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Apparent digestibility of differently processed grain legumes, cow pea and mung bean in black tiger shrimp, *Penaeus monodon* Fabricius and associated histological anomalies in hepatopancreas and midgut

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Abstract

Experiments were conducted to test the effect different treatment process like dehulling, soaking, autoclaving, germination and germination in combination with autoclaving on proximate composition and antinutritional factors (ANFs) of legume seeds, cow pea and mung bean. An *in vivo* digestibility trial was conducted in black tiger shrimp *Penaeus monodon* to determine the coefficient of total tract apparent digestibility (CTTAD) of differently processed legume seeds. The CTTADs were determined by comparing the concentrations of digestibility marker (Cr_2O_3) in the feed and faeces of the juvenile shrimp (4 ± 0.5 g). Seeds processed by germination in combination with autoclaving were low in ANFs and higher in proximate composition with increased protein contents of 18.3 and 15.6% in cow

Abbreviations: ANF, antinutritional factors; ANOVA, analysis of variance; AOAC, Association of Official Analytical Chemists; B, F and R (cells), types of hepatopancreatic cells; Bb, brush border; CEC, columnar epithelia cells; CPA, autoclaved cow pea; CPD, dehulled cow pea; CPG, germinated cow pea; CPGA, autoclaved germinates of cow pea; CPR, raw cow pea; CPS, soaked cow pea; Cr_2O_3, chromic oxide; L, lumen; M Et, myo-epithelial layer; MBA, autoclaved mung bean; MBD, dehulled mung bean; MBG, germinated mung bean; MBGA, autoclaved germinates of mung bean; MBR, raw mung bean; MBS, soaked mung bean; PM, periotrophic membrane; RF, reference diet; RW, raw; SL CC, sloughed cellular contents; SPSS, Statistical Package for Social Sciences; TD, test diet; TI, test ingredient; Ver., version; W, wall

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pea and mung bean, respectively. Though trypsin inhibitor activity was significantly (P<0.05) high in germinated seeds, there was a significant reduction by 83.3 and 81.21% on germination followed by autoclaving. Due to unexpected mortality of shrimp, dietary treatments containing raw, soaked, and germinated cow pea and mung bean were removed from the trial. There was a significant difference (P<0.05) in the CTTAD values between the feedstuffs and various treatment processes made. Higher CTTAD dry matter (DM), crude protein (CP) and nitrogen free extract (NFE) were obtained with seeds processed with germination in combination with autoclaving and the trend is similar in both the seeds tested. CTTAD for DM, CP and crude lipid of the grain legumes ranged between 0.683–0.885, 0.684–0.834 and 0.704–1.302, respectively. Histological examinations on hepatopancreas and midgut of shrimp sampled at slaughter revealed some common anomalies. With the exception of the shrimp fed dehulled cowpea, histology was normal in all the shrimps sampled at the end of the digestibility trial.

Keywords: *Penaeus monodon*; Digestibility; Plant feedstuffs; Dehulling; Soaking; Autoclaving; Germination; ANFs; Histology

1. Introduction

Legume seeds are high energy, medium protein ingredients which include peas, grams and beans and other closely related species within the Fabaceae family. In shrimp feed, soybean meal is the most widely used among various available plant protein feedstuffs, owing to its nutritional quality, favorable cost and consistent availability (Lim and Dominy, 1990; Samocha et al., 2004). Only recently, researchers have begun to evaluate the suitability of grain legumes such as feed pea (Cruz-Suarez et al., 2001; Davis et al., 2002; Bautista-Teruel et al., 2003), lupin (Sudaryono et al., 1999), cow pea and rice bean (Eusebio, 1991) in shrimp feeds. India is a major producer of grain legumes globally which are frequently used in poultry and livestock diets (Singh, 2003). Grain legumes offer flexibility in feedstuff selection to the feed manufacturer as they have the potential to provide both good energy and moderate protein to the diet. However, the utilization of available protein and carbohydrates in legume feedstuffs are much less than that calculated from the chemical composition because of the presence of various antinutritional factors (ANFs) such as trypsin inhibitors (TI), phytates, saponins and polyphenolic compounds (Liener, 1989; Siddhuraju et al., 2002; Siddhuraju and Becker, 2005). To inactivate or reduce the above mentioned antinutrients, various conventional, simple processing methods have been used such as dehulling, dry heating, roasting, boiling, soaking (in water, alkali and acid), solvent extraction, germination and fermentation (Shastry and John, 1991; Elemo et al., 1998; Siddhuraju et al., 2002). However, none of these methods is able to remove completely all the detected antinutrients that are present in feed materials. Hence, a combination of processing methods is generally more effective than a single method (Siddhuraju and Becker, 2005).

Determination of digestibility can be used to select ingredients that optimize the nutritional value and cost of formulated feeds. Digestibility of a feedstuff by the animal depends not only on the animal digestive tract architecture, physiology and environmental conditions, but also on the physical and nutrient characteristics of the feedstuff (Lee and Lawrence,