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Fishmeal replacers by alternative sources for shrimp feed: General aspects

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Abstract: *Shrimp production for the year 2025 is expected to be 7,760,000 tons worldwide, which consumed around 10.48 million tons of feed. In Latin America they will be used around of 806,288 tons mainly distributed in three main producers in the region such as Ecuador (543,750 tons), Mexico (187,538 tons) and Brazil (75,000 ton). The shrimp industry is one of the dominant consumers of fishmeal in the aquaculture sector, and to meet the demand of a growing industry given a limited supply of marine ingredients, food manufacturers have decreased the inclusion of fishmeal fish in most commercial diets. It has been found that almost 20% of the overall production of fish meal is supplied through fishery by-products and that the inclusion of at least 10% of a high quality marine origin ingredient is required in the diet. The use of plant no-conventional ingredients has shown that inclusion in shrimp diets above 25% can have a negative effect on their growth. In addition, the inclusion of marine ingredients in at least 5% in the diet contributes to maintaining the palatability of the diets. Regarding the availability of by-products and food waste (3% to 38%), post-harvest technology such as bioconservation and biotransformation contribute to improving the potential as substitute ingredients for fishmeal, and it has been identified that marine plants and microbial biomass have limitations for their application at the industrial level. However now in commercially manufactured shrimp feeds, fishmeal can be partially or totally substituted using alternative plant sources in combination with poultry by-products (as an example), without significantly affecting the growth of shrimp at a semi-intensive level. Finally, it is considered that it is necessary to base the regional development of shrimp farming with a greater use of food inputs not suitable for human consumption, available locally to replace fishmeal, which will translate into long-term ecological, economic and social sustainability shrimp aquaculture industry deadline.*
Key Word*: Fish meal; shrimp; aquaculture; alternative sources.*

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I. Introduction

Shrimp production for the year 2025 is expected to be 7,760,000 tons worldwide, which consumed around 10.48 million tons of feed[1]. In Latin America they will be used around of 806,288 tons mainly distributed in three main producers in the region such as Ecuador (543,750 tons), Mexico (187,538 tons) and Brazil (75,000 ton).The shrimp industry is one of the main consumers of fishmeal in aquaculture and its increasing demand and cost has caused feed manufacturers to decrease the inclusion of fishmeal in commercial shrimp diets[2].Fishmeal (FM) is one of the main components in diets for the culture of shrimpfor its high quality protein (66.0% to 74.0%), micronutrients, associated content of omega-3 or n-3 long-chain polyunsaturated fatty acids (8% to 11% crude lipids). Fishmeal is included between 20.0% to 35.0% in shrimp diets. Due to the rapid development of aquaculture in recent decades, generated an increase in demand for this product, but the limited amount of production of FM caused the price increase and this problem resulted in the need to identify alternative sources of protein for its substitution[3]. A considerable research effort has been generated to reduce the amount of FM in the diet, therefore, the production of food for shrimp is expected to include a minimum or no amount of FM in the coming years to make this productive activity be more socially sustainable and friendly to the environment in the future[4]. In the same way it has happened with fish oils of which alternatives such as single-cell oils, algae oils, plant oils, animal fats, transgenic oils, and fish by-product oil have been tested[5].

II. Sources of animal origin

Alternative sources of protein animal to replace fishmeal in shrimp feed have been selected according to their nutritional value, amount of ingredient, potential to produce and biological response, among those found: marine animal meals (squid meal, squid liver meal, red crab and krill meal) and by-products (fish protein hydrolysates, fish silages, squid oil and shrimp head meal). Supplies of squid meal and oil are scarce and expensive, and their use can only be justified in very small[6], terrestrial animal meals (blood meal, feather meal, meat meal with low ash, meat meal of beef, meat meal of sheep and mixed meat meal), animal by-products (fishery by-products, meat and bone meal and, poultry by-products), and insect meals with the crude protein content of 8.5% to 36.0%,also contain lower levels of omega-3 and higher levels of omega-6 fatty acids[7]. The poultry by-product has been used as substitutes for FM with promising results, but it may vary in nutrient profile, quality based on location, manufacturing methodology, and specific combination materials. Coextruded poultry, soybean by-product meal and minced poultry by-product meal have been used to reduce FM content in diets, without affecting growth, survival and palatability[8].Also, the contribution of dietary nitrogen from poultry by-product meal (PM) to shrimp growth has been evaluated and was similar to FM, but the increase in PM negatively affected growth due to its low lipid quality[9].The replacement of FM with meat and bone meal was 60% to 75% and varies according to the manufacture and proportion of the materials used. However, a decrease in growth has been reported due to dietary methionine deficiency and highly unsaturated fatty acid[10].The processed swine meat meal (SMM) was able to replace 35% of the protein contribution of the FM, but when the protein replacement level was 65%, the growth yield, apparent digestibility of dry matter, raw energy and protein decreased. Increased dietary SMM represents deficiencies in essential amino acids, such as methionine[11].

III. Sources of vegetal origin

Among the sources of vegetable origin that can replace fishmeal were found: plant protein of marine origin, microbial biomass (bacteria that have 50.0% to 60.0% and yeasts with 45.0% to 55.0% crude protein),microalgae (71.0% and 40.0% protein and lipid content, respectively)[12], among which have been found *Haematococcuspluvialis* and *Spirulina platensis*, macroalgae (<1.0% to 48.0% protein content), and plant protein ofterrestrial origin like oilseed meals (canola expeller,canola solvent, cottonseed, peanut, soybean full fat, soybean expeller, soybean solvent), grain legumes (chick pea, field pea, lupin meal and distiller's dried grains soluble), and cereals &by-products (corn gluten, wheat gluten,sorghum grain,wheat grain and wheat offal meal). The substitution of fishmeal for vegetable ingredients is mentioned as environmentally sustainable, since which reduces dependency on the finest marine resources. However, the nutritional requirements of shrimp species may limit the amount of fishmeal substitution due to the need for essential nutrients, which are variable or unbalanced in the ingredients of land plants[13].Among the most studied alternative vegetable sources was soybean meal (SM)[14]. Suitable results were found in growth and survival, on the assimilation of a diet based on vegetable protein (soy primary source of vegetable protein) with high levels of carbohydrates[15].SM has high digestibility in *L. vannamei*, but its manufacturing process can negatively affect digestibility[16]. However, genetic selection in soy may increase digestibility and growth in white shrimp, this response may be due to a better balance in its amino acid composition[17]. Another source of vegetable protein is canola meal, this can be included up to levels of 30.0%, it does not affect growth but it has a tendency to decrease survival at levels above 15.0% inclusion[18].

IV. Digestive protein enzymes in shrimp

It is important to note that the digestibility of fishmeal substitute ingredients can vary due to intrinsic and extrinsic factors of the shrimp culture. As is the case when the organisms were cultivated in eutrophic water from culture in ponds, there are higher activities of serine proteases, collagenase, amylase, lipase, cellulose and acid phosphatase than when cultivated in well water (clear water), probably due to the natural productivity that serves as a source of organic substrate[19]. Digestive enzymatic activity of amylases, lipases, proteases, trypsin and chymotrypsin has been detected in shrimp. Enzymes that hydrolyze a specific peptide bond regardless of its position in the polypeptide or protein molecule are called endopeptidases or more commonly proteinases[20].In*L. vannamei* it has been determined that a decrease in protease and trypsin has been detected in shrimp up to 6.0 g, on the contrary, there was an increase in the activity of chymotrypsin and lipases with the increase in weight of the shrimp. The amylase activity doubled after 2.0 g of weight.In this group is the family of serine proteases such as trypsin and chymotrypsin, which are considered the most important enzymes and responsible for approximately 60.0% in protein digestion, are the most abundant proteolytic enzymes in the digestive gland of shrimp[22]. In general terms, the digestibility of animal and vegetable ingredients have been adequate. However, in some meat meals it was low (64.0% to 74.0%). Energy digestibility was high for ingredients with a high level of protein (animal & plant), but low for those containing a high level of carbohydrate and fiber[23].

V. Conclusion

In conclusion, it has been found that almost 20.0% of the overall production of fishmeal is supplied through fishery by-products and that the inclusion of at least 10.0% of a high quality marine origin ingredient is required in the diet. The use of plant no-conventional ingredients has shown that inclusion in shrimp diets above 25.0% can have a negative effect on their growth. In addition, the inclusion of marine ingredients in at least 5.0% in the diet contributes to maintaining the palatability of the diets.Regarding the availability of by-products and food waste (3.0% to 38.0%), post-harvest technology such as bioconservation and biotransformation contribute to improving the potential as substitute ingredients for fishmeal, and it has been identified that marine plants and microbial biomass have limitations for their application at the industrial level.However now in commercially manufactured shrimp feeds, fishmeal can be partially or totally substituted using alternative plant sources in combination with poultry by-products (as an example), without significantly affecting the growth of shrimp at a semi-intensive level. Finally, it is considered that it is necessary to base the regional development of shrimp farming with a greater use of food inputs not suitable for human consumption, available locally to replace fishmeal, which will translate into long-term ecological, economic and social sustainability. shrimp aquaculture industry deadline.

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