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LEADING AND FEEDING

Nutritional solutions based on macro-minerals

Impact of Monosodium Phosphate (MSP), Monoammonium phosphate (MAP), Monocalcium phosphate (MCP) on Phosphorus and protein digestibility and performances in juvenile *Litopenaeus vannamei*

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1 INTRODUCTION

Inorganic feed phosphates (IFP), a common and stable source of phosphorus (P), are used in shrimp feeds to meet animals' P requirements, that may be impacted by minerals dietary concentration (P, Calcium (Ca), etc.) and digestibility. Several IFP exist on the market with different characteristics (P content, P water solubility, Ca content or pH). Thus, **P digestibility, retention and level released in the water can vary depending on IFP source**. Today, there is still a lack of data on P requirements and digestibility data in fish and especially in crustaceans.

In the present study, performances and digestibility of **monocalcium phosphate (MCP), monoammonium phosphate (MAP) and monosodium phosphate (MSP)** supplemented in low P plant-based diets for juvenile whiteleg shrimp (*Litopenaeus vannamei*) were measured during growth period (until 23 g of individual weight).

2 MATERIALS AND METHODS

Diet formulation	
P-level: Negative CTRL (without IFP)	4.7 g/kg
P-level: IFP treatments	7.2 g/kg
% inclusion MCP	1.2 %
% inclusion MSP	1.1 %
% inclusion MAP	1 %
Ca/P Negative CTRL	0.45
Ca/P MCP	0.55
Ca/P MSP & MAP	0.29

- **52** days
- **400 L** circular tank RAS
- **4** replicates (tank)/treatment
- **100** shrimps/m³
- basal diet: **fish meal-free**; iso nutrient

- Feed started with 5 % biomass and provided nutrients according to estimated nutrient requirements and recommendations for juvenile shrimp to have similar performances to a commercial diet. Experimental diets were formulated with Cr_2O_3 as a marker.
- Apparent nutrient digestibility coefficients (%) of diets and apparent phosphorus digestibility coefficients (%) of IFP sources were calculated according to Lemos *et al.*, 2021, on the performance and digestibility of inorganic phosphates in diets for juvenile shrimp (Lemos *et al.*, 2021).
- Analysis of variance (ANOVA) or Kruskall-Wallis were used to compare diet performances. Differences between means were analyzed by post hoc Tukey HSD or Dunn tests and considered significant at $P < 0.05$.

3 RESULTS AND DISCUSSION

The negative control showed signs of P deficiency, leading to a **significant reduction of shrimp performances compared to IFP supplemented diets** ($P < 0.05$) (Figure 1). Performance of shrimp fed IFP diets had a better final body weight between 22.8 – 23.3 g and a survival rate between 87 – 91%, without differences among these 3 treatments ($P > 0.05$).

IFP supplementation resulted in **higher crude protein Apparent Digestibility Coefficient** (ADC) (Figure 2) **and diet P digestibility** compared to negative control ($P < 0.05$). The phosphorus ADC of IFP sources have then been calculated: 88.2 % MSP, 84.2 % MAP and 79 % MCP ($P > 0.05$) (Figure 2).

(Different letters indicate statistically significant differences (P ≤ 0.05))

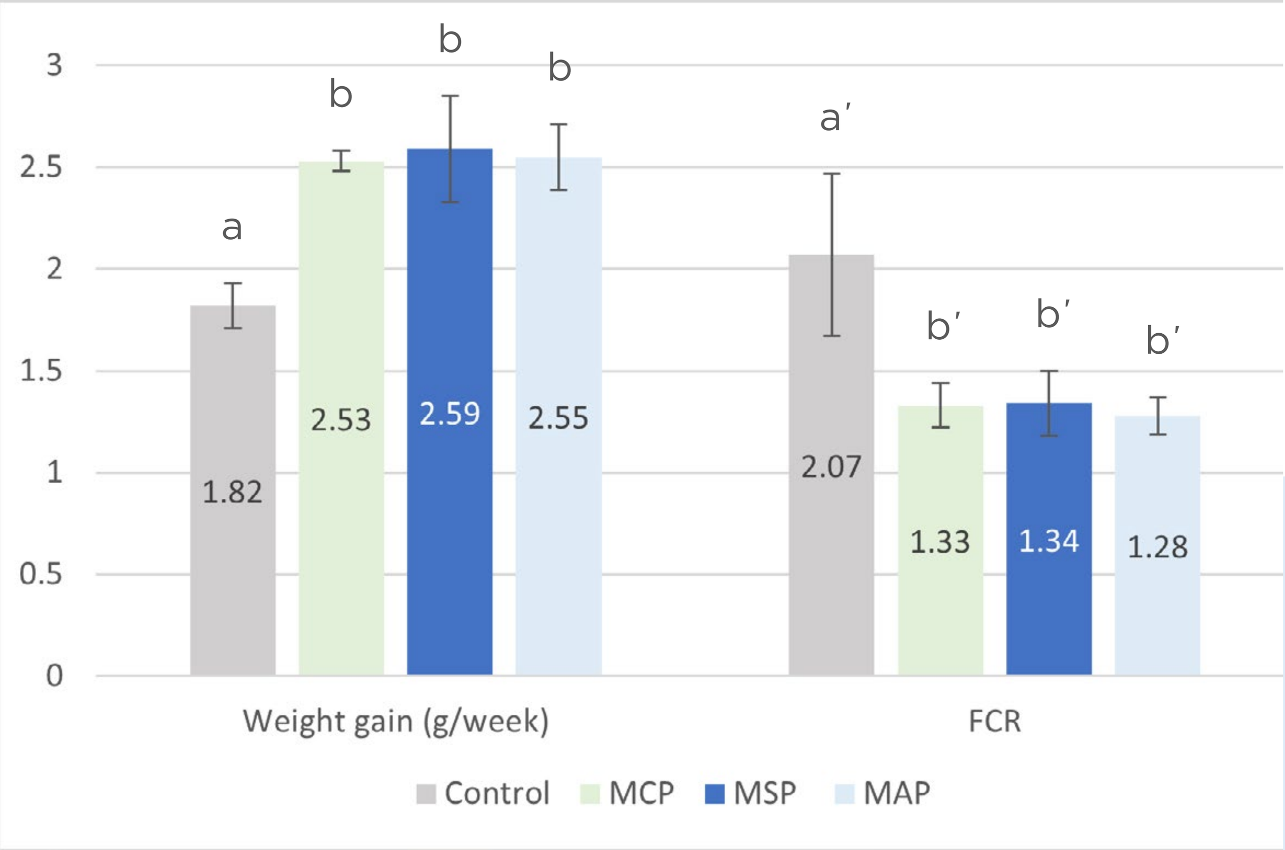

Figure 1. Shrimp performances

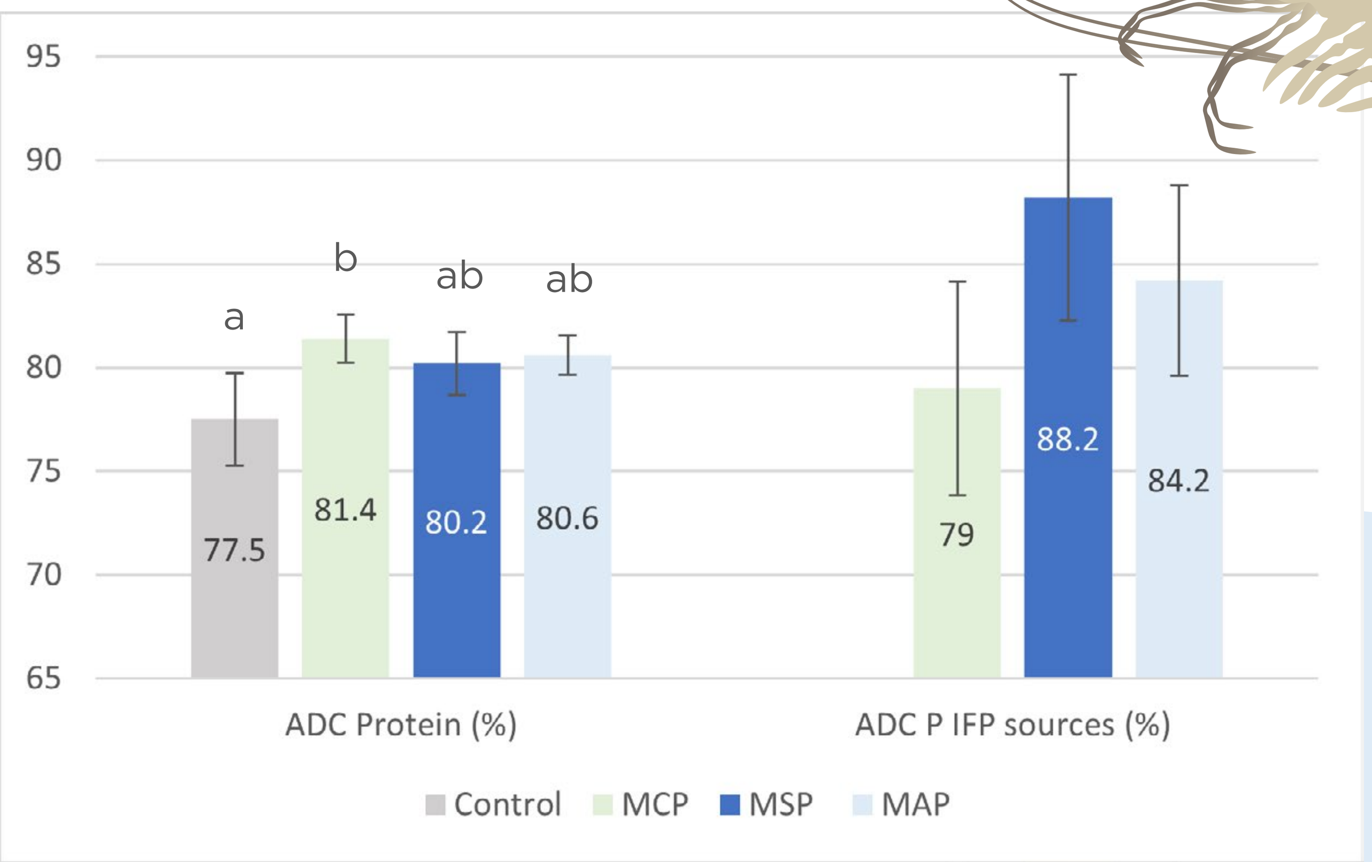

Figure 2. Apparent Digestibility Coefficient (ADC)

Present results corroborate with previous publications (Davis and Arnold, 1994; Zwart, 2018; Lemos *et al.*, 2021) and also suggest **a potential significant difference in nutrient utilization of phosphates by shrimp according to the source of IFP**, as checked in MCP and MAP outputs comparatively. The difference in the digestibility of P from a variety of inorganic phosphates is also considered to be due to the difference in P water solubility (Davis and Arnold, 1994; NRC, 2011).

4 CONCLUSION

- **Inorganic feed phosphate can be considered as an adapted ingredient to support growth in shrimp.**
- **These results constitute the first shrimp comparative reference in the literature between these three IFP. As known for MCP and MAP, MSP is also suitable for juvenile shrimp feeding. It provides an optimized feed efficiency, plus a numerically higher P digestibility.**

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