutrients through food. It is a material that offers sustenance necessary for life and development maintenance. Nutrients are chemicals found in food that are vital to life and health; they provide us energy, serve as the building blocks for growth and repair, and control chemical reactions. The chemical components of food known as nutrients are needed by the body to produce energy, give it structure, and assist in controlling chemical reactions. Nutrients are divided into six groups (Figure 1):

1. Carbohydrate
2. Lipid
3. Protein
4. Water
5. Vitamins
6. Minerals

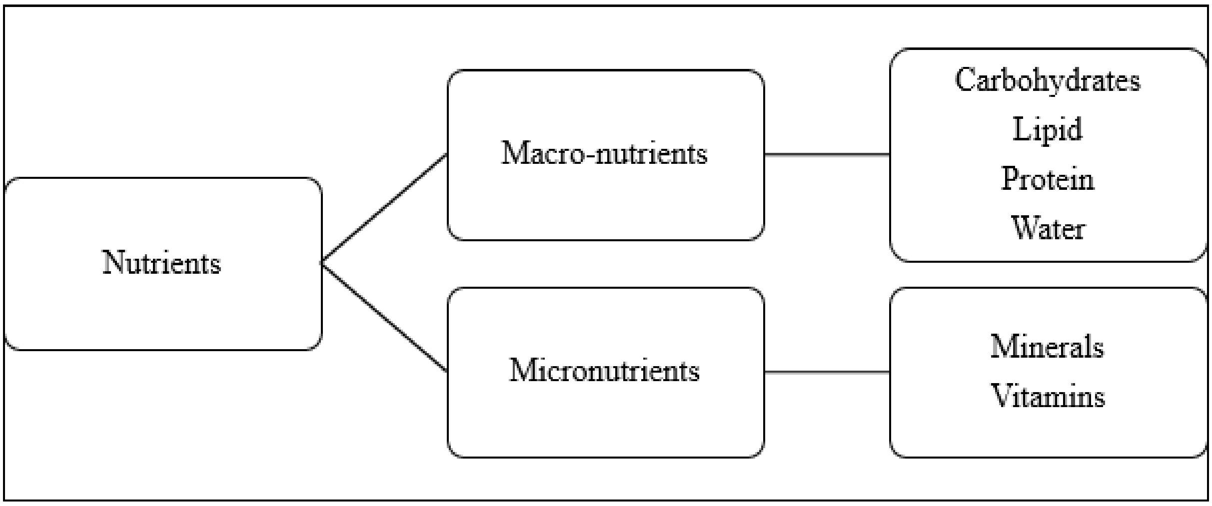

Figure 1: Types of Nutrients

Macronutrients

These are nutrients required in higher concentrations. Macronutrients fall into three categories: proteins, lipids, and carbs. In the same way that other macronutrients are needed in big quantities, water is also necessary because it does not produce energy.

Micronutrients

Even while the body needs micronutrients in lower quantities, it nevertheless needs them to do its daily tasks. All of the necessary vitamins and minerals are considered micronutrients. Thirteen necessary vitamins and sixteen vital minerals are present. Micronutrients are not energy sources as proteins, fats, or carbs are, but they do help in energy metabolism as cofactors or parts of enzymes (called coenzymes). Proteins called enzymes catalyze—or speed up—chemical reactions within the body and are essential for all bodily processes, such as energy production, nutrition digestion, and the synthesis of macromolecules.

Minerals

In order to guarantee the best possible health and growth for living things, minerals are essential in determining the minimum needs and maximum tolerance for each element. In the realm of nutrition, a mineral denotes a fundamental chemical element essential for an organism to conduct crucial biological functions. Minerals are inorganic compounds that are divided into two categories: trace minerals and macro minerals, based on the body's requirement (Chitra *et al.*, 2017).

1. **Macro-minerals:** The body of an animal needs these minerals in huge amounts.
2. **Trace minerals:** The animal body only needs comparatively tiny amounts of these minerals.

*Only a few milligrams or fewer of trace elements, such as zinc, iron, iodine, molybdenum, and selenium, are needed daily. Hundreds of milligrams or more of major minerals, including calcium, magnesium, potassium, salt, and phosphorus, are needed daily. In addition to being essential for the proper operation of enzymes, minerals are also needed for the body's fluid balance, bone formation, hormone synthesis, nerve impulse transmission, muscular contraction and relaxation, and defense against dangerous free radicals (*Antony Jesu Prabhu *et al.*, 2016).

General Functions of Minerals

One way to sum up the overall role of minerals and trace elements is as follows:

- ✓ They are cofactors in metabolism, enzyme activators, and catalysts.
- ✓ Minerals are indispensable for the development of skeletal frameworks, encompassing the creation of teeth and bones, thereby playing a pivotal role in this aspect of bodily formation.
- ✓ The soft tissues seen in animals are composed of minerals.
- ✓ Minerals are essential for the movement of nerve signals and the contraction of muscles.
- ✓ The preservation of minerals is essential for the pH balance of bodily fluids, including blood.
- ✓ Because they are essential for maintaining homeostasis, minerals control how water and other solutes are exchanged inside an animal's body.

Macro-minerals & its Functions

Calcium	• Vital for blood clotting, muscle function, and the formation of bone, cartilage, and the exoskeleton of crustaceans. • Crucial for enzyme activity and plays a significant part in activating enzymes. • Plays a pivotal role in controlling membrane permeability.
Phosphorus	• Inorganic phosphates are crucial for maintaining the pH balance of animal fluids. • They are integral components of nucleic acids, phospholipids, and numerous enzymes. • Essential for the formation of bone, cartilage, and the exoskeleton of crustaceans. • They play a pivotal role in metabolism and cellular energy processes.
Magnesium	• Crucial for the development of bone, cartilage, and the exoskeleton of crustaceans. • Plays a vital role in activating enzymes, regulating nerve irritability, and facilitating muscle contraction. • Maintains the intracellular pH balance.
Sodium	• Primary monovalent ion found in intracellular fluids. • Essential for maintaining osmotic balance and acid-base equilibrium.

	• Facilitates the absorption of carbohydrates.
Potassium	• Predominant intracellular cation. • Necessary for the synthesis of glycogen and proteins. • Critical for maintaining osmotic balance and acid-base equilibrium. • Essential for the breakdown of glucose.
Chromium	• Primary monovalent anion presents in extracellular fluids. • Plays a crucial role in facilitating the transportation of oxygen and carbon dioxide within the bloodstream, alongside regulating the pH balance of digestive juices. • Essential for maintaining osmotic balance and acid-base equilibrium.
Sulphur	• Integral to the structure of vitamins such as cysteine and methionine. • Constituent of various vitamins. • Involved in the detoxification of aromatic compounds.
Macro-minerals & its Functions	
Iron	• Facilitates oxygen and electron transport within the body. • Essential component of respiratory pigments and enzymes crucial for tissue oxidation.
Zinc	• Found in metalloenzymes. • Plays an essential role in both the production and metabolism of RNA. • Acts as a cofactor for numerous enzymes. • Facilitates wound healing processes.
Copper	• Found in various oxide reduction enzymes. • Participates in iron metabolism. • Constituent of the enzyme caeruloplasmin. • Essential for melanin formation and the integrity of the myelin sheath surrounding nerve fibers.
Cobalt	• Constituent of vitamin B12. • Vital for the generation of blood cells and the preservation of the integrity of nerve fibers.

Iodine	• Essential for regulating the metabolic rate of all bodily processes. • Found in enzymes and thyroid hormones such as thyroxine and triiodothyronine.
Selenium	• Plays a critical function in preserving Vitamin E and constitutes a component of the enzyme glutathione peroxidase.
Chromium	• Plays a central role in carbohydrate metabolism, cholesterol regulation, and amino acid metabolism. • Acts as a cofactor for insulin. • Essential for nutritional and physiological responses in fish.

Why to Use Organic Mineral in Aquatic Animal Feed?

When it comes to micronutrients, aquatic animals need more than terrestrial ones. The physio-chemical characteristics of the aquatic organism and its kind have a significant impact on mineral absorption. Mineral absorption is restricted due to antagonistic interactions with feed components. The bioavailability of minerals is limited by the formation of insoluble complexes, or those that are too big to be absorbed when interacting with other ingredients in the diet. Additionally, several minerals compete with one another for the same transporters and metabolic pathways during absorption, limiting the animal's access to certain vitamins or minerals. Because they are relatively loosely bonded, inorganic mineral forms, like sulfates, are free to interact. Because organically bonded minerals are non-reactive, complex formation will not occur. Additionally, absorption through the ligand's route can help to partially prevent competition for absorption.

Phosphate & Fishpond

The primary ingredients of a healthy aquaculture pond are phytoplankton and zooplankton, which are the fish's natural food sources. These minuscule, single-celled creatures are called phytoplankton. They divide their cells by using the minerals in the water, and in order to do so, they need phosphate and nitrogen. Thus, in order to support their growth, we must keep phosphate in the water. Six milligrams of usable phosphorus per 100 grams is the required amount. The pH of the soil and water determines the phosphorus availability. It has been demonstrated that for phosphorus to be bioavailable, soil pH should be between 6.5 and 7.5 and water pH should be between 7.5 and 8.5. Otherwise, phosphate bonds with calcium if pH is greater and iron and aluminium if pH is lower. There shouldn't be less than 3 mg of usable phosphate per 100 grams. Commercial fertilizers are available to increase the quantity of phosphorus; the most popular is SSP (Single Super Phosphate). Every bigha, 5.5 to 6.0 kg of SSP are administered. The application technique is distinct due to the fact that phosphorus is not as easily soluble as nitrogen. To do that, we must first dissolve the appropriate quantity of fertilizer in water in a different container, and then, two to three hours later, we must add the liquid suspension to the water along with some nitrogen fertilizer.

Dietary Mineral Requirements in Fish/ Shrimp

In addition to the minerals they eat, aquatic creatures may also absorb minerals from the surrounding water due to their ability to vary in response to osmotic pressure or salt control. Since they inhabit a hypertonic environment, fish and shrimp may be partially met in their mineral needs by consuming salt water. Additionally, they produce by directly absorbing minerals through their skin, fins, and gills. In freshwater fish and prawns, the circumstances are the opposite. As a result, freshwater fish and shrimp have higher requirements than marine fish and shrimp for a sufficient supply of minerals in their diet. The concentration of an element in the body of water will determine how much of that element a species of shrimp or fish needs to eat.

MINERALS	FISH	SHRIMP
Calcium	0.2-0.4%	1-2%
Copper	3-4 ppm	8-12 ppm
Iodine	0.6-1.1 ppm	0.4-0.6 ppm
Iron	150-200 ppm	60-100 ppm
Magnesium	0.04-0.07%	0.2-0.3%
Manganese	11-13 ppm	40-60 ppm
Phosphorus	0.6-0.8%	1-2%
Selenium	0.03-0.04 ppm	0.17-0.25 ppm
Zinc	15-30 ppm	80-120 ppm

Microencapsulated Vitamin C Used in Aquaculture

For the aquaculture business, 70% ascorbic acid, often known as vitamin C, is a feed-stable, microencapsulated version of the mineral. Additionally, animal feed contains it. With its unique barrier coating technique, Maxx Performance provides the highest quality highly stabilized vitamin C available for the longest possible stability in animal feeds used in aquaculture across the globe. Nutrient-based coating solutions with 70% encapsulated, stabilized vitamin C provide consistent feed stability and demonstrate increased bioavailability. Fish can now benefit from a well-known antioxidant's ability to boost immunity and increase resistance to stress and illness thanks to a product that can be applied directly to feed or top-dressed.

Composition

Leveled off 70% of the product's weight is made up of 70% raw crystalline ascorbic acid, which is used in the manufacturing of 70% vitamin C. The remaining thirty percent is made up of fully hydrogenated vegetable oil, a coating substance allowed by GRAS. processing and storing of feed Stabilized 70% ascorbic acid is a vitamin C source that has been treated to withstand the cold and steam pelleting conditions. Almost all of the vitamin C is retained throughout processing and delivery via cold pelleting. There is a 94% stability during the steam pelleting process, and depending on the use, the product can have a shelf life of up to 180 days.

Microalgae As a Source of Vitamin in Aquaculture

For bivalves in all growth stages as well as the larvae of some fish and crustacean species raised in aquaculture, microalgae provide an essential source of food. Additionally, zooplankton that is raised to feed the larvae and juveniles of some fish and crab species consumes them. Important nutrients from microalgae are transported to higher trophic levels in these later aquaculture food chains by means of the intermediate zooplankton. Microalgae's size, shape, digestion, and biochemical makeup all affect how nutritious they are. The vitamin content of several species might vary by a factor of 10 or more within a single study. In aquatic food chains, microalgae play a crucial role as the main source of vitamins. They are given to zooplankton, such as rotifers and Artemia, which are then fed to fish or crab larvae. The composition of the intermediate zooplankton's algal feeds affects the amount of vitamins it contains. For instance, the amount of ascorbate in Artemia and rotifers is proportionate to the amount in their diet of algae. It is also unknown for other vitamins whether they are diluted or concentrated by metabolism and/or low transfer efficiency in the food chain; further study is needed in this area. If there is a drop in vitamin content between the trophic levels, some of the variations between the microalgae that are shown here might be substantial. The creation of artificial meals for larvae may benefit from knowledge about the vitamins that are naturally present in microalgae. The goal of research over the past few decades has been to create micro-

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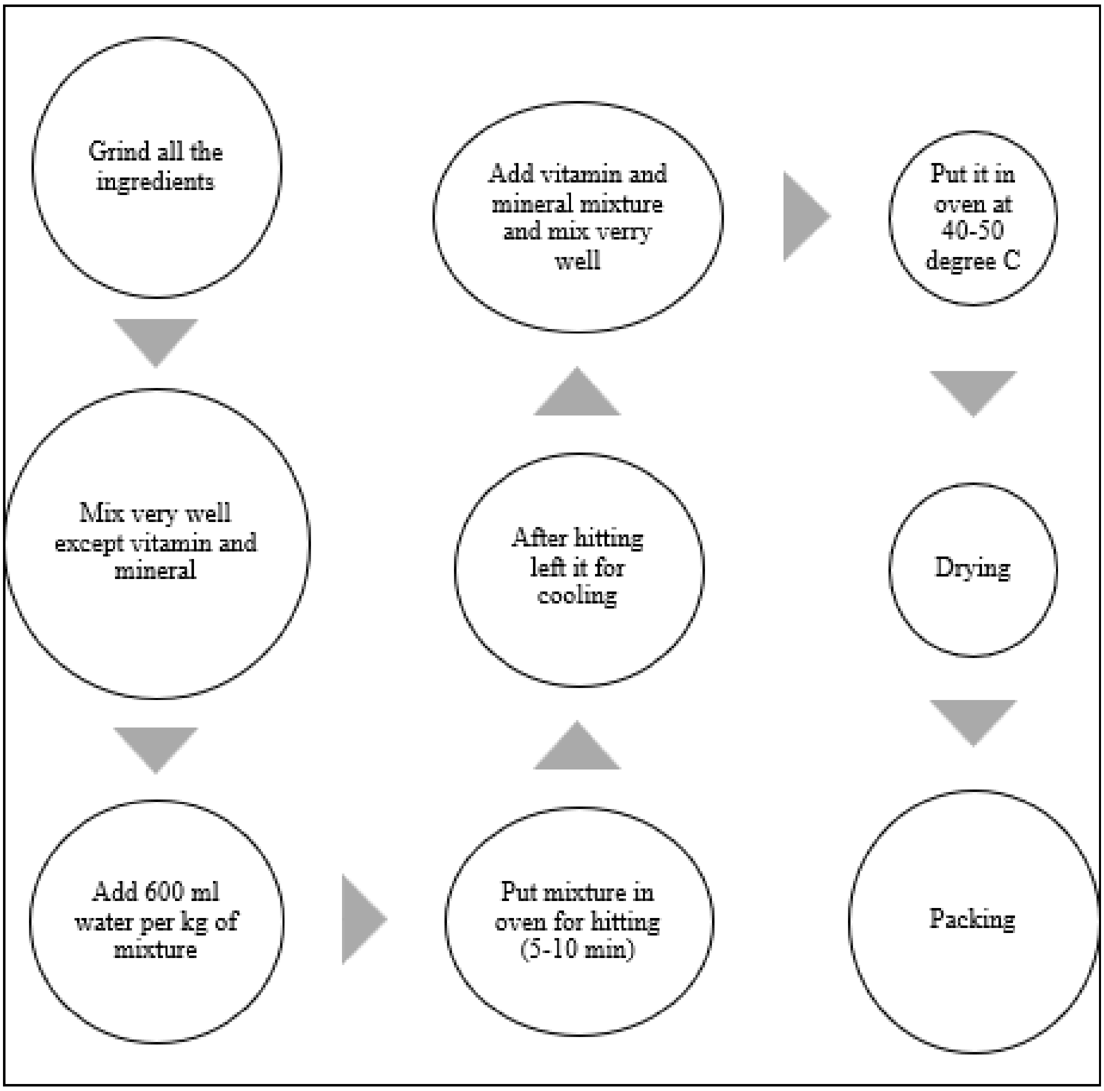
meals that can completely or partially replace live microalgae as larval diets. Their primary drawback, in spite of advancements, is still their very poor nutritional content as compared to live diets. The vitamins contained in the artificial micro-diets are frequently not well defined, or their contents are based on the vitamins found in animal tissue culture medium or the dietary needs of adult animals. For example, fish larvae may require more ascorbate than adults do, especially during the stress of metamorphosis, therefore such levels may not be ideal for these species. It is reasonable to believe that natural food sources with sufficient vitamin content provide larval animals in culture with a favorable development response. If so, the vitamin content shown here may serve as a reference for the ideal vitamin content of artificial diets created for larvae that would typically feed directly on microalgae.

Process of Using Mineral and Vitamin in Farm Made Feed



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Summary

"Diving into the Depths" explores the critical role of micro-nutrients in fish and aquatic environments. From the fundamental importance of minerals in biological functions to the specific functions of macro-minerals like calcium, phosphorus, and magnesium, this article delves into their significance in maintaining health and growth. It highlights the necessity of organic minerals in aquatic animal feed to ensure optimal absorption and utilization. Moreover, it discusses the vital role of microencapsulated vitamin C and microalgae as essential sources of nutrition in aquaculture. By understanding the intricacies of mineral and vitamin utilization in farm-made feed, aquaculturists can enhance the health and productivity of aquatic organisms.

References

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