

Thesis title: Use of enzymes to improve feed conversion efficiency in Japanese quail fed a lupin-based diet

Summary

There is growing interest in quail production worldwide because, compared to broiler chickens, they are fast-growing, healthy, easy to handle, and have a high feed conversion ratio (FCR). Australian quail have a large body mass and therefore the potential to be some of the best meat-producing quail in the world, but Australian quail producers have been experiencing unprecedented increases in feed costs, mostly driven by the price of imported soybean meal. Feed is the biggest cost (70%) of total quail production, so there is great interest in replacing soybean meal.

One possibility is to replace soybean meal with Australian sweet lupin meal because they have similar contents of protein and energy. However, lupin meal rarely comprises more than 5% of commercial poultry diets. This is mainly because 35% of the lupin kernel is composed of complex non-starch polysaccharides (NSPs). The main NSP in lupin is pectin with branched side-chains of xylan.

Non-starch polysaccharides are indigestible in monogastric animals because they do not secrete the required enzymes to break them down. The digestion of lupin meal is thus very limited with several adverse consequences: i) accumulation of undigested NSP or pectin increases the viscosity of the gut, reducing digestibility of dry matter and growth performance; ii) undigested pectin in the gut increases the water intake, resulting in wet droppings (wet litter), causing odours, coccidiosis outbreaks, soiled eggs; iii) undigested nutrients are excreted into the environment.

The work in this thesis aims to eliminate the negative effects of feeding lupin-based diets to Japanese quail by supplementing lupin meal with exogenous enzymes that break down NSPs. To achieve this goal, three hypotheses were tested:

- a) A synergistic interaction between pectinase and xylanase will improve the physico-chemical properties of lupin more than pectinase or xylanase alone;
- b) For Japanese quail, a combination of pectinase and xylanase will improve feed conversion ratio (FCR) more than the pectinase or xylanase alone;
- c) There will be an optimal dose of the combination of pectinase and xylanase that will offer the best improvement in the nutritive value of lupin meal.

To test my first hypothesis, ground lupin kernels were incubated *in vitro* with pectinase and xylanase, alone and in combination, and the effects on the physical and chemical properties were measured (water holding capacity, viscosity, filtration rate, pectin content). The results revealed that the combination of pectinase and xylanase significantly improved the physico-chemical properties of lupin more than the individual enzymes. This was achieved by a reduction in water-holding capacity by (3%), viscosity (11%) and pectin content (24%) compared to the individual enzymes.

The concept was transferred to an *in vivo* experiment with Japanese quail, using diets containing 10% or 20% lupin meal, with each level of lupin content supplemented with no enzyme (control), pectinase, xylanase, or pectinase + xylanase. The combination of pectinase and xylanase improved growth performance and the FCR in quail consuming a diet containing 10% and 20% lupin kernel compared to the individual enzymes. On the other hand, at this stage, the best diet is one based on 10% lupin meal supplemented with the enzyme combination.

Finally, in the third experiment, I returned to *in vitro* methodology to attempt to identify the optimal doses for the enzyme combination. Ground lupin kernels were incubated with combinations of 3 doses of polygalacturonase (0.35, 0.7, 1.4 U/g), 3 doses of pectinesterase (0.1, 0.2, 0.4 U/g), and 3 doses of xylanase (0.095, 0.19, 0.38 U/g). In the physico-chemical properties, there were some significant differences among the enzyme-dose combinations, but clear overall dose-responses were rarely evident. It seems that all of treatments led to major improvements in the physico-chemical properties of lupin meal, but all the doses were exerting maximum effects, making it difficult to detect a dose-response and thus identify clear optimal doses.

In conclusion, quail producers can include up to 10% of Australian sweet lupin meal in the diet if they supplement with a combination of pectinase and xylanase. This will bring important benefits to the industry by reducing the total production cost without compromising growth performance, FCR or bird welfare.