



USING EARLY NUTRITIONAL PROGRAMMING TO ENHANCE THE UTILIZATION OF PLANT BASED DIETS IN LARGEMOUTH BASS

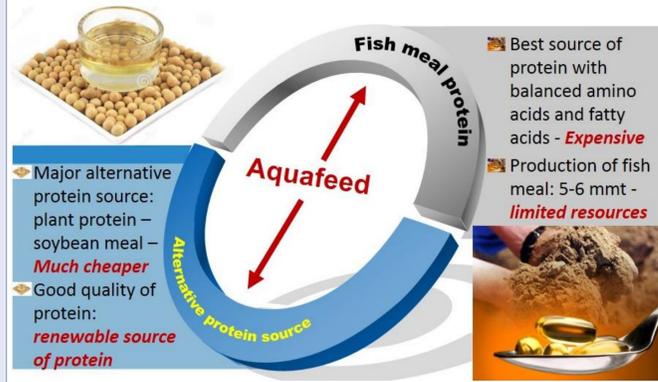


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INTRODUCTION

Aquaculture has been the **fastest growing animal food-producing sector** globally for over half a century, currently representing about **50% of human consumed fish**. There is need for sustainable aquaculture – the replacement of fish-based feed sources by plant-based ingredients.



Complete replacement of fish meal (FM) is often impeded by poor growth in carnivorous fish fed high levels of plant ingredients (Kaushik et al., 2004; Bell and Waagbo, 2008; Montero and Izquierdo, 2010).

Therefore, a strategy of **'adapting the fish to a new feed'**, is that of early nutritional intervention. It is established in mammals and other vertebrates that nutrition during very early stage of life can permanently influence metabolism; the ability to effectively utilize nutrients in later stages of life and the risk to suffer metabolic syndrome; a phenomenon known as **"Nutritional Programming, hereafter NP"** (Symondas et al., 2009).

Adaptive changes in gene expression, preferential colonial selection of adapted cells in programmed tissues and programmed differential proliferation of tissue cell types **might be the biological mechanism for the nutritional programming until adult**.

Therefore, our project was focused to **explore the potential to improve, by means of early nutritional exposure, the growth of carnivorous fish largemouth bass (LMB, *Micropterus salmoides*) fed plant-based diet to reduce its reliance on fish meal as a main dietary protein source.**

GOAL & OBJECTIVES

The overall goal - **to develop alternative methods for enhanced utilization of plant-based diets** and sustainability of LMB production.

The specific objectives are to:

- improve the acceptance and **utilization of feeds rich in plant ingredients** in fish, by means of early exposure to the same plant-based feed during the early stage of feeding
- assess the **potential of early NP by determining the growth, physiological and health parameters**

MATERIALS & METHODS

A three-phase experiment was designed to evaluate the NP of plant-based diets in early juvenile LMB (Figure 1).

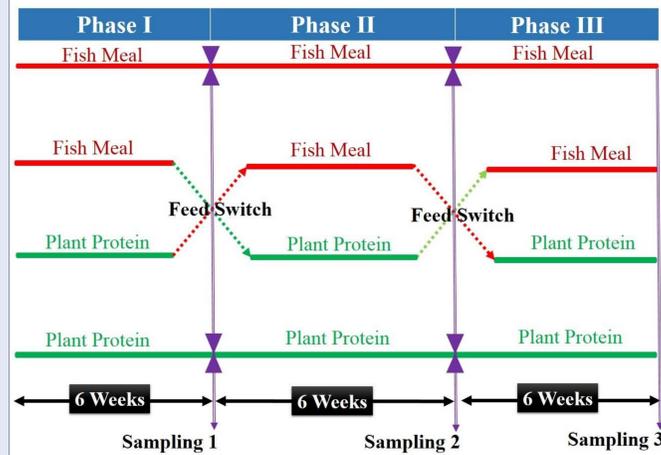


Figure 1: Experimental design

Preceding the experiment, **LMB hatched larvae were fed *Artemia nauplii* for four weeks** and then 1000 larvae distributed into tanks 1 and 2 for the commencement of Phase I (500 larvae/tank). Individual fish larvae weight was 0.1 g and tank size – 100L

In **Phase I**, tank 1 and 2 were fed a FM-based diet (FMBD) and a plant-based diet (PBD) respectively, further details are depicted in Figure 1.

FMBD and PBD were formulated to contain 40% protein and 10% lipid. Fish were fed 3 times daily.

DATA ANALYSES

Following the experimental protocol, fish were weighed at each sampling point after a 24 hour fasting. Three fish/tank were used for blood chemistry.



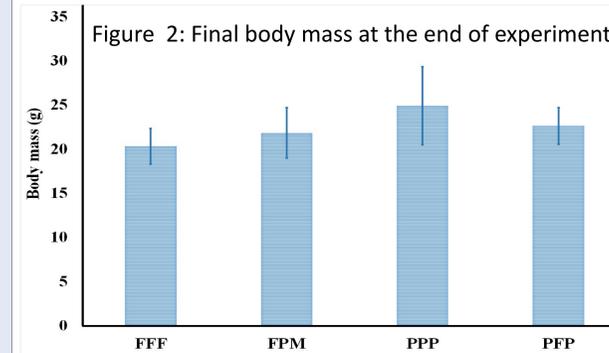
Blood biochemical parameters including alanine aminotransferase (ALT), albumin (ALB), alkaline phosphate (ALP), calcium (Ca), globulin (GLB), glucose (GLU), phosphorous (PHOS) and total protein (TP) were determined by **ABAXIS Vetscan analyzer**.

Proximate analyses of dry diets and dry whole-fish were determined by **MicroPHAZIR™ AG Analyzer**.

All data were subjected to a one-way analysis of variance (ANOVA) followed by Duncan's multiple range test if $p < 0.05$. All statistical analyses were performed using the SAS software.

RESULTS

Data for sampling 3 (end of the experiment) is being presented. The **growth performance of early juvenile LMB was unaffected** ($P > 0.05$) by the dietary treatments and feeding protocols (Figure 2). However, there is increasing trend for PBD fed group.



FFF: Fish meal (FM) feeding followed by FM and FM; **FPM**: FM feeding followed by plant protein (PP) and FM; **PPP**: PP feeding followed by PP and PP; **PFP**: PP feeding followed by FM and PP

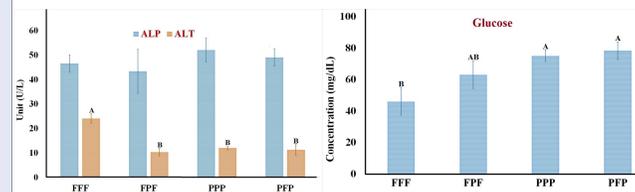


Figure 3: Stress enzymes (ALP and ALT) activity and glucose concentration in the blood of fish. Mean values with different superscript differ significantly ($P < 0.05$).

There were significant differences in concentration of GLU, PHOS and ALT activity in blood whereas no effect on ALP activity. Higher glucose concentration was observed in PBD fed group (Figure 3).

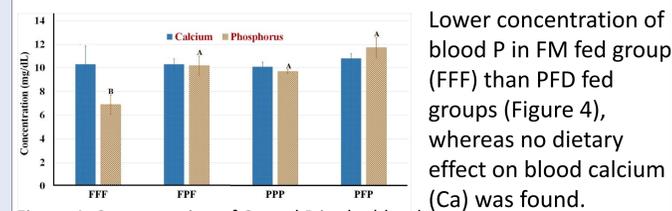


Figure 4: Concentration of Ca and P in the blood

There were no significant effects ($P \geq 0.05$) on ALB, GLB and TP concentration in the blood (Figure 5).

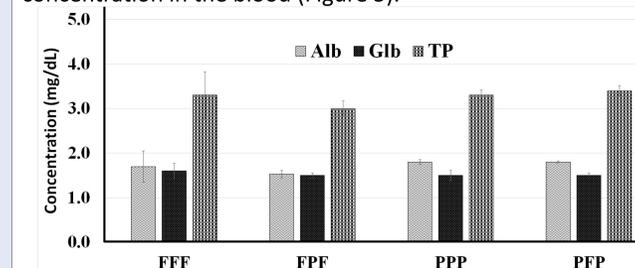


Figure 5: Concentration of albumin (ALB), globulin (GLB) and total protein (TP) in blood of fish

DISCUSSION & CONCLUSION

LMB are the most sought-after freshwater sport fish in the United States and **there are growing markets for them as a farmed food fish as well**.

This is the first study that evaluated the NP of PBD in LMB. Additionally, despite no significant differences in growth, the **observed positive trend towards plant protein suggests further research on this subject is needed**.

Reduced blood protein is normally linked to sub-health or sub-nutritional status of the animal. Diets did not have any significant effects on blood protein, indicating that there were **no adverse effect on the nutrient transport and health status of fish**.

In general, health parameters of LMB in all treatments were found to be within normal ranges. Overall, this study **assessed an alternative method of utilizing PBD by early-stage LMB, which can reduce the cost of LMB production** in the USA.

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