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Evaluation of the nutritional value of prototype lupin protein concentrates when fed to rainbow trout (*Oncorhynchus mykiss)*

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Abstract

This study examines the palatability and discrete nutritional evaluation of some prototype lupin protein concentrates (PC) when fed to rainbow trout. Products were developed from both *Lupinus angustifolius* and *Lupinus luteus* kernel meals with an increase in protein of 415 g/kg DM to 690 g/kg DM for *L. angustifolius* and 545 g/kg DM to 750 g/kg DM for *L. luteus*, respectively. This study completes a three-phase approach to evaluating the nutritional value of these products. The digestibility of energy, nitrogen, phosphorus and organic matter were determined in earlier studies using the diet substitution approach. The apparent digestibility of the energy from the *L. angustifolius* PC and the *L. luteus* PC along with the apparent protein digestibility were used to formulate two series of experimental diets to examine both the palatability and discrete nutritional value of the products. Serial inclusion of either PC at 0%, 10%, 20%, 30% and 40% into a typical salmonid diet specification allowed an examination of the palatability of each product. Additional negative controls, based on the 0% diets with inclusion of sulfamerazine sodium, were included in the experiment to demonstrate the capacity of the experiment to detect significant palatability issues. No significant effects of inclusion of either PC on any fish performance criteria, such as feed intake or growth, were identified. In contrast, significant reductions in feed intake and consequently growth were observed from fish fed either of the negative controls. This experiment demonstrated that each PC was highly palatable at inclusion levels up to and including 40% of the diet. Using a protein-limited-restrictively-fed experimental approach the discrete nutritional utilisation of each PC was defined. Growth of fish fed the PC treatments was not significantly different to that of the 0% reference diet. Two control diets with substitutions of cellulose to an equivalent inclusion level to that of the PC have provided an indication of the net benefit of the test ingredients. This experiment demonstrated that each PC provided equivalent nutritional value to the fish at either of the two inclusion levels (20% and 40%) evaluated. These PCs differed in their viscosity and gelling properties which

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may allow feed manufacturers the opportunity to manipulate the physical attributes of their feeds. Together, these studies clearly show that the prototype PCs have substantial potential as a prospective feed ingredient for the aquaculture sector.

Keywords: Plant proteins; Fish meal replacement; Protein concentrate; Protein isolate; Biological value

1. Introduction

In an effort to reduce reliance on fish meal as their primary protein source most modern, nutrient-dense, aquaculture diets now use some inclusion of plant protein ingredients. Lupin (*Lupinus* spp.) meals are one ingredient that have been shown to provide some potential as a useful feed ingredient in fish diets and are being used in commercial diets in increasing quantities (Burel et al., 1998; Carter and Hauler, 2000; Glencross and Hawkins, 2004). There are traditionally three lupin species that are commercially produced and used as feed ingredients. These are the European white lupin (*Lupinus albus*), the Australian narrow-leafed lupin (*Lupinus angustifolius*) and the yellow lupin (*Lupinus luteus*) (Petterson, 2000). Typically it is the kernel meals of lupins that are being used in fish diets. This is supported by numerous reports on the nutritional evaluation of all three lupin kernel meal varieties in aquaculture diets (De la Higuera et al., 1988; Gomes et al., 1995; Burel et al., 2000; Farhangi and Carter, 2001; Glencross and Hawkins, 2004; Glencross et al., 2004a). However, some problems with high inclusion levels of lupins in fish diets have been reported, with minor aberrations in digestion, growth and metabolic processes being reported (Burel et al., 1998; Farhangi and Carter, 2001; Glencross et al., 2004a). These have been attributed to a range of issues including some anti-nutritional factors (Refstie et al., 1998; Francis et al., 2001; Glencross et al., 2003a).

In addition to some issues with prospective ANF in lupin kernel meals it would be of substantial value if they had slightly enhanced nutritional characteristics, such as higher protein levels. To address this, preliminary work on the development of a series of prototype protein concentrates from lupin kernel meals is progressing and a range of products of varying compositional characteristics has been produced (Glencross et al., 2004b). Presently it is unknown if these products have suitable nutritional characteristics for use in aquaculture diets.

In the process of ingredient evaluation there are several key facets to determining or placing a nutritional or biological value on a feed ingredient, principal of which is defining the proportion of nutrients that an animal can obtain from a particular ingredient through its digestive and absorptive processes. Other key facets of this process include the examination of palatability and the capacity for the ingredient to be utilised for growth without influence of factors disturbing metabolic utilisation of the diet. This later issue is about determining the extent of any effect of biologically active components in the ingredient or other factors that might limit its effectiveness as a useful feed ingredient. This strategy has already been used effectively to examine biological value issues in other plant meals (Glencross et al., 2003b). This study reports on two methods of evaluation of the nutritional value of a variety of prototype protein concentrates prepared from lupin kernel meals when included in diets fed to rainbow trout.

2. Materials and methods

2.1. General methods

2.1.1. Ingredients and ingredient preparation

Composition and source of all of the ingredients used are presented in Table 1. Lupin kernel meals (*L. angustifolius*, cv. Gungarru and *L. luteus*, cv. Wodjil) were obtained from commercial grain millers and ground to < 800 μm particle size. Samples of each meal were solubilised in water at room temperature and the pH adjusted to 9.0 with NaOH (1.0 M) with vigorous stirring for 60 min. After mixing, the solution was filtered through an 800 μm filter bag to separate the non-solubilised material from the solubilised protein. The protein