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Review

The Nutritional Values of Microbial Live Feeds and Their Applications in Fish Farming

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Microorganisms are good sources of nutrients in fish farming. They provide essential amino acids, protein and polysaccharides need by fish and other aquaculture species. They include bacteria, yeasts, fungi and algae. The quality of aquaculture water determines the productivity of the aquaculture and influence the microbial diversity of the aquatic system. The beneficial microbes can be feed directly as live feeds or supplemented with aquaculture feeds. In addition to rich sources protein and carbohydrates, they provide organic acids, fatty acids, growth promoting factors and some extracellular enzymes required for food digestion in the intestinal tract of fish and other aquaculture species. Environmental factors and the nutritional needs of the aquaculture determine the suitability of microbes as live feed. Viable micro-organisms are added directly to the feed or by inoculating the culture water or could be sprayed or top-dressed into basal diets. The ability of some microorganisms to mutate into pathogens, non acceptance of GMOs and over production of antimicrobial substances by some species are some of the associated problems. Despite these shortcomings, the use of beneficial microorganisms has facilitated the development of aquaculture worldwide.

Keywords: Live Feeds, Microorganisms, Polysaccharides, Amino Acids, Fatty Acids Extracellular Enzyme, Growth Factors, Supplements

INTRODUCTION

According to Wang (2007), microorganisms are good sources of nutrients in fish farming. They provide essential amino acids, lipids, protein and polysaccharides need by fish and other aquaculture species (Figure 1). These microorganisms are also rich sources of exogenous enzymes, vitamins and can function in the digestion and absorption process that take place in the digestive tract of aquarium organisms. Wang (2007); and Austin and Austin (2007) argued that bacteria can be established in the gut of fish through food or live food enrichment. They further stated that bacteria, yeasts and microalgae have been used as food supplements. Yeast can directly be fed as a

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Organic acids

(lactic acid, citric acid, etc)

Enzymes ↑ growth factors

Carbohydrases,Proteases, lipases (vitamins, growth promoting hormones)

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Microbial live food

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Fatty acids proteins

(DHA, EPA AND AA) ↓ (amino acids, polyamines)

Polysaccharides

Figure 1: Nutritional Values of Microbes

primary food source for many fish larvae (Hirata et al., 1998). Thus,

Bacteria
Yeasts → Zooplanktons → Fish
Microalgae

Water is the home of fish and its quality is one of the most important aspects of pond management. Eze, and Ogbaran (2010) stated that water quality means the component of water which must be present for optimum growth of aquatic organisms. It is sometimes, an indication of aquatic pollution with high levels of nitrate and phosphorous. These compounds are essential in aquaculture where cultivation of microalgae is required (Eze, and Ogbaran, 2010).

Microbial diversity of fish farm depends on its water quality. Bacteria genera such as Aeromonas, Vibrio, Staphylococcus, Corynobacteria, Pseudomonas, Acinetobacter, Enterobacter, Escherichia, Klebsiella, Proteus, Serratia, and Bacillus have been isolated from fresh water fish and its associated wastewater (Sikoki, and Veen, 2004).). According to Sikoki, and Veen, (2004) (2000), Carnobacteria, Lactobacillus, Leuconostoc, Streptococcus, Lactococcus and Vagococcus have, also, been isolated from fish and fish farm wastewater. Besides, beneficial diatoms (chlorella, Chaetoceros and Skeletonema) and yeasts genera (Candida albicans and Saccharomyces, e.t.c) are found in fish pond.

Hirata et al. (1998) stated that in contrast to the use of microorganisms in terrestrial animals, its use in fishery goes beyond feeds. Its use as a prophylactic measure and probiotics increases on daily basis. These microbial products are used as food supplement in fish culture (Hirata *et al.*, 1998). Bacteria, yeasts, algae and zooplanktons are important ingredients in artificial fish diets and they are cultured easily and economically usually from pond wastewater using traditional culture methods.

BENEFICIAL MICROORGANISMS USED AS FEED IN FISH FARMING

1. Microbial Live Foods

These include bacteria, fungi, protozoa, yeasts and microalgae.

Bacteria and Fungi

Studies have shown that bacterial cells are rich sources of essential amino acids, protein and polysaccharides and also, are rich sources of exogenous enzymes and vitamins (Wang, 2007). They play major role in the digestion and absorption processes in fish and other aquarium organisms by breaking down larger food particles into smaller ones essentially at the early stage of life.

Yeast can be directly fed as a primary food source for many fish larvae. It is, also, used as a feed for zooplankton which is grown for use in fish larvae culture and as an important ingredient in artificial larval diets. Wang (2007) evaluated yeasts as supplement or replacement for algae in the post larval shrimps feeding. Hirata et al. (1998) stated that in contrast to the use of microorganisms in terrestrial animals, its use in fishery goes beyond feeds. Its

use as a prophylactic measure and probiotics increases on daily basis. These microbial products are used as food supplement in fish culture (Hirata *et al*., 1998).

Micro algae

Microalgae of interest in fish farming are chlorophyll bearing unicellulars. However, the use of beneficial multi-cellulars usually in colonial or filamentous forms like *Spyrogira* and *Volvox* have been documented. Besides chlorophyll, some microalgae show various carotenoid pigments which gives their characteristic colours. The *Chlorophyta* (green algae) serve as primary food producers in the aquatic food chain. Recently, mass culture of unicellular algae such as diatoms and small phytoplankters has become quite popular and encouraged for feeding larvae of fishes, prawns, shrimps and molluscs in aqua hatcheries.

According to Brown et al. (1997), the nutritional value of any algal species for a particular organism depends on its cell size, digestibility, lack of ability to produce toxic compounds, and its biochemical composition. He stated that microalgae grown to late-logarithmic growth phase typically contain 30 to 40% protein, 10 to 20% lipid and 5 to 15% carbohydrate (Brown *et al*., 1997). He added that these algae when cultured through to stationary phase, has a significant alteration of its composition (Brown *et al*., 1997 and Harrison, 1990). Some essential components of Polyunsaturated fatty acids (PUFA) derived from microalgae are in form of docosahexaenoic acid (DHA), Eicosapentaenoic acid (EPA) and Arachidonic acid (AA) and are known to be essential at early stage of rearing fish (Sargeant *et al*., 1997). Variations occur in vitamin contents among species of microalgae with ascorbic acid having the greatest variation from algae (i.e. 1 to 16 mg g-1 dry weight) (Brown and Miller, 1992).

The benefits of microalgae in aquaculture are essentially due to its nutritional value as well as its small size which enhances ease of consumption for the early stages of various aquatic species. Maruyama *et al*. (1997) stated that microalgae are essential food sources for rearing all stages of aquatic animals. They also constitute an important source of food for live food organisms used in aqua hatcheries. Microalgae are frequently supplied together with rotifers during first feeding of marine larvae and the technique has enhanced survival as well as growth. According to Maruyama *et al*. (1997), the two types of algal live feeds used in aquaculture are;

I. Live algal cells.
II. A supplementary food (such as baker's yeast).

2. Production of digestive enzymes and growth promoting factors

Some microorganisms function and participate efficiently in the digestive processes of aquatic animals (Balcazar et al. 2006). This, they do by contributing in the digestion process through the production of extracellular enzymes, such as proteases, lipases, as well as growth promoting factors (Wang et al. 2000). Studies have shown that these enzymes are produced by amylolytic, protolytic, lipolytic and cellulolytic microbial species isolated from the gut of fish and other aquatic species (Onianwah et al, 2018). The study done by Das et al (2014) showed that gastrointestinal tract of fish have broad and variable enzymatic potentials. They were able to characterize amylase, cellulose, protease and lipase from gut bacteria flora using cultural, qualitative and quantitative enzyme assay methods. These microbes, also, supply vitamins, fatty acids and essential amino acids to the host (Balcazar et al. 2006; Tinh et al. 2007) as in *Bacteroides* and *Clostridium* species as well as auxenic algae (*Isochrysis galbana*) supplemented with a bacterial strain CA2. This showed improved growth performance with efficient nutrient utilization (Douillet & Langdon 1994). Yeasts are well known in animal nutrition because they can produce polyamines, which enhance intestinal maturation (Wang et al. 2000). Many strains of yeast have been used as dietary supplements in a number of fish species (Tinh et al. 2007).

APPLICATIONS OF MICROBIAL LIVE FEEDS

The method of applications of microbial live feed depends on a number of factors such as nature and viability of microbes being used, environmental factors (pH, salinity, e.t.c.) and the nutritional needs of the aquaculture. Viable micro-organisms are added directly to the feed or by inoculating the culture water (Figure 2 below) with live bacteria, fungi, yeasts and algal species (Bucio Galindo et al., 2009). In some studies, live cultures are sprayed or top-dressed into basal diets and use of freeze-dried/lyophilized cells, dead cells, disrupted cells, cell free supernatants and spores have all showed effectiveness (Merrifield et al., 2010c).

THE ADVANTAGES OF LIVE FOOD MICROORGANISMS IN AQUACULTURE

These include:

1. Live foods have the advantage of small size, and are applied at the on-set of feeding in larvae and juvenile stage of growth.
2. They are easily digestible protein rich diet for fish.
3. Microalgae stimulate enzyme's synthesis and production of some essential growth factors.
4. They are utilized as feed for various stages of growth.
5. They are used to rear zooplanktons for feeding of fish.
6. Sources of protein, energy, vitamins, lipids, pigments and sterols.

Figure 2: Algal culture being added into a fish pond
(Source: Centre for Sustainable Aquatic Research, Swansea University)

7. Beneficial microorganisms enhances gut maturation in aquaculture species

PROBLEMS ASSOCIATED WITH THE APPLICATION OF BENEFICIAL MICROORGANISMS

Beneficial microorganisms are generally considered safe and well tolerated (FAO, 2012). Despite this fact, some constrains are associated with their use, thus:

- Firstly, is the potential of non-pathogenic microbes transforming into pathogens through mutation thereby causing infection of the host in aquaculture system (Ochoa-Solano, and Olmos-Soto, 2006).
- Secondly, the non-acceptance of the use of GMOs in aquaculture is a major setback and requires regulation and policy statements reassuring consumers of the safety of products in line with the recommendation of FAO that beneficial microorganisms are generally regarded as safe (FAO, 2012 and WHO, 2006).
- Thirdly, there is the issue of overproduction of some antimicrobial agents which can impart negatively on the gut and environmental microbiota culminating in the engineering of new endangered species of microorganisms (Panigrahi, and Azad, 2007).
- Fourthly, is the fear of harmless commensals of the gut migrating to other unfamiliar parts of the host to cause infection (Ochoa-Solano, and Olmos-Soto, 2006).
- Improved aquaculture business requires funding. Since farming business is still at subsistent level government attention is required to make policies that supports aquaculture funding.
- Lastly is inadequate enlightenment to create awareness on the Safety of the use of GMOs.

PROSPECTS AND SUSTENANCE OF THE USE OF BENEFICIAL MICROORGANISMS IN AQUACULTURE

- The use beneficial microorganisms boost employment generation through the establishment of more functional feed production industries
- It will encourage efficient feeds production which have easy digestibility through production of more efficient microbial enzymes
- Enhanced healthy aquaculture development requires skill hence proficiency training is necessary. This can be achieved by establishment of training centres
- There will be increase in world protein supply through sustainable aquaculture development using beneficial microorganisms.
- Both individual and national economy will be enhanced by improved aquaculture development through the use of microbial live foods.
- All these improve the quality of life and contribute to human development. As such adequate funding is required.

CONCLUSION

Live feed microorganisms include bacteria, yeasts, fungi and algae. They are good sources of amino acids, protein and polysaccharides, organic acids, fatty acids, growth

promoting factors and some extracellular enzymes required for quality aquaculture development. They are usually fed directly as live feeds or supplemented with aquaculture feeds. Viable micro-organisms are added directly to the feed or by inoculating the culture water or could be sprayed or top-dressed into basal diets. The ability of some microorganisms to mutate into pathogens, non acceptance of GMOs and over production of antimicrobial substances by some species are associated problems. Despite these shortcomings, the use of beneficial microorganisms has facilitated the development of aquaculture worldwide.

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