Performance evaluation and nutrient digestibility of rabbits fed dietary prebiotics, probiotics and symbiotics

Ewuola, E. O., Amadi, C. U. and Imam, T. K.

Animal Physiology Laboratory, Department of Animal Science,
University of Ibadan, Ibadan, Nigeria
**Corresponding author:* bisi_ewuola@yahoo.co.uk; GSM +2348060862361

Abstract

A total of 32 weaned rabbits (56 days old; 586 ±60.31g body weight) were selected to investigate the effect of dietary growth promoters on the growth performance, nutrient digestibility and carcass characteristics of rabbits. The rabbits were randomly assigned to four dietary treatments (n = 8) including a basal diet (control), diet 2 (prebiotics: Biotronic®, 4kg/ton), diet 3 (probiotics: Biovet®-YC 500g/ton) and diet 4 (Symbiotic: Biotronic®, 4kg/ton and Biovet®-YC, 500g/ton) in a 12-week feeding trial. Body weight (BW), daily weight gain (DWG), daily feed intake (DFI) and feed conversion ratio (FCR) of individual rabbits were monitored throughout the experimental period. Feed and faecal samples were collected and analyzed for nutrient digestibility at the last week of the experiment. Five rabbits per treatment were euthanized for carcass characteristics at the end of the feeding trial. The supplementation of prebiotics and symbiotics to rabbit diets significantly (P<0.05) increased the FBW, DWG and FCR compared to probiotic diet and the control. However, the daily feed intake was not significantly affected among the dietary treatments. The nutrient digestibility of the rabbits was significantly (P<0.05) influenced by the dietary treatments. There were significant (P<0.05) differences in the dry matter, crude protein, crude fibre, ash, ether extract, and nitrogen free extracts among the dietary treatments. The addition of growth promoting additives had no significant effect on the carcass characteristics measured except the right arms of the experimental rabbits. The results suggest that the prebiotic and symbiotic supplementation can be alternated as natural growth promoter in antibiotic free rabbit diets. This will enhance growth performance by increasing nutrient digestibility of rabbits.

Key words: Prebiotics, Probiotics, Symbiotics, Rabbits, Performance, Digestibility.

Introduction

Gastro-intestinal tract disorders, infections and diarrhoea increase at the time of weaning in young rabbits. This causes large economic losses in the rabbit industry. Weaning is a critical stage for rabbits because of alternations in gastrointestinal tract architecture and function as well as changes in adapting enteric microbiota and immune responses (Boudry *et al.*, 2004; Mao *et al.*, 2005). Rabbits can be affected by weaning stress, such as nutritional, environmental and social stresses, which can cause depressed growth performance, nutrient mal-absorption and high incidence of diarrhoea (Hedemann and Jensen, 2004; Yuan *et al.*, 2006). Weaning is a complex step involving dietary, environmental, social and psychological stresses which interfere deeply with feed intake, GIT development and adaptation to the weaning diet (Pluske *et al.*, 1997).

Despite increasing knowledge in gut morphological changes in young rabbits (Chiou *et al.*, 1994; Yu and Chiou, 1997; Sabatakou *et al*., 1999; Gutiérrez *et al.,* 2002) difficulties subsist to evaluate the respective roles of intrinsic factors such as age and extrinsic factors such as feed. However, the understanding of the gut maturation is essential to determine the nutritional requirements of young rabbits around weaning. Nutrition is an important factor in growth as it enhances the genetic makeup and expression, resulting in maximum growth most especially when supplemented with antibiotics as growth enhancer or promoter. Antibiotics, as growth promoter and therapeutic medicines to decrease the susceptibility to infectious disease, have been widely used in animal production for many years (Fuller, 1992; Barton, 2000). The European Union Commission banned the use of antibiotics as a growth promoter in animal diet (EUC, 2005), because of issues with bacterial antibiotics resistance and antibiotic chemical residue in animal products which may cause problems for human health (Bach, 2001; Smith *et al.,* 2002). Many alternatives in the use of antibiotics have been suggested such as prebiotics, probiotics, symbiotics, enzymes, certain organic acids, essential oils, acidifiers and modifiers of microbial activities (Turner *et al.,* 2001) for investigation.

The use of prebiotics and probiotics are promising approaches that have potential to reduce enteric diseases in livestock and enhance their productivity. These substances have been proposed to assist in the prevention of carcass contamination and improve the immune response in the livestock (Huang *et al.,* 2004). Prebiotics are defined as non-digestible feed ingredients that beneficially affect the host by selectively stimulating the growth and activity of one or a limited number of bacteria in the colon. Consumption of functional oligosaccharides has been shown to improve the growth performance and enhance host health status (Gibson and Roberfroid, 1995). Certain oligosaccharides, including galacto-oligosaccharide, mannan-oligosaccharide, chito-oligosaccharide or fructo-oligosaccharide may improve growth performance in rabbits (Davis *et al.,* 2004; Miguel *et al.*, 2004). Probiotics are defined as “a live microbial feed supplement which beneficially affects the host animal by improving its intestinal balance” (Fuller, 1989). Most organisms used in probiotics are strains of gram positive bacteria of the genera. Bacillus (*B. subtilis*), Enterococcus (*E. faecium*), Lactobacillus (*L. acidophilus*), Bifidobacteria (*B. lactis*), Streptococcus (*S. infanarius*), some yeasts or fungi such as *Saccharomyces cerevisae.* The probiotics mode of action is by “competitive exclusion”. Symbiotics are mixtures of prebiotic and probiotic (Gibson and Roberfroid, 1995) which work by additive or synergistic effects. With the above in mind, this prompted the design of this experiment to investigate growth performance and nutrient digestibility of rabbits fed dietary prebiotics, probiotics and symbiotics.

Materials And Methods

Experimental plan and feeding trial

Thirty-two weaned rabbits (56 days old; mean weight, 586±60.31g) were procured from a commercial rabbit farm at Iwo road, Ibadan, Nigeria for the experiment. All the rabbits were housed in individual wooden cages (55cm x 40cm x 40 cm) during the 12-week experimental period. The rabbits had access to water and feed *ad-libitum* twice daily at 08.00h and 16.00h. The rabbits were randomly assigned to 4 dietary treatments in a completely randomized design. Four diets were formulated including the control (basal diet), diet 2 (prebiotics: Biotronic® at 4kg/ton), diet 3 (probiotics: Biovet®-YC at 500g/ton) and diet 4 (symbiotics: the combination of both Biotronic® and Biovet®-YC at recommended rate above). Prebiotics used was Biotronic® which contains fructo-oligosaccharide and organic acids. Probiotics used was Biovet®-YC which contains *Lactobacillus acidophilus* (45,000 million cfu), *Saccharomyces cerevisiae* (125,000 million cfu), and *Saccharomyces boulardii* (30,000 million cfu), alpha amylase, and Sea Weed powder. The diets were formulated to meet the nutrient requirements of rabbits recommended by NRC (2000) and contained no antibiotics (Table 1). Weekly body weight changes and daily feed intake of individual rabbit were monitored during the experimental period. Feed conversion ratio was estimated from dry matter intake and weight gain.

Table 1: Gross composition (%) of experimental diets for growing rabbits.

	Treatments/Diets			
Ingredients(%)	**1(control)**	**2(prebiotics*)**	**3(probiotics**)**	**4(symbiotics***)**
Maize	30.0	30.0	30.0	30.0
Soybean meal	25.0	25.0	25.0	25.0
Wheat offal	9.0	9.0	9.0	9.0
Rice husk	30.0	30.0	30.0	30.0
Fish meal	3.0	3.0	3.0	3.0
DCP	2.0	2.0	2.0	2.0
Salt	0.5	0.5	0.5	0.5
Premix	0.45	0.45	0.45	0.45
Lysine	0.05	0.05	0.05	0.05
Total	**100**	**100**	**100**	**100**
calculated nutrients				
Digestible energy (kcal/kg)	2744	2744	2744	2744
Crude Protein (%)	16.19	16.19	16.19	16.19
Crude fibre (%)	10.18	10.18	10.18	10.18

*Prebiotics (Biotronic®) inclusion rate at 4kg/ton, **Probiotics (Biovet®-YC) inclusion rate at 500g/ton, ***symbiotic: Prebiotics (Biotronic®) + Probiotics (Biovet®-YC) at normal inclusion rate. DCP- Dicalcium phosphate

Nutrient digestibility

During the last week of the experiment, faecal droppings from each animal were collected, weighed, mixed and aliquots were taken daily. The daily aliquots and the respective feed samples for each animal were oven-dried in an air-circulating oven at 105^0C for 24 hours (to determine their dry matter contents) for further analyses. The chemical compositions of the experimental diets (Table 2) and faecal samples collected, which were used to calculate the apparent digestibility of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fibre (CF), ash and nitrogen-free extract (NFE), were determined by the method of AOAC (2001).

Carcass characteristics

Five rabbits per treatment were selected, fasted over night, stunned and euthanized at the end of the feeding trial for carcass evaluation. Each animal was skinned, eviscerated and cut to various body parts or regions (head, neck, chest, loin, arms and legs) and weighed.

Statistical analyses

The design used for this experiment is a Completely Randomized Design (CRD). The data collected on performance indices, nutrient digestibility and carcass characteristics were subjected to statistical analysis using analysis of variance procedure of SAS (1999).

Table 2: Proximate composition (g/100g DM) of experimental diets for growing rabbits.

	Treatments			
Parameter	**1 (Control)**	**2(Prebiotics)**	**3(Probiotics)**	**4(Symbiotics)**
Dry Matter	87.47	89.14	88.08	88.62
Crude Protein	18.16	18.97	18.73	19.31
Crude Fibre	12.64	13.72	12.81	12.98
Ash	12.05	12.51	12.31	12.42
Ether Extract	11.62	11.80	11.71	9.99
Nitrogen Free Extract	45.53	43.14	44.44	45.30

Results And Discussion

Growth indices of rabbits fed dietary prebiotics, probiotics and symbiotic supplements are as shown in Table 3. All the growth parameters examined were significantly (P<0.05) influenced by the dietary treatments except the daily feed intake. The final live weight, daily weight gain and feed conversion ratio of rabbits fed prebiotic and symbiotic diets were significantly (P<0.05) higher than those that fed probiotic and the control diets. The daily feed intake was not significantly different among the dietary treatments. There was a trend of improvement in overall final live weight, daily weight gain and feed conversion ratio between the treatment groups and the control group in this study. The significant increase in the final live weight and daily weight gain of rabbits fed prebiotic and symbiotic diets was in agreement with the findings of Piray *et al.* (2007) who reported significant increase in body weight gain in broilers receiving diets supplemented with prebiotics. At variance to this result was the finding of Peeters *et al.* (1992) who observed that gluco-oligosaccharides did not effect any significant differences in treated rabbits compared to the control. Lebas (1996) and Mourao *et al.,* (2004) found no effect on growth rate of rabbits fed probiotic diet as evidence in this study. The increase in the body weight gain of broilers fed probiotics reported by Midilli and Tuncer (2001) was at variance with the result observed in this study. Aguilar *et al.* (1996) also reported a possible effect of probiotics on growth rate of rabbits without any effect on feed conversion ratio compared to the control diet.

Table 3: Performance of rabbits fed dietary prebiotics, probiotics and symbiotics

			Treatments		
Parameter	**1(Control)**	**2(Prebiotics)**	**3(Probiotics)**	**4(Symbiotics)**	**SEM**
Initial live weight (g)	587.00	586.00	585.00	585.00	
Final live weight (g)	1710.00^{b}	1810.71^{a}	1708.00^{b}	1824.27^{a}	102.7
Daily weight gain (g)	13.37^{b}	14.58^{a}	13.37^{b}	14.75^{a}	0.62
Feed intake (g)	94.70	95.27	94.47	97.37	3.10
Feed conversion ratio	7.08^{a}	6.53^{b}	7.07^{a}	6.60^{b}	0.17

a, b : mean in the same row with different superscripts are significantly ($P<0.05$) different.
SEM : Standard error of mean.

Under commercial condition, the combination of prebiotics and probiotics in broiler diet have been shown to increase daily weight gain and feed efficiency than feeding only prebiotic or probiotic which corroborates the result with symbiotic diet observed in this study. Probiotics, containing lactic acid bacteria lowers the intestinal pH due to production of lactic acid and organic acid while cells adhere to intestinal cell wall and prevent colonization by pathogens. Probiotic microbes stall competition for nutrient with pathogenic bacteria. Probiotics and prebiotics suppresses the growth of pathogenic microorganisms in the intestine and increases the growth rate and feed conversion efficiency. The inclusion of *L. sporogenes* at 100mg/kg in commercial broiler feed has been reported to increase body weight gain and improved feed conversion ratio in broiler chicks during 0 – 6 weeks of age (Panda *et al.,* 2005). The addition of probiotic at 50g/100kg feed in broiler mash significantly increase growth performance (Gohain and Sapcota, 1998). Live yeast culture (*S. cerevisiae*) plus lactic acid producing bacteria (*L. acidofillus* and *S. faecium*) was supplemented in broilers (1kg/tonne) and results showed improved weight gain and feed conversion. With laying hens, lactobacilli resulted in an improved egg production and feed efficiency (Mohan *et al.,* 1996) contrary to the observation with probiotics in this study probably because of the strains, composition and dosage of the Biovet®-YC used as probiotics. Similar results in line with the finding in this study for probiotics were reported by Gohain and Sapcota (1998) and for prebiotics by Sims and Sefton (1999).

In contrary to non significant differences in feed intake among the dietary treatments, dietary probiotics and prebiotics (Sanchez and Ayaya, 1998) have been shown to increase feed intake. We hypothesized that dietary supplementation of lactobacillus based probiotics would help the beneficial microflora by stimulating the good microflora or by adding beneficial microbes in the gut. This might improve gut health and in that aspect indirectly cause an increase feed intake. Heugten *et al.* (2003) reported that dietary supplement with probiotics could potentially alter gut microflora by selectively stimulating growth of beneficial bacteria while suppressing the growth of pathogenic bacteria.

The nutrient digestibility of rabbits fed dietary prebiotics, probiotics and symbiotics supplement is as shown in Table 4. The nutrient digestibility of the rabbits were significantly (P<0.05) influenced by the dietary treatments. There were significance (P<0.05) differences in the dry matter, crude protein, crude fibre, ash and ether extract among the dietary treatments. The dry matter was significantly (P<0.05) higher in rabbits fed the symbiotic (61.26%) and prebiotics diet (60.83%) compared to those fed probiotics diet (55.07%) and the control diet (53.83%). The crude protein was significantly (P<0.05) higher in rabbits fed the prebiotic diet (75.93%) and symbiotic diet (75.873%) compared to those fed control diet (70.87%) and probiotic diets (69.92%). The crude fibre was significantly (P<0.05) higher in rabbits fed the probiotic diet (52.79%) compared to those fed control diet (15.45%) while those fed the symbiotic (28.09%) and prebiotic (34.13%) diets were statistically the same. The ash was significantly (P<0.05) higher in rabbits fed symbiotics diet (49.01%) and probiotics diet (48.58%) compared to those fed control diet (34.15%) or probiotics diet (27.20%). The ether extract was significantly (p<0.05) higher in rabbits fed the probiotics diet (75.320%) compared to those fed control diet (63.493%) while those fed the prebiotic (69.14%) and symbiotic (65.57%) diets were statistically similar. The nitrogen free extract of rabbits fed symbiotics (73.323%) and probiotics (66.25%) diets were significantly (P <0.05) higher than those fed control (56.95%) and prebiotics (41.45%) diets. The effect of prebiotics and probiotics on digestibility has not been seriously addressed by researchers. In the trial of Yamani *et al.* (1992), lacto-sacc (a complex product containing micro-organisms percentage *Lactobacillus acidophilus, Streptococcus faecium* and yeasts percentage but also enzyme activities percentage protease, cellulases, amylase) improved crude fibre digestibility at 8 and 12 weeks. Amber *et al.* (2004) worked with Lact-A-Bac (*Lactobacillus acidophilus*) and reported improvement in the digestibility of energy and of most analytical fractions (dry matter, crude protein, ether extract) including crude fibre which corroborates the results obtained in this study. However, Gippert *et al.* (1992) and Luicke *et al.*

(1992) found no effect of these growth promoters on nutrient digestibility in rabbits.

The carcass characteristics of rabbits fed dietary prebiotics, probiotics and symbiotics supplements are as shown in Table 5. The relative weights of various carcass characteristics examined were not statistically significant (P> 0.05) except the right arm which was significantly (P<0.05) influenced among the dietary treatments. Similar effect of probiotic and prebiotic on carcass characteristics was reported by Khan *et al.* (1992) and Ozturk and Yidirim, (2005) respectively. A possible explanation for the differences between findings of different researchers may be related to the doses of probiotics and prebiotics applied, animal species and study population (e.g. in age, weight or breed), strains of microorganism used and composition of diets.

Conclusion

In conclusion, the study suggested that Biotronic® and symbiotics (Biovet®-YC + Biotronic®) showed a good potential to be used as alternative and natural growth promoting additive in antibiotic-free rabbit diets to improve nutrient digestibility and enhance growth rate in the animals.

Table 4: Nutrient digestibility on rabbits fed dietary prebiotics, probiotics and symbiotics.

			Treatments		
Nutrient	**1(Control)**	**2(Prebiotics)**	**3(Probiotics)**	**4(Symbiotics)**	**SEM**
Dry Matter (%)	53.83^{b}	55.06^{b}	60.83^{a}	61.25^{a}	1.87
Crude Protein (%)	70.87^{b}	75.93^{a}	69.91^{b}	75.87^{a}	1.75
Crude Fibre (%)	15.45^{c}	34.13^{b}	52.79^{a}	28.08^{b}	1.36
Ash (%)	34.15^{b}	27.19^{b}	48.57^{a}	49.01^{a}	1.86
Ether Extract (%)	63.49^{b}	69.14^{ab}	75.32^{a}	65.57^{b}	1.78
NFE	56.95^{ab}	41.44^{b}	66.24^{a}	73.32^{a}	1.61

a, b : mean in the same row with different superscripts are significantly (P<0.05) different.
SEM : Standard error of mean. NFE-Nitrogen Free Extract (%)

Table 5: Carcass characteristics of rabbits fed dietary prebiotics, probiotics and symbiotics.

	Treatments				
Parameter	**1(Control)**	**2(Prebiotics)**	**3(Probiotics)**	**4(Symbiotics)**	**SEM**
Head (g)	7.65	8.22	8.86	8.17	0.71
Neck (g)	1.82	1.85	1.92	2.18	0.23
Rack (g)	8.51	7.84	8.11	8.08	0.49
Loin (g)	10.85	10.93	11.35	11.81	0.61
Skin (g)	8.63	8.58	8.65	8.44	0.86
Left Legs (g)	9.05	9.01	8.82	9.27	0.37
Left Arms (g)	3.49	3.39	3.48	3.66	0.20
Right Legs (g)	9.25	9.08	8.66	9.30	0.59
Right Arms (g)	3.57^{ab}	3.22^{b}	3.72^{a}	3.64^{ab}	0.14
Carcass weight (g)	47.57	47.46	48.20	48.49	0.98
Slaughtered Weight (g)	1742.0	1754.0	1676.0	1804.0	94.6

a, b : mean in the same row with different superscripts are significantly ($P<0.05$) different.
SEM : Standard error of mean.

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