JOURNAL OF VETERINARY AND APPLIED SCIENCES
2018 VOL. 8 (1): 1 - 7
Manuscript No. JVAS/2017/017; Received: 20/09/2017; Accepted: 09/06/2018
Published by: Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria

PROBIOTIC EFFECTS OF *SACCHAROMYCES CEREVISIAE* ON NUTRIENT DIGESTIBILITY AND pH OF THE GASTROINTESTINAL TRACT OF BROILERS

Ezema Chuka[1], Isokpan Joy Osariemen[1] and Ugwu Chidozie Clifford [2]

[1]Department of Animal Health and Production, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu, State, Nigeria and [2]Department of Animal Science and Technology, School of Agricultural Sciences and Agricultural Technology, Federal University of Technology, Owerri, Imo State, Nigeria.

===

ABSTRACT

The study investigated the probiotic effects of Saccharomyces cerevisiae on nutrient digestibility and pH of the gastrointestinal tract of broilers. One hundred day old broiler chicks were randomly assigned to two groups (A and B) of 50 birds each. Each group was sub-divided into 5 replicates of 10 birds per replicate. Group A (control group) birds were fed diet that had no probiotic while group B (treatment group) birds were fed diet mixed with probiotic at 0.8g per kilogram of feed. They were given feed and water ad libitum and the quantity of feed and water consumed daily was determined and recorded. At weeks 3, 5 and 7, three birds were randomly selected from each group and the pH of their duodenum, jejunum, ileum, caecum and colon were determined. At week 6, three broilers were randomly selected from each group and the apparent digestibility coefficient of the dry matter, organic matter, crude protein and crude fibre were determined. The results of the study showed that supplemented group had significantly ($p < 0.05$) higher mean weight gain than the control. The results also revealed that there was significant ($p < 0.05$) increase in apparent digestibility co-efficient of organic matter, crude protein and crude fibre in the probiotic supplemented group in contrast to the control. The experiment showed significant ($p < 0.05$) decrease in the pH of the colon at both weeks 3 and 5 and increased water intake in the probiotic supplemented group. It was concluded that Saccharomyces cerevisiae supplementation increased apparent digestibility of nutrients, reduced pH of colon and improved weight gain performance in broilers.

Keywords: *Broilers, Probiotic, Digestibility, pH, Weight gain*

===

INTRODUCTION

Over the past 50 years, there has been an increase in the use of antibiotics in poultry production as growth promoters which at sub-therapeutic levels lead to the development of resistance among bacterial strains [1]. These antibiotics leave residues in the dressed carcass which led to the banning of antibiotic growth

***Correspondence: E-mail: chuka.ezema@unn.edu.ng; Tel: +234 7060721739**

ISSN: 2315 – 6856; e-ISSN: 2636 – 5553; *Website: www.jvasonline.com*

promoters and the need for development of suitable alternatives. Among the available options is the use of probiotics as growth promoters.

Probiotics are live microorganisms that have beneficial effects on growth and improvement of health status of animals. Probiotics do not leave residues in the carcass [2]; are not harmful to both animals and man and are known to improve yield [3]. The use of probiotics has many potential benefits, such as exclusion and killing of pathogens in the intestinal tract, reduced bacterial contamination on processed broiler carcasses and enhanced nutrient absorption [4]. Probiotics act by maintaining the dynamic equilibrium of the microbiota which could lead to reduced digestive disorders and contribute to better health and vitality of the host animal [5]. Since healthy animals utilize and convert nutrients of ingested feedstuff effectively into increased growth, the beneficial impact of probiotics on the intestinal microbiota could lead to improved daily weight gain and feed conversion. It is a fact that the pH of the intestine influences the enzyme activity which directly affects the digestibility of feed nutrients.

Saccharomyces cerevisiae is arguably one of the most studied microorganisms. However, its mechanism of action as a probiotic has not been fully understood [6]. It has been reported that it elaborates enzymes which aid in digestion [7]. It also produces lactic acids which increase acidity of the digestive tract thereby decreasing pH in the digestive tract which prevents the development of pathogenic microorganisms and increase enzyme activity with consequent increase in digestibility and utility of minerals, proteins and amino acids [8]. Mannaoligosaccharide obtained from cell wall of *S. cerevisiae* is a natural alternative feed additive which appears to be involved in acceleration of the growth of beneficial bacteria present in normal microflora and the strengthening of the immune system against pathogenic microorganisms [9]. Although *S. cerevisiae* has been established worldwide as brewers' yeast, bakers' yeast and also for wine making, its activity as a probiotic in poultry production has not been very well documented. The study was therefore designed to determine the effect of *S. cerevisiae* as a probiotic on the pH of the gastrointestinal tract, nutrient digestibility and consequently, weight gain of broilers.

MATERIALS AND METHODS

One hundred day old TAMTEK breed broiler chicks were procured from Ibadan, Nigeria and randomly assigned to two treatment groups (A and B) of 50 birds per group. Treatment A had no probiotic in their feed (control) while the treatment group B had probiotic added in their feed. All the birds in each group were weighed and the mean initial weight was determined. Commercial strains of *S. cerevisiae* was procured from B. F. P. Dock Road, Felixtowe, United Kingdom and were identified through growth on Glucose Yeast Agar, using morphology and physiological characteristics. The feeds used for the study were super broiler starter, ordinary broiler starter and broiler finisher diets. The probiotic was added to the feed in the ratio of 0.8g to1kg of feed. The birds were fed super broiler starter from day 1 to day 14, ordinary broiler starter from day 15 to day 28 and finisher diet from day 29 to 56. Table 1 shows the proximate analysis of the commercially procured feed [10].

Feeding Management

The experimental diets were fed to the birds *ad libitum*. Fresh feed were added to the feed troughs twice daily (08 hours and 16 hours). Clean drinking water was constantly available for the birds.

Data Collection

Weight gain

All the birds in the two treatment groups were weighed weekly from D 0 to D56. The mean final live weight and mean weight gain of each treatment group was determined.

pH of the gastrointestinal tract

At weeks 3, 5 and 7, three birds were randomly selected from each group to determine the pH of their duodenum, jejunum, ileum, caecum and colon. At week 3, fifteen test tubes were placed in a rack and appropriately labelled respectively for the duodenum, jejunum, ileum, caeca and colon in triplicates. The birds were sacrificed and the digestive tracts removed. For each bird, sections of these parts were cut and put into their respective test tube containing 10 ml of phosphate buffered saline. The pH of each section of the tract in the test tube was read after 5 minutes using a pH meter. The mean pH for each of the named sections of the GIT was obtained and recorded. These steps were repeated at weeks 5 and 7 respectively.

Table 1: Composition of experimental diets (NRC, 1994)

Feed type	Ingredients	Crude protein (%)	Metabolizable energy (kg/c
Super Broiler Starter			
Maize	40	36.0	13736
PKC	10	1.5	300
Soya bean	38	15.96	1026
Fish	3.0	1.97	85.5
Wheat/offal	3.5	0.595	65.45
Bone meal	4.0		
Salt	0.5		
Lysine	0.3		
Methionine	0.2		
Premix	0.5		
Total	**100**	**23.625**	**2850.55**
Ordinary Broiler Starter			
Maize	46	4.14	1579.64
PKC	13	1.95	390
Soya bean	28	11.76	756
Fish	3.0	3.28	142.5
Wheat/offal	2.5	0.425	46.25
Bone meal	4.0		
Salt	0.5		
Lysine	0.3		
Methionine	0.2		
Premix	0.5		
Total	**100**	**21.55**	**2914.89**
Broiler Finisher			
Maize	57.5	5.175	1974.55
PKC	10	1.5	300
Soya bean	26	10.92	702
Fish	1.0	0.66	28.5
Bone meal	4.0		
Salt	0.5		
Lysine	0.3		
Methionine	0.2		
Premix	0.5		
Total	**100**	**18.255**	**3005.05**

Digestibility study

At the 6^{th} week, 3 broilers were randomly selected from each group and placed in different battery cages for faecal collection. They were allowed to acclimatize for 4 days. Total feed consumed by each bird per day was determined for 10 days. The daily feed intake was determined by feeding a known quantity of feed and by the next day weighing the left over which was then subtracted from the quantity fed. Total quantity of faeces voided by each bird was also determined by collecting the quantity of faeces voided each day by each group and weighing with a standard weighing balance for 10 days. Proximate analysis of both the feed and faeces were performed following the standard procedure and the apparent digestibility coefficient of the dry matter, organic matter, crude protein and crude fibre were calculated using the formula described by Crampton and Haris [11].

Statistical Analysis

The data generated form weight measurements, feed intake, pH measurements and digestibility studies were grouped as means and standard errors of the means and analyzed using one-way analysis of variance (ANOVA). Mean values were compared using Duncan New Multiple range test and significant levels were accepted at the probability of 95% ($p<0.05$) [12].

RESULTS

The results of mean final live weight, mean weight gain, mean feed intake, mean feed conversion ratio (FCR) and mean feed efficiency are presented in Table 2. The mean final live weight, mean weight gain and mean feed intake were significantly ($P < 0.05$) higher among the group that were fed probiotic supplemented diet (Group B) than the control (Group A). The FCR was significantly ($P < 0.05$) lower in group B (1.58) than in group A (1.85) and consequently, the feed efficiency was significantly ($P < 0.05$) higher in group B (63.26%) than in the control (54.19%) (Table 2).

Table 2. Weight gain, feed intake, feed conversion ratio (FCR) and feed efficiency of broilers fed diets supplemented with probiotic.

Parameter	Group A	Group B
Mean initial weight (kg)	0.08 ± 0.01^a	0.08 ± 0.01^a
Mean final live weight (kg)	2.28 ± 0.02^a	2.61 ± 0.05^b
Mean weight gain (Kg)	2.20 ± 0.03^a	2.53 ± 0.08^b
Mean feed intake (kg/bird)	4.06 ± 0.07^a	4.00 ± 0.11^b
Feed conversion ratio	1.85^a	1.58^a
Feed efficiency (%)	54.19^a	63.25^a
Water intake (ml/day)	320.90 ± 6.01^a	364.70 ± 10.23^a

^{ab}Means in the same row with different superscripts are significantly different ($P < 0.05$).

The results of apparent digestibility coefficients are presented in Table 3. The mean apparent digestibility coefficients of organic matter, crude protein and crude fibre were significantly ($P \leq 0.05$) higher in group B than in group A. However, there was no significant difference ($P > 0.05$) in the mean dry matter of both groups.

Table 3. Apparent digestibility coefficients of broiler diets supplemented with probiotic

Parameter	Group A	Group B
Dry matter (%)	84.21 ± 2.18^a	84.96 ± 2.24^a
Organic matter (%)	55.11 ± 2.09^a	65.97 ± 2.16^b
Crude protein (%)	37.98 ± 0.40^a	45.41 ± 0.66^b
Crude fibre (%)	28.38 ± 0.48^a	45.67 ± 0.64^b

^{ab}Means in the same row with different superscripts are significantly different ($P < 0.05$).

Table 4: pH of different sections of the gastrointestinal tract of broilers fed diet supplemented with probiotic.

Week/Section of GIT	Group A	Group B
Week 3		
Duodenum	6.47 ± 0.06^{a}	6.65 ± 0.15^{a}
Jejunum	6.74 ± 0.07^{a}	6.73 ± 0.11^{a}
Ileum	6.86 ± 0.02^{a}	6.87 ± 0.02^{a}
Caecum	6.75 ± 0.01^{a}	6.70 ± 0.08^{a}
Colon	6.85 ± 0.60^{a}	6.63 ± 0.08^{b}
Week 5		
Duodenum	6.47 ± 0.05^{a}	6.28 ± 0.08^{a}
Jejunum	6.39 ± 0.16^{a}	6.58 ± 0.05^{a}
Ileum	6.87 ± 0.02^{a}	6.76 ± 0.10^{a}
Caecum	6.50 ± 0.19^{a}	6.54 ± 0.10^{a}
Colon	6.72 ± 0.06^{a}	6.06 ± 0.03^{b}
Week 7		
Duodenum	6.44 ± 0.09^{a}	6.43 ± 0.04^{a}
Jejunum	6.55 ± 0.02^{a}	6.45 ± 0.05^{a}
Ileum	6.79 ± 0.01^{a}	6.66 ± 0.01^{a}
Caecum	6.70 ± 0.03^{a}	6.54 ± 0.06^{a}
Colon	6.58 ± 0.03^{a}	6.51 ± 0.05^{a}

^{ab}Means in the same row with different superscripts are significantly different ($P < 0.05$).

DISCUSSION

The observed significant increase in weight of the probiotic supplemented group may be attributed to the effect of probiotics in increasing nutrient digestibility and utilization which is in agreement with earlier reports [4]. This could be as a result of the ability of *S. cerevisiae* to produce mannaoligosaccharides in their cell wall which strengthens the immune system of the chicken [8] thereby preventing diseases that should have retarded growth and weight gain since healthy animals utilize and convert nutrients of ingested feed more and translate them to weight gain. Probiotic have been found to increase weight gain in broilers [13].

The mechanism of probiotic stimulation of growth performance is very complex and includes increasing nutrient availability while increasing volatile fatty acid production which are directly absorbed in the hindgut and used as energy source in the tissues [14]. Another mechanism by which probiotics stimulate growth include their effect in regulating the immune system which leads to suppression of the negative effects of chronic immune activation [14,15,16] and by directly protecting epithelial barriers, probiotics enhance nutrient absorption which may also result in enhanced growth.

However, Ashayerizadeh et al. [17] did not find any significant differences in the performance of chicken fed diets containing a mixture of *Lactobacillus* cultures and other bacteria, compared with a non-supplemented diet. It was stated that variations in the effects of probiotics on growth performance of broiler chicken may be attributed to the difference in the strains of bacteria used as the dietary supplements.

There was a glaring increase in the mean apparent digestibility co-efficient of organic matter, crude protein and crude fibre in the probiotic supplemented group in contrast to the control. The increase in digestibility could be due to activities of digestive enzymes that were released by the probiotic. Digestive enzymes aid in the breakdown of food particles into smaller portions which can be easily absorbed by the body. *Saccharomyces cerevisiae* has been reported to elaborate digestive enzymes which help the host to digest fibrous feed [13]. The fibrous walls in the feed make the nutrient unavailable for utilization by the bird. The digestive enzymes produced by the probiotic breaks the walls of the feed ingredients making the nutrients available to the bird for growth and production. Increase in apparent digestibility coefficient is directly correlated to increased weight gain.

Previous studies using growing pigs reported that probiotics increased apparent ileal digestibility and apparent total tract digestibility [18]. Veizaj et al. [19] observed that supplementation with combined probiotics in the diets of weaned piglets, slightly improved weight gain and feed conversion ratio.

The pH of the colon was significantly lower at weeks 3 and 5 among the birds in group B than those in group A. The decrease in pH could be as a result of activities of probiotic at the colon. The yeast undergoes anaerobic fermentation in the colon to produce alcohol which is acidic [20] and lactic acid [7] both of which may be responsible for the reduced pH in that section of the GIT. These acids prevent the development of pathogenic microorganisms and increase enzymatic activity that subsequently result in increased digestibility and utilization of minerals, protein and amino acids [21].

The birds fed diets supplemented with *S. cerevisiae* recorded increased water intake which could be due to increased water re-absorption in the colon [22]. This could also bring about reduced pH of the colon as the removal of water increases the acidity of the colon. Chen et al. [23] observed that probiotic supplementation in the diets of broilers significantly increased the small intestinal weight but had no effect on the intestinal pH. This could also be due to differences in the strain of probiotics used

CONCLUSION

In conclusion, the study has shown that supplementation of broiler diet with *S. cerevisiae* as a probiotic may have contributed to increased nutrients digestibility, reduced pH of colon, increased water intake and improved weight gain in broiler chicken.

REFERENCES

1. Ahmad, I. (2006). Effect of probiotics on broilers performance. *International Journal of Poultry Science*, 5: 593 - 597.
2. Ajuwon, K. M. (2016). Toward a better understanding of mechanism of probiotics and prebiotics action in poultry species. *Journal of Applied Poultry Research*, 25 (2): 277 – 283. Doi: 10. 3382/japr/pfv074.
3. Ashayerizadeh, 1., Dabiri, N., Mirzadeh, K. H. and Ghorbani, M. R. (2011). Effects of dietary inclusion of several biological feed additives on growth response of broiler chickens. *Cell Anim Biol*, 5: 61 – 65.
4. Association of Official Analytical Chemists (!994). *Official methods of analysis*. Association of Analytical Chemists, Vols. 1 & 11, Arlington.
5. Cao, G. T., Zeng, X. F., Chen, A. G., Zhou, L., Zhang, L., Xiao, Y. P. and Yang, C. M. (2013). Effects of a probiotic, *Enterococcus faecium* on growth performance, intestinal morphology, immune response, and caecal microflora in broiler chickens challenged with *Escherichia coli* K88. *Poultry Science*, 92: 2949 - 295.
6. Chen, G. O., Sleman, S. M. B., Mingan C. and Paul, A. I. (2015). Novel Probiotics: Their effects on growth performance, gut development, microbial community and activity of broiler chickens. *Animal Nutrition*. 1 (3): 184 – 191.

7. Crampton, E. W. and Harris L. E. (1969). *Applied Animal Nutrition*, 2nd Edn., Freeman and Co., San Francisco, Califonia.
8. Ezema C. and Ugwu C. C. (2015). Yeast (*Saccharomyces cerevisiae*) as a probiotic of choice in broiler production. In: *Beneficial microorganisms in agriculture, aquaculture and other areas*. Microbiology Monographs, Springer, London, 29: 59 – 79.
9. Ferket, P. R., Parks, C. W. and Grimes, J. L. (2002). Mannan oligosaccharides versus antibiotics for turkeys. Nutritional biotechnology in the feed and food industries: *Proceedings of Alltech's 18th Annual Symposium*, Kentucky, USA, Pp. 43 - 64.
10. Bajagal, Y. S., Kileve, A. V., Dart, P. J. and Bryden, W. L., (2016). Probiotics in animal nutrition – Production, impact and regulation. In: *FAO Animal Production and Health Paper*, Makkar, H. P. S. (Editor), 179: 23 – 28.
11. Fuller, R. (1989). Probiotics in man and animals. *Journal of Applied Bacteriology*, 66: 365 - 378.
12. Duncan, D. B. (19550. Multiple range and multiple F-tests. *Biometrics*, 11: 1 – 42.
13. Gunal, M., Yayli, G., Kaya, O., Karahan, N. and Sulak, O. (2006). The effects of antibiotic growth promoter, probiotic or organic acid supplementation on performance, intestinal microflora and tissue of broilers. *International Journal of Poultry Science*, 5: 149 - 155.
14. Hung, A. T., Lin, S.-Y., Yang, T.-Y., Chou, C.-K., Liu, H.-C., Lu, J.-J., Wang, B., Chen, S.-Y. and Lien, T.-F. (2012). Effects of Bacillus coagulans ATCC 7050 on growth performance, intestinal morphology, and microflora composition in broiler chickens. *Animal Production Science,* 52(9): 874–879.
15. Karademir, G. and Karademir. B. (2003). Yem katkı maddesi olarak kullanılan biyoteknolojik ürünler. *Lalahan Hay. Araş. Ens. Derg*., 43: 61 – 74. (article in Turkish with an abstract in English).
16. Kim J. S., Ingale, S. L., Kim, Y. W., Kim, K. H., Sen, S., Ryu, M. H., Lohakare, J. D., Kwon, I . K. and Chae, B. J, (2012). Effect of supplementation of an multi-microbe probiotic product on growth performance, apparent digestibility, cecal microbiota and small intestinal morphology of broilers. *Journal Animal Physiology and Animal Nutr*ition (Berl.), 96: 618 - 26.
17. Lacy, M. P. (2002). Broiler Management. In: C*ommercial chicken meat and egg production*. Bell, D.B. and Weaver, W. D. (eds.), Kluwer Academic Pub. Norwell, MA. Pp. 829 - 868.
18. Mookiah, S., Sieo, C. C., Ramanasamy, K., Abduliah, N. and Ho, Y. W. (2014). Effects of dietry prebiotics, probiotics and synbiotics on performance, caecal bacteria populations and caecal fermentation concentrations of broiler chickens. *Journal of the Science of Food and Agriculture*, 94 (2): 341 - 348.
19. Mountzouris, K., Tsitrsikos, P., Palamidi, I., Arvaniti, A., Mohnl, M., Schatzmayr, G. and Fegeros, K. (2010). Effects of probiotic inclusion levels in broiler nutrition on growth performance, nutrient digestibility, plasma immunoglobulins, and cecal microflora composition. *Poultry Science,* 89 (1): 58 – 67.
20. Philips, J. A., Porto, M. C., Wang, H., Rubin, E. J. and Perrimon, N. (2008). ESCRT factors restrict mycobacterial growth. *Proceedings of the National Academy of Sciencesof the United States of America*, 105: 3070 – 3075.
21. Veizaj, E., Tafaj, M. and Manner, K.(2008). The effect of the combined probiotic preparation on growth performance, digestibility, microbial composition of intestine and faeces of weaned piglets. *Agricultura*, 5: 37 – 41.
22. Yan, L. and Kim. I. H. (2011). The apparent total tract digestibility, apparent ileal digestibility and noxious gas content of growing pigs fed probiotic supplemented diets. *Wayamba Journal of Animal Science*, 3: 122 – 127.
23. Yang, Y., Iji, P. A., Kocher, A., Mikkelsen, L. L. and Choct, M. (2008). Effects of dietary mannanoligosaccharide on growth performance, nutrient digestibility and gut development of broilers given different cereal-based diets. *Journal of Animal Physiology and Animal Nutrition*, 92: 650 - 659.