Exploring the nutritional quality and digestibility of local and regional feed ingredients for shrimp aquaculture in New Caledonia


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INTRODUCTION

Aquaculture is essential in the blue economy and can generate high-quality farmed seafood that improves food security and socio-economic conditions in the South Pacific. But the region faces many challenges such as geographical distances, lack of seeds and feeds, limited domestic markets and climate change.

The blue shrimp aquaculture sector in New Caledonia is an example of socio-economic success with a production of 1,500 tonnes (18 million euros per year). Aquafeeds are produced on the island but is entirely dependent on the importation of distant resources such as fishmeal and soybean meal from South America and India.


Shrimp farm in New Caledonia

To develop more circular aquafeeds, this study aimed to identify and analyse local and more regional sources of plant, animal and microbial raw materials and by-products for the manufacture of feed for animal production, with a focus on shrimp aquafeed formulations. About twenty ingredients were selected and analysed for their nutritional composition and digestibility. Analyses are still ongoing; some results are presented below in the form of proximal composition and digestibility of proteins from 12 ingredients from animal and plant.

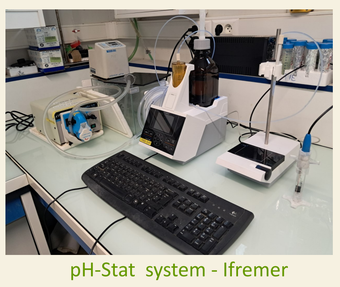
METHODOLOGY

Selected ingredients of different types and origins, from pacific region and beyond, were provided by SICA, a feed manufacturer, based in New Caledonia: from animal (fish, krill, insect, meat, blood) and plant origins (soybean, rapeseed and coconut).

Nutrient compositions were analysed by the CSIRO Queensland Science Precinct laboratory (St Lucia, Australia) as per Simon *et al* (2021) : crude protein, crude lipid, ash, dry matter and amino acid composition.


QBP Nutrition laboratory - CSIRO

Protein digestibility was measured at Ifremer laboratory (Boulouparis, New Caledonia) by the pH-stat method with an automatic titrator (TritroLine® 7000, SI Analytics) which gives the degree of protein hydrolysis. The physicochemical conditions were adjusted as per Dornic *et al* (2024). Briefly ingredients is solubilized in ultrapure water to a protein concentration of 50 or 25 mg.mL^{-1} and pH is adjusted at 8.5. The buffering capacity is determined over 40 minutes, before adding enzymatic extract from digestive gland of blue shrimp to calculate the degree of protein hydrolysis over 60 minutes reaction as follows:


pH-Stat system - Ifremer

$$DH\ (\%) = ((V_T - V_B) \times N_b \times \frac{1}{\alpha} \times \frac{1}{M_p} \times \frac{1}{H_{tot}}) \times 100$$

V_R = volume of 0.01 N NaOH added to maintain the pH at 8.7 in mL during the test; V_B = volume of 0.01 N NaOH added to maintain the pH 8.0 in mL during the buffering capacity test; N_b = normality of the titrant (0.01); α = dissociation coefficient of the α-amino groups at the temperature and pH studied (α= 1.469 at 28°C and pH = 8, Rutherfurd 2010) ; M_p = mass (g) of protein in the sample ; H_{tot} = total number of peptide bonds in the protein source (in meq.g protein^{-1}).

RESULTS - DISCUSSION

Fishmeal produced in New Caledonia from fishing waste has a proximal and amino acid composition quite similar to that imported from Peru (Fig. 1 & 2). While the essential amino acids are present in lower concentrations, the protein digestibility of this local fishmeal is slightly higher than that of the imported one (Fig. 3).

Products of animal origin, whether marine or terrestrial, have high protein concentration (55-76% dry weight), similar to that of fishmeal, except the lobster meal which contains roughly half (33.6%). This crustacean meal has also the lowest *in vitro* digestibility among all the test ingredients (Fig. 3).

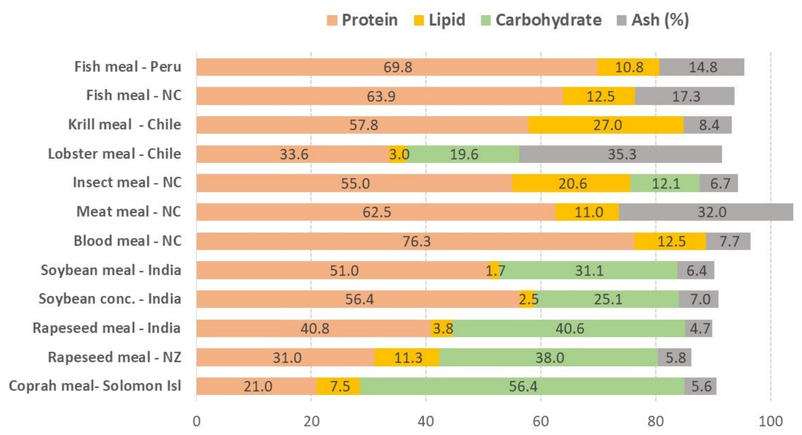


Figure 1: Protein, lipid, carbohydrates and ash content (% of dry weight)

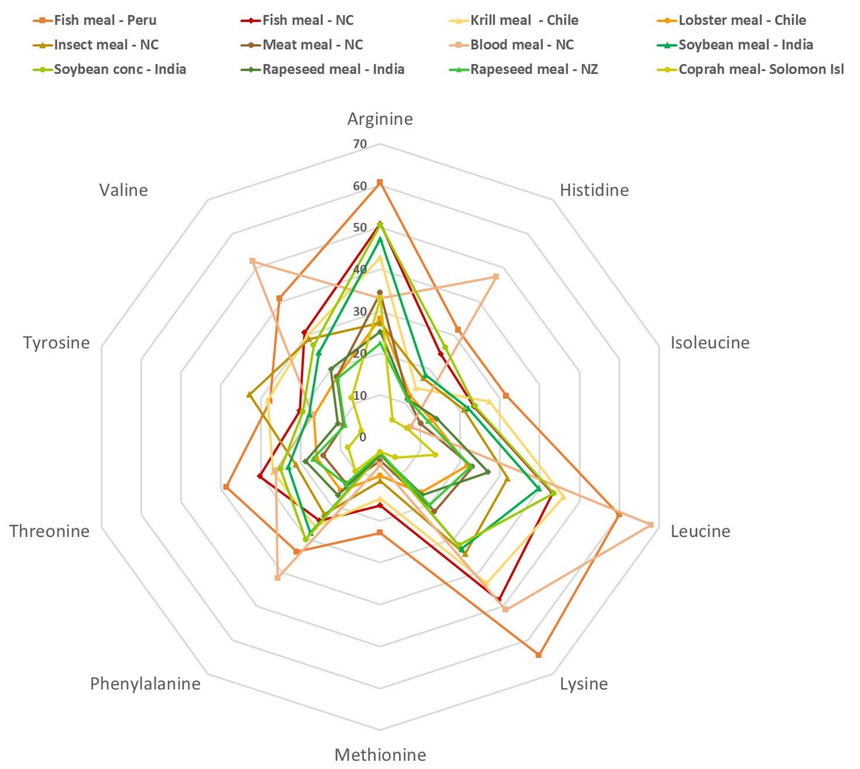


Figure 2: Ingredients composition in 10 essential amino acid (g/kg of dry weight)

Insect meal produced from black soldier fly larvae, in New Caledonia, contains 55% crude protein with lower essential amino acid content than fishmeal (except for tyrosine). The protein digestibility is similar to fish and krill meal.

Blood meal (by-products of meat processing derived from cattle, pigs, deer, sheep and goats) has high crude protein content but amino acid analyses reveal low amino acid content, particularly in isoleucine and methionine (<10g/kg). The essential amino acid content of meat meal is lower than that of other animal meals tested, and its digestibility is lower for shrimp.

Among plant sources, soybean products are widely used as a substitute for fish meal due to their adequate protein content. Other promising plant ingredient, produced in Pacific region, is rapeseed meal even if protein content and essential amino acids are lower (Fig. 1 & 2). The in vitro digestibility is the highest for soybean meal and lowest for New Zealand rapeseed meal (Fig. 3). Coprah meal from Solomon Islands, low in protein, has also the lower digestibility among ingredients from plant origin. These plant products can have negative impact on growth because of anti-nutritional factors (Peng, 2022; Kaiser, 2022), so their incorporation into aquafeeds must be evaluated in vivo, under rearing conditions.

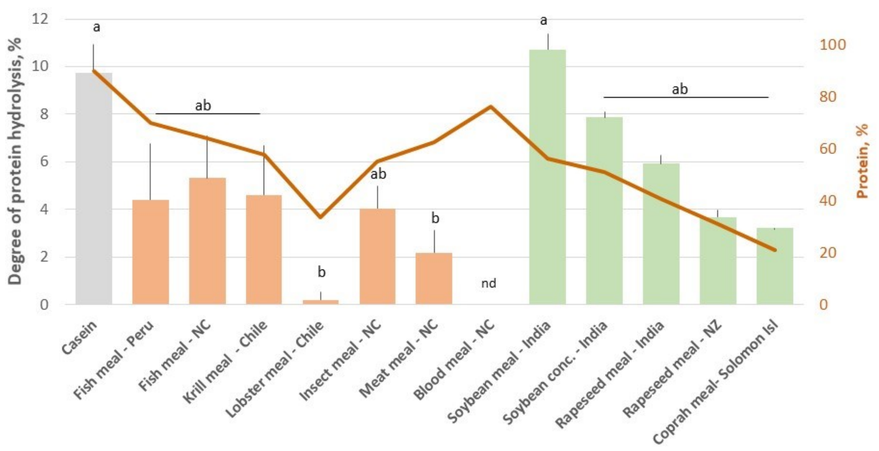


Figure 3: Protein digestibility (mean ± SE) of selected ingredients and their protein level
Casein is used as standard ; nd, not determined for technical reasons; different letters indicate significant differences (p<0.05)

Other ingredients could be interesting for application in feed formulation and are currently under evaluation: poultry by-product meal, feather meal, macro and microalgae, halophytes, microbial biomass.

CONCLUSION - PERSPECTIVES

Some ingredients appear promising for aquafeeds and are currently being evaluated for their in vivo digestibility.

This ongoing project on food security and resilience in the aquaculture sector is part of sustainable development of Pacific islands. Exploring local resources for their application in feeds is part of strengthening the circular bioeconomy: economic profitability of the activity, local job creation, and reduction of the carbon footprint of aquafeeds.

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