APPLICATION OF SAGO (*METROXYLON SAGU*) STARCH IN THE DIET OF NILE TILAPIA, *OREOCHROMIS NILOTICUS* (LINNAEUS, 1758) JUVENILES ON NUTRIENT DIGESTIBILITY AND DIGESTIVE ENZYMES

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Abstract: Omnivorous fish utilize dietary carbohydrates better due to the efficiency of nutrient digestibility and enzymes in the digestive tracts. However, the effectiveness of nutrient digestibility and digestive enzymes can be affected by different levels of dietary carbohydrates in the diet. Very limited information is known about the effect on nutrient digestibility and digestive enzymes by different levels of sago starch utilization. A 12 - week feeding trial was conducted to identify the effects of sago (*Metroxylon sagu*) starch in the diet of Nile tilapia, *Oreochromis niloticus* juveniles on nutrient digestibility and digestive enzyme activities. Six isoenergetic (20.25±1.35 kJ/g) semi-purified experimental diets were formulated which consisted of dietary protein levels (P22%; P26%; P30%) incorporated with C38% and C44% of sago starch as the carbohydrates source. All the diets were designated as D1 (P:22%, C:38%); D2 (P:26%, C:38%); D3 (P:30%, C:38%); D4 (P:22%, C:44%); D5 (P:26%, C:44%) and D6 (P:30%, C:44%), respectively. A control diet used was formulated from corn starch and labelled as D0 (P30%: C40%). The result showed fish fed on treatment D3 (80.12%) had higher nutrients digestibility followed by D2 (77.54%), D1 (74.72%), D0 (69.83%), D6 (65.67%), D5 (57.40%) and D4 (50.29%). Digestive enzymes (amylase, lipase and protease) activities were significantly affected among all diets. Fish fed on diet, D3 showed high amylase (6.54 Umg^{-1}), lipase (5.68 Umg^{-1}) and protease (0.77 Umg^{-1}) activities compared to fish from other diet treatments. Two-way ANOVA result confirmed that the incorporation of different levels of protein and carbohydrate had significantly influenced nutrient digestibility and digestive enzyme activities of *O. niloticus* juveniles. Overall, fish fed on C38% sago starch-based diets showed positive result and performed better than those fed with C44% diets. The

study revealed the ability of *O. niloticus* juveniles to spare protein with sago starch was at optimum level of C38% combined with P26% and P30% protein level.

Keywords: Nile tilapia, sago starch, nutrient digestibility, digestive enzymes, juveniles.

Introduction

Dietary carbohydrates are considered as less expensive energy source components in aquatic animal feeds and are efficiently utilized by omnivorous and/or herbivorous warm water fish (Kong *et al*., 2019). In practical terms for fish, carbohydrates can be broadly categorized as starch and non-starch polysaccharides (NSP). Starch which includes dextrin and glucose are relatively well digested and utilized by fish compared to the non-starch polysaccharides (Song *et al*., 2018). Starch is the predominant carbohydrate in plant such as wheat, corn, field peas, grains and legumes, and has been incorporated into diets for fish (Zhang *et al*., 2016). Although carbohydrate is categorised as non-essential nutrients for fish growth, it is commonly incorporated in aquafeeds, providing an energy source for fish (Wang *et al*., 2016). The application of carbohydrate in fish diets has a great benefit in aquaculture sustainability because it contributes to low-cost feed formulation and increases protein retention, reduces ammonia excretion and improves stability and floatability of pellets in extruded diets (Corrêia *et al*., 2019).

As the non-protein energy source, carbohydrates also play an important role in maximizing the efficiency of protein digestibility by the protein sparing effect (Chen *et al*., 2020). Kamalam *et al*. (2017) stated that the ability of fish to utilize dietary carbohydrates differs depending on the feeding habits, type of dietary carbohydrate, physical state and complexity of carbohydrates that are consumed. The adaptive responses of an aquatic animal to their natural feeding habits usually determine their capability to utilize feeds from carbohydrate sources. In fact, the optimal level of carbohydrate applied in aquaculture feed production is important aspect in order to formulate a healthy metabolically efficient diets for cultured fish (Feng *et al*., 2019). Generally, fish species (herbivorous/omnivorous) can utilize high carbohydrate, varied from 350 to 400 g/kg, and their excellent digestive enzymes activity exhibition is the main reason for this high capability of carbohydrate utilization (Azaza *et al*., 2015).