

## AQUACULTURE FEED SUPPLEMENT

The invention relates to an aquaculture feed supplement for shrimp and fish, wherein the feed is produced by ambient temperature extrusion technology and where the feed supplement produced is in a pellet form and is a final product to be fed to shrimp and fish as-is. The feed is fed direct to the cultured organism as part of their diet and feed regimen opposed to being an ingredient or additive component for a conventionally produced formulated aquaculture feed. More particularly the invention relates to a supplement feed containing bioactive plant ingredients prepared thru a process of fermentation and processed at ambient temperature which is not intended to complete all dietary requirements of the cultured animal but as a supplement to conventional aquafeeds and fed at a rate of 1 to 10 percent of the total diet and feed regimen. The supplement can improve aquaculture pond water quality, animal health and immunity to disease, and improve animal growth and survival.

The product is a supplement to a formulated aquaculture feed as part of the feeding regimen and is not a complete replacement to an aquafeed nor an ingredient for an aquafeed. A "complete" formulated compound aquaculture feed is produced with the intention to provide all necessary amino acid proteins, carbohydrates, minerals, and vitamins required for the cultured specie's development and growth. The aquaculture feed supplement is not intended to fulfill all of the requirements for growth but to supplement a formulated compound aquaculture feed but contains bioactive plant ingredients that supplement the rest of the diet. The supplement is fed directly to the cultured species in the form of a pellet and is intended to function as a replacement to a percentage, from 1 to 10%, of the compound feed. The supplement is in pelleted form

that is or an appropriate size to be readily consumed by the cultured shrimp or fish animal and is fed daily, or at regular intervals, directly into the net cage, tank, or pond where the animals are cultured.

- 5 The aquaculture feed supplement is in an extruded pellet form and is feed directly to the cultured aquaculture species and is not an ingredient or additive to be incorporated into the formulated compound feed, applied to the surface of the feed, or added as a liquid or powder into the culture tank or pond water.
- 10 The aquaculture feed supplement is formulated for shrimp and fish aquaculture species, primarily these being *Litopenaeus vannamei*, commonly called white leg shrimp, or Pacific white shrimp, but could also include *Penaeus monodon*, commonly known as the giant tiger prawn, Asian tiger shrimp, or black tiger shrimp both of the Penaeidae family. Common fish species the aquaculture feed supplement could be fed to include
- 15 *Lates calcarifer*, commonly called barramundi or Asian sea bass and *Salmonidae*, commonly called salmon.

- In the original and widest sense extrusion means to create an object having a fixed cross-sectional profile. This is done by pulling or pushing a formable material through
- 20 a die opening having the desired cross-section. In the foodstuff industry and the feed industry, particularly in the aquaculture feed industry, the notion of extrusion is used in a narrower sense. In these industries so-called extruders of the single screw and double screw types are utilized. The material being extruded is a mixture of protein raw materials, starch containing raw materials, fat, for example in the form of oils and water.
- 25 The water may be added to the mixture in the form of water or steam. Steam and water

may also be added to the mass inside the extruder. In the extruder itself the pasty mass is forced by means of the screws toward a constriction in the outlet end of the extruder and further through a die plate where the mass gets a desired cross-sectional shape. On the outside of the die plate is normally positioned a rotating knife cutting the string coming out of the die holes to a desired length. Normally the pressure on the outside of the die plate will be equal to the ambient pressure. The extruded product is referred to as extrudate. Due to the pressure created inside the extruder, and the addition of steam to the mass, the temperature will exceed 100 °C and the pressure will be above atmospheric pressure in the mass before it is forced out of the die openings. This extrusion process is also referred to as cooking extrusion.

Contrary to the described cooking extrusion process employed in the aquaculture feeds industry our process follows the original sense of the term and additional heat by means of steam is not added thus keeping the extrusion at ambient temperature or near ambient accepting that heat will be generated thru the process of extrusion but no additional heat or steam is added. In this manner, the ingredients are not cooked during the process of extrusion and kept below 50 degrees centigrade in order to maintain the integrity of the bioactive ingredients.

Starch containing ingredients comprise part of the aquaculture feed supplement but since they are not cooked during the process of ambient-temperature extrusion, they are pre-cooked, fermented, or a combination of pre-cooking and fermentation prior to the process of extrusion. This process is referred to per-conditioning and is necessary for the starch granules to swell so that the starch becomes crystalline in structure. This process is referred to as gelatinization of the starch and becomes a binder to hold the

extrudant together and improve its water-stability. In aquafeeds, starch-containing raw materials are added due to their properties as binding agent in the finished feed pellet. In addition, many farmed aquaculture species have little or no digestive enzymes that may alter the starch to digestive sugars. The process of cooking and fermentation of the starch makes it more digestible since the raw starch has been decomposed into smaller sugars.

The aquaculture feed supplement is manufactured via the process of ambient temperature extrusion into a ready-to-feed pellet. For a shrimp supplement, the pellet is available in a 0.5, 1, 1.2, and 1.8mm size +/- 0.2mm and of equal diameter and length. The moisture is of a range from 10 to 15 percent. The pellet has a sinking characteristic when used in aquaculture net, tank, or pond with a salinity of the range from 0 to 40 parts per thousand of salt. The pellet has a water stability time of up to 4 hours when wetted.

The aquaculture feed supplement is comprised of bioactive compounds of a plant-based origin that are prepared thru a process of fermentation and processed at ambient temperature which is not intended to complete all dietary requirements but to improve aquaculture pond water quality, animal health and immunity to disease, and improve animal development, growth, and survival. The supplement's primary bioactive ingredients can be comprised of macroalgae (seaweeds) of the types of Rhodophyta (red), Phaeophyta (brown) and Chlorophyta (green). Combined, these macroalgae form over 50 percent of the supplement's compositions. Other bioactive ingredients may be included to a lesser amount. Additionally, starch containing plant-based ingredients are included in the product formulation to act as a binder and to increase

the water stability of the pellet. The starch may be in a cooked form and may be derived from wheat, corn, potatoes, sweet potatoes, cassava, tapioca, or other starch-containing plants.

- 5 Bioactive compounds can have a positive effect on a living organism and its tissues and cells. Unlike dietary nutrients, which are essential to life, bioactive compounds, while non-essential, can have an as yet to be fully understood positive benefit on the aquaculture species and may include compounds such as carotenoids and astaxanthin.
- 10 The primary ingredients of the aquaculture feed supplement are macroalgae of the families of Rhodophyta (red), Phaeophyta (brown) and Chlorophyta (green). Each type of macroalgae and may be combined into the supplement formula of percentage from 5 to 45% on a dry-weight basis. Other bioactive ingredients may also be added at a percentage from 0 to 5%. All components are dried to below 15% moisture content,
- 15 ground to under 0.5mm in diameter, blended and mixed in a rotary mixer, fermented with bacteria and/or fungus, extruded into pellet form, dried, and packaged.

The object of the invention is to deliver ingredients containing bioactive molecules that are beneficial for aquaculture water stability, animal disease resistance, and improved

20 growth and survival rates directly to the animal being cultured in the form of a ready-to-eat pellet. This is opposed to the bio-actives being made into ingredients which are then incorporated into a formulated aquafeed, applied to the feed surface, or added to the culture tank or pond as a powder or liquid that is not directly available for the culture organism to consume.

In the following are described examples of preferred embodiments illustrated in the accompanying drawings, wherein:

Figure 1 shows ingredient grinding;

Figure 2 shows ingredient fermentation;

5 Figure 3 shows product pellet production;

Figure 4 shows aquaculture feed supplement;

Figure 5 shows administration of the aquaculture feed supplement; and

Figure 6 shows possible beneficial effects of the aquaculture feed supplement on feed conversion ratio;

10 Figure 7 shows possible beneficial effects of the aquaculture feed supplement on survival rate; and

Figure 8 shows possible beneficial effects of the aquaculture feed supplement on average daily gain.

## Claims

1. An aquaculture feed supplement as defined substantially according to corresponding description and figures.
- 5 2. The method of delivery of claim 1 is that it is fed directly to cultured aquatic species.
3. The method of delivery of claim 1 is in the form of a pellet.
4. The method of delivery of claim 1 is that it is a direct replacement to a complete formulated aquafeed.
- 10 5. The amount of inclusion of claim 3 into an aquaculture feed regimen is of a level of 1 to 10% replacement of formulated aquafeed.
6. More precisely, amount of inclusion of claim 4 is 2 to 5% replacement of formulated aquafeed.
7. The cultured species of claim 2 are aquatic animals and may be
- 15 a. Shrimp of the species of the *Penaeidae* family being *Litopenaeus vannamei*, commonly called white leg shrimp, or Pacific white shrimp, but could also include *Penaeus monodon*, commonly known as the giant tiger prawn, Asian tiger shrimp, or black tiger shrimp; and/or
- b. Common fish species the aquaculture feed supplement could be fed to
- 20 include *Lates calcarifer*, commonly called barramundi or Asian sea bass and Salmonidae family, commonly called salmon.
8. The composition of claim 1 contains bioactive plant ingredients.

9. The composition of claim 1 contains seaweeds macroalgae (seaweeds) being
- a. of the types of Rhodophyta (red);
  - b. of the type of Phaeophyta (brown); and
  - c. of the type of Chlorophyta (green).
- 5 10. The composition of claim 1 contains a starch to act as a binder.
11. The method of creation of claim 9 is a process of drying and grinding.
12. The method of creation of claim 1 is a process of fermentation by:
- a. Bacteria; and/or
  - b. Fungus.
- 10 13. The method of creation of claim 1 is a process of extrusion:
- a. creation of a pellet of round or cylindrical shape;
  - b. diameter of 0.1 to 10mm; and/or
  - c. more precisely, 0.5, 1, 1.5, 2, 3, 5, 8, and 10mm.
14. The method of creation of claim 13 is at ambient temperature extrusion of up
- 15 to 50 degrees centigrade.
15. The function of claim 1 is improve an improvement in aquatic animal aquaculture
- a. improve aquaculture pond water quality;
  - b. improve animal health and immunity to disease;
  - 20 c. improve animal growth; and/or
  - d. improve animal survival.