Livestock Science 157 (2013) 184–190

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Growth performance, apparent nutrient digestibility, caecal fermentation, ileal morphology and caecal microflora of growing rabbits fed diets containing probiotics and prebiotics

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ARTICLE INFO

Article history:
Received 22 July 2012
Received in revised form
5 June 2013
Accepted 6 June 2013

Keywords:
Weaner rabbits
Mannan oligosaccharides
Arabinoxylan oligosaccharides
Probiotics
Prebiotics

ABSTRACT

Ninety eight male, mixed breed weaner rabbits were used in a 70 day feeding trial to study the performance, apparent nutrient digestibility, caecal fermentation, ileal morphology and caecal microflora of growing rabbits fed diets containing *Prediococcus acidilactis* (1×10^{10} cfu/g; 0.5 g/kg), *Bacillus cereus* (1×10^{9} cfu/g; 0.5 g/kg), mannan oligosaccharides (MOS; 1 g/kg), arabinoxylans oligosaccharides (AX; 1 g/kg), oxytetracycline (1 g/kg), or synbiotics (TGI; 1 g/kg). A basal diet containing no feed additive was formulated. There were 14 rabbits per treatment. Rabbits fed diets containing MOS had the highest ($P<0.05$) final live weight and weight gain. Dietary inclusion of prebiotics (MOS, AX) resulted in higher ($P<0.05$) weight gains and improved feed to gain ratios. Rabbits fed diets containing MOS showed the highest ($P<0.05$) while those fed diets containing probiotics (*Prediococcus acidilactis*, *Bacillus cereus*) had the least ($P<0.05$) caecal total volatile fatty acid (VFA) concentration. Rabbits fed diets containing prebiotics (MOS, AX) had longer ileal villi than groups fed with other treatments ($P<0.05$). Inclusion of various additives showed reduced caecal coliform counts. The lowest ($P<0.05$) lactobacillus count was obtained in the caecal content of rabbits fed diets containing MOS. Poor growth response was obtained with rabbits fed diets containing *Prediococcus acidilactis* or *Bacillus cereus* while inclusion of prebiotics in growing rabbits resulted in improved growth and gut morphology. Rabbits fed diet containing MOS showed the highest overall final live weight, weight gain, total VFA concentration and reduced caecal lactobacillus count.

1. Introduction

Antibiotics have been widely used in animal production to improve the health, growth rate and well-being of animals. The development of resistant strains of bacteria to antibiotics and the incidence of certain diseases in man traceable to overuse of antibiotics led to the ban on the use of antibiotics as growth promoter by the European Union. In fact the scientific steering committee of the European Parliament in its opinion reported that 'regarding the use of antimicrobials as growth promoting agents, the use of agents from classes which are or may be used in human or veterinary medicine (i.e. where there is a risk of selecting for cross resistance to drugs used to treat bacterial infections) should be phased out and ultimately abolished' (Regulation of the European Parliament and Council, 2003). This situation stimulated research to explore

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http://dx.doi.org/10.1016/j.livsci.2013.06.017

alternatives to antibiotic growth promotants. Prebiotics, probiotics and synbiotics have since been used as alternative growth promotants in poultry (Spring et al., 2000; Fernandez et al., 2002; Xu et al., 2003; La Ragione et al., 2004), pigs (Lee et al., 2009; Chu et al., 2011) and ruminant feeds (Philippeau et al., 2010).

Probiotics are mono- or mixed cultures of living microorganisms which beneficially affect the host by improving the properties of the indigenous microbiota (Fuller, 1992). Probiotics are direct-fed microbial feed supplements which modulate the gut microflora by successfully competing with pathogens through a competitive exclusion process (Mountzouris et al., 2007). Available probiotics include the colonising (*Lactobacillus* and *Enterococcus* spp) and free flowing, non-colonising (*Bacillus* spp, *Saccharomyces cerevisiae*) microorganisms. The mode of action of probiotics is that they produce specific and intermediate metabolites which stimulate the body immune systems (Sherman et al., 2009). Previous studies with rabbits indicated that dietary supplementation of probiotics improved growth rate and enhanced efficiency of feed conversion (Amber et al., 2004).

Prebiotics are nondigestible food ingredient(s) that beneficially affects host health by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon (Gibson and Roberfroid, 1995). They are selectively fermented ingredients that allow specific changes, both in the composition and/or activity in the gastrointestinal microbiota which confers benefits upon host well-being and health (Gibson et al., 2004). Most interest in the development of prebiotics has been focused on the use of nondigestible oligosaccharides and polysaccharides (Mussatto and Mancilha, 2007) which cannot be digested but are readily fermented by anaerobic, colonic bacteria which are regarded as beneficial (Zhang et al., 2003). Prebiotics have shown considerable promise in promoting health and performance of rabbits (Fonseca et al., 2004; Pinheiro et al., 2009). There are few studies on the use of probiotics and prebiotics in rabbit nutrition.

A synbiotic is a mixture of probiotics and prebiotics that benefits the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract. The synbiotic concept has been suggested to give synergistic effects of both prebiotics and probiotics and thus offer a number of health-promoting effects, stimulate growth and improve the welfare of the host (Gibson and Roberfroid, 1995; Awad et al., 2006). Dietary inclusion of Biomin (a synbiotic produced by a combination of the probiotic strain *E. faecium* and prebiotic derived from chicory and sea algae) showed a greater growth-promoting effect in broilers than control group and group fed with probiotic *Lactobacillus* sp (Awad et al., 2009). Previous studies have also shown improved growth and health status of swine fed with synbiotics over groups fed with probiotics (Nemcová et al., 1999). Studies on the use of synbiotics in rabbit nutrition are rare. This study therefore seeks to investigate the growth performance, apparent nutrient digestibility, caecal fermentation, ileal morphology and caecal microflora of growing rabbits fed diets containing probiotics and prebiotics.

2. Materials and methods

2.1. Experimental animals and management

The study was carried out at the rabbit unit of the Teaching and Research Farm of the University of Agriculture, Abeokuta, Nigeria. Rabbits were kept in a well ventilated building in which the maximum temperature was 29.7 °C and the minimum temperature was 26.2 °C. A cycle of natural 12 h of day light and 12 h of dark was used throughout this trial. SimLac (a product containing 1×10^{10} cfu viable strain of *Prediococcus acidilactis per gram*) and SimPro (a product containing 1×10^{9} cfu viable strain of *Bacillus cereus per gram*) supplied by a commercial company (Simbiyotec Biological Product Inc. Tuzaistanbul) were used in this study. Mannose oligosaccharides (MOS) and arabinoxylans oligosaccharides (AX) (Alltech Inc. Kentucky, USA) were used as prebiotics. Total Gut Integrity® (TGI) (a commercial product from Polchem Hygiene Laboratory, PVT. Ltd, Pune, India) was used as synbiotic. The TGI supplement used was based on natural raw materials in combination with a probiotic (*Bacillus cereus*) along with a bacterial cell wall preparation, a non-digestible oligosaccharides (fructo-oligosaccharides), immune-stimulating substances and phycophytic substances that stimulate cellular immunity. Ninety eight male, mixed breed weaner rabbits were used for the study.

2.2. Experimental diets

A basal diet containing no additive (control diet) was formulated while an additional six diets were formulated as shown in Table 1 to include SimPro (0.5 g/kg), SimLac (0.5 g/kg), AX (1 g/kg), MOS at (1 g/kg), TGI (1 g/kg) or feed grade oxytetracycline (1 g/kg). The inclusion level of SimPro and SimLac used were according to manufacturer's specifications. Inclusion level of prebiotics (AX, MOS) used in the current study was based on previous studies (Bovera et al., 2010) while therapeutic dosage of oxytetracycline was used as a negative control. The additives were added to the basal diet and thoroughly mixed to formulate the experimental diets. The rabbits were allotted to the seven dietary treatments with 14 rabbits each. Rabbits were housed individually in cages. The housing and the description of the rabbit hutch was as reported by Oso et al. (2010). Each cage unit contained a feeder and drinker providing free access to feed and water. Fresh experimental diets and clean water were offered. Except for the oxytetracycline group, no medication was administered to the rabbits throughout the 70 day study. Proximate composition (A.O.A.C, 1990) and fibre fraction (Van Soest et al., 1991) of the basal diet was determined.

2.3. Growth response and apparent nutrient digestibility

Feed intake and live weight per cage were recorded on a weekly basis. The average feed intake, weight gain and the feed to gain ratio were also computed.

At the end of the feeding trial, six rabbits per treatment were randomly selected, housed individually in metabolic cages and used to measure apparent nutrient digestibility.