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Hemp Seeds: A Sustainable Alternative to Fishmeal in Aqua Feed Production

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SUMMARY

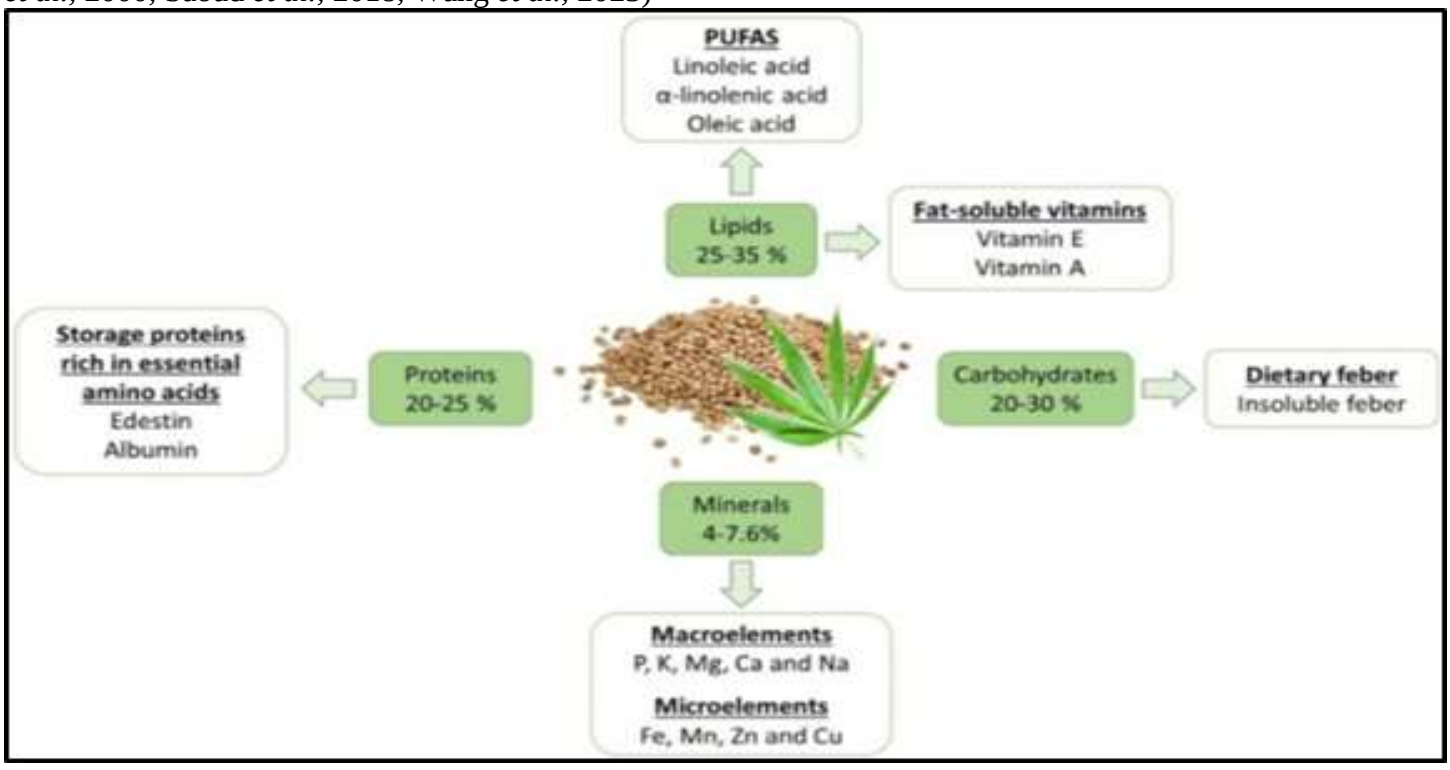
Aquaculture is one of the fastest-growing sectors for addressing global food crisis. However, it encountered significant challenges due to insufficient supply of fishmeal, which supplies all nutrients for fish growth. Hemp is also a potential feed ingredient that, due to its nutrient profile, can replace fishmeal. This study focuses on the nutritional profile, bioactive components, and their effects on growth, nutrient consumption, blood, and immunological parameters in fishes.

INTRODUCTION

As the world's population grows, the task of producing enough food on a sustainable basis becomes more essential. Aquaculture is critical to supplying nutritious and safe food for humans. However, one key difficulty in this industry is the rising cost of feed, which is primarily due to the scarcity of marine feed materials such as fishmeal and oil. According to the FAO's (2022) results, the manufacture of fish meal and oil consumed around 9.06 percent (16 million tons) of total fish harvested. So discovering alternatives to fishmeal is critical in aquaculture. Plant meals are an excellent substitute for fishmeal in the aqua feed business due to their high nutrient profile, particularly their bioactive components. According to that, hemp has a good nutrient source, which is necessary for aquatic animal growth.

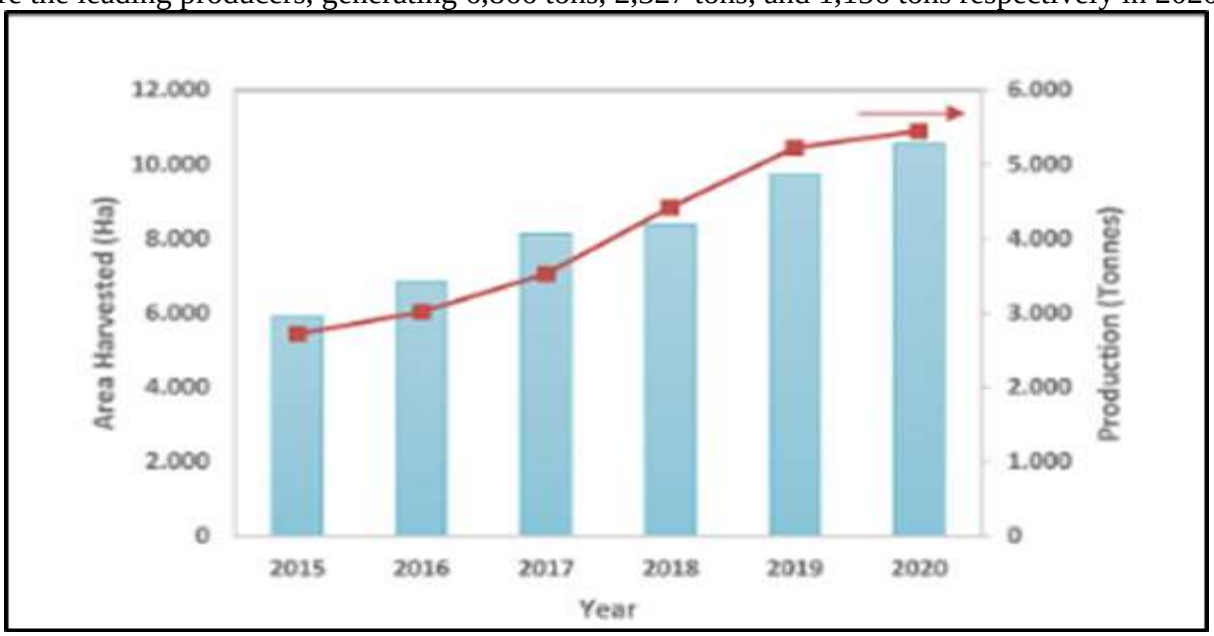
Hemp (Cannabis sativa)

Hemp is a versatile herbaceous plant belonging to the cannabis family. It possesses an excellent nutrient profile, making it essential for sustainable aquaculture. According to Cerino *et al.*, (2021), hemp seeds contain approximately 25% to 35% lipids, 20% to 25% proteins, 20% to 30% carbohydrates, and 4% to 7.6% ash. After processing, hemp protein isolates can reach protein levels of up to 44% to 85%, positioning hemp as a viable substitute for marine ingredients in terms of sustainability and nutrition. In aquaculture, hemp has been utilized as a substitute for fish meal in various fish species, including *Rachycentron canadum*, juvenile Sunshine bass, and Nile tilapia. It shows positive effects in growth, nutrient utilization, antioxidant and immune properties (Webster *et al.*, 2000, Saoud *et al.*, 2018, Wang *et al.*, 2023)



Hemp Distribution and production

Around 10000-15000 years ago, hemp was discovered in Asian countries for its medical benefits. Around 1500 BCE, it spread to Egypt and eastern European countries before reaching the rest of Europe. According to FAO figures for 2015-20, global hemp production has tripled from 2,718 to 5,449 tons. Russia, Chile, and Ukraine are the leading producers, generating 6,866 tons, 2,327 tons, and 1,156 tons respectively in 2020.



Nutrient profile of hemp

Hemp is a nutrient-dense aquaculture feedstock that contains vital fatty acids and amino acids required for aquatic creature growth. It has significant levels of omega-3 and omega-6 fatty acids, which are essential for fish brain development. It contains a total of ten essential amino acids, the majority of which are arginine. Furthermore, as a plant-based product, hemp contains fiber that can be fermented by beneficial bacteria such as lactobacillus, resulting in short-chain fatty acids that support gut health and improve intestinal immunity in aquatic species.

Bioactive Components in Hemp and Their Impact on Aquaculture

Hemp has two types of bioactive components: polyphenols and phytocannabinoids. Tetrahydrocannabinol (THC), cannabidiol (CBD), and cannabigerol (CBG) are three major phytocannabinoids. These chemicals dramatically improve antioxidant capacity, innate immunity, and total body composition in fish. The better permitted limit for tetrahydrocannabinol was less than 0.2% however it will have certain detrimental effects on the food producing industry.

Antinutritional factors (ANF) in hemp

Hemp also contains antinutritional substances that limit nutrient absorption in fish, such as phytic acid, trypsin inhibitors, and saponin (Urbano *et al.*, 2000). Phytic acid was found in hemp at a concentration of 6-10%, which interfered with enzyme activity and affected fish growth. However, there are various technologies available for reducing the antinutritional elements in hemp seed, such as fermentation and heating.

Role of THC in Aquaculture

While hemp contains minimal THC, its presence can offer various benefits in aquaculture. THC has been shown to boost immune responses and reduce stress in aquatic organisms. For instance, in Betta fish (*Betta splendens*), THC can diminish aggressive behaviors, promoting a calmer environment. In Giant yellow croaker 100mg/kg CBD boosting the innate immune defense, antioxidant capacity and blood biochemical parameters (Wang *et al.*, 2023). In Nile Tilapia the supplementation of THC reduced the stress and enhanced the feed efficiency (Juries, 2021)

Maintaining Water Quality

Hemp also plays a crucial role in maintaining water quality. As a natural phytoremediator, it absorbs excess nutrients and pollutants, reducing harmful algal blooms and enhancing the overall health of aquatic

ecosystems. Furthermore, hemp improves nitrogen metabolism in fish, which helps lower ammonia production in the aquatic environment.

Economic Benefits

Incorporating hemp into aquaculture is not only environmentally beneficial but also economically advantageous. With the increasing demand for sustainable seafood, aquaculture operations that adopt hemp can tap into a growing market. Additionally, hemp is a relatively low-maintenance crop that can be cultivated alongside fish farming, potentially increasing overall yields and profitability for farmers.

Case Studies of Hemp in Aquaculture

Research by Webster *et al.*, (2000) indicates that hemp seed meal can effectively substitute fish meal when combined with other protein sources in aquaculture feeds. Studies involving juvenile cobia (*Rachycentron canadum*) have shown that incorporating hemp seed meal in various plant-based diets positively affects survival rates, feed efficiency, muscle composition, and weight gain. In juvenile sunshine bass the inclusion of hemp meal did not give any adverse effects regarding FCR, FER, PER and protein gain like nutrient utilization parameters (Sample, 2022).

The Future of Hemp in Aquaculture

Looking ahead, the potential for hemp in aquaculture is vast. Researchers are exploring innovative breeding techniques and farming methods to maximize its benefits. Introduce modern technologies like defatting, fermentation for reducing ANF and increasing nutrient profile of hemp. As sustainable practices become increasingly important in food production, hemp could play a pivotal role in shaping the future of aquaculture. For future if we focus the optimal dietary level of hemp for different species surely we will utilize the potential of it in Aquaculture.

CONCLUSION

Hemp is more than just a trendy superfood, it is a powerful ally in the quest for sustainable aquaculture. By enhancing fish nutrition, improving water quality, and supporting economic viability, hemp presents a multifaceted solution to some of the industry's most pressing challenges. As we strive for a more sustainable future, embracing innovative crops like hemp will be essential for the health of our oceans and the food systems that rely on them.

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