APPLICATION OF ENZYME TECHNOLOGY TO IMPROVE THE NUTRITIVE VALUE OF HIGH-FIBRE FEEDSTUFFS FOR NON-RUMINANTS

Thesis

submitted to the

Board of Post Graduate Studies of the

University of Nairobi

in partial fulfillment of the requirements for the

Master of Science Degree in Biotechnology

at the

Center for Biotechnology and Bioinformatics

by:

Waititu Samuel Mwangi

BEd. (Science), Egerton University, 2006

July 2011

DECLARATION

Except where reference is made to the work of others, the work described in this thesis is my own or was done in collaboration with my advisory committee. This thesis does not include proprietary or classified information.

Signature:…….Date…….....

Waititu Samuel Mwangi

(Candidate)

APPROVAL

I/We confirm that the work reported in this thesis was carried out by the candidate under my/our supervision

Signature:…….Date…….....

Prof. Charles M. Nyachoti

University of Manitoba

Department of Animal Science

Faculty of Agriculture and Food Sciences

Signature:…….Date…….....

Dr. Joyce G. Maina

University of Nairobi

Department of Animal Production

College of Agriculture &Veterinary Sciences

Signature:…….Date…….....

Prof. James O. Ochanda

University of Nairobi

Center for Biotechnology and Bioinformatics

College of Biological and Physical Sciences

ABSTRACT

An experiment was conducted to determine the effect of supplementing a high fibre diet with combinations of NSP-degrading enzymes on growth performance and nutrient utilization of broiler chickens. The ingredients of the high fibre diet were obtained from U.S.A and Canada but are feedstuff locally available in Kenya, and were chosen to formulate a diet representing a practical Kenyan poultry diet, whereas those of the low fibre diet represented a standard Canadian poultry diet. Proximate analysis was done on the feedstuff comprising the high fibre diet to determine their nutritional values and non-starch polysaccharides (NSP) profile to aid in feed formulation and selection of enzymes, respectively. Two basal diets, a standard low fibre diet, LF, and a high fibre diet, HF, were formulated to meet NRC (1998) nutrient specifications for broiler chickens except for metabolizable energy and crude protein content of both diets, which were 94% and 97% NRC, respectively. The LF basal diet was composed of wheat, corn, were soybean meal, DDGS and canola meal, whereas the HF basal diet was composed of sorghum, brewers' dried grains, cottonseed meal and sunflower seed meal. Titanium oxide (0.3%) was added to the diets as a marker to determine nutrient digestibility. The basal diets were formulated with or without enzyme blends A, B or C to give 8 dietary treatments, which were analyzed as a *2 X 4* factorial arrangement to determine the main effects of diets and enzymes, and interactions between the diet type and enzymes. Enzyme A provided 1,100 units (U) of cellulase, 100 U of pectinase, 50 U of mannanase, 40 U of galactanase, 1,000 U of xylanase, 250 U of glucanases, 10,000 U of amylase, 1,000 U of protease, 600 U of invertase and 500 U of phytase per kilogram of diet. Enzyme B provided 3,000 U of cellulase, 800 U of pectinase, 300 U of mannanase, 40 U of galactanase, 850 U of xylanase, 600 U of glucanases, 2,000 U of amylase, 150 U of protease, 600 U of

invertase and 500 U of phytase per kilogram of diet. Enzyme C provided 5,000 U of cellulase, 1,000 U of pectinase, 400 U of mannanase, 1,400 U of galactanase, 1,500 U of xylanase, 1,500 U of glucanases, 6,000 U of amylase, 600 U of protease, 600 U of invertase and 500 U of phytase per kilogram of diet. Four hundred male broiler chickens were divided into 10 groups of five birds each and fed the 8 diets in mash form from 1 to 21 days of age. Compared with the LF basal diet, the HF basal diet had higher content of NSP (13.3% vs. 10.5%) and neutral detergent fibre (NDF) (18.8% vs. 12.4%). Birds fed HF diets had lower ($P < 0.05$) feed intake and body weight gain, and higher gizzard-to-body-weight ratios compared to those fed the LF diets, but their feed conversion ratios were similar ($P > 0.05$). Supplementation of multicarbohydrases improved ($P < 0.05$) body weight gain, AMEn content of diet, digestibility of NDF, and degradation of NSP in ileal digesta of broilers in both diet groups. Feed intake and feed conversion ratios improved ($P < 0.05$) in birds fed enzyme supplemented diets. Supplementation of phytase improved ($P < 0.05$) digestibility of phosphorus and calcium with greater effects observed in birds given HF treatments. Supplementation of multicarbohydrases decreased ($P < 0.05$) viscosity of jejunal digesta with greater effects observed in broilers fed the LF diets. Enzymes improved ($P > 0.05$) digestibility of crude protein and amino acids and significant diet*enzyme interactions ($P < 0.05$) were observed for digestibilities of glycine, serine, asparagine and threonine. Generally, enzyme blend C had the highest activities of multicarbohydrases showed better effects on most measured responses for broiler chickens in both diet groups but more so for those fed LF diets. It is evident from the present study that the addition of appropriate combinations of carbohydrase enzymes to target cell wall polysaccharide structures could further improve growth performance and nutrient utilization of high fibre diets by broiler chickens. The

chickens fed the enzyme supplemented high fiber diet likely resulted from the cell wall degrading activity of the enzyme supplements and, to some extent, the reduction of digesta viscosity. However, more research