Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola

ISSN 1516-635X 2021 / v.23 / n.2 / 001-010

http://dx.doi.org/10.1590/1806-9061-2020-1388

Original Article

Effects of Dietary Supplementations of Synbiotics on Growth Performance, Carcass Characteristics and Nutrient Digestibility of Broiler Chicken

■Author(s)

Nisar H[I] https://orcid.org/0000-0003-0470-8826
Sharif M[I] https://orcid.org/0000-0002-1954-5778
Rahman MA[I] https://orcid.org/0000-0002-6894-1128
Rehman S[I] https://orcid.org/0000-0003-2366-8153
Kamboh AA[II] https://orcid.org/0000-0002-5176-6685
Saeed M[III] https://orcid.org/0000-0001-5048-5753

[I] Institute of Animal and Dairy Sciences, University of Agriculture, Faisalabad.
[II] Department of Veterinary Microbiology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tandojam, Pakistan.
[III] Department of Poultry Science, Faculty of Animal production and technology, Cholistan University of Veterinary and Animal Sciences Bahawalpur 63100 Pakistan.

■Mail Address

Corresponding author e-mail address
Muhammad Sharif
Institute of Animal and Dairy Sciences, University of Agriculture, Faisalabad, Pakistan.
Phone: +92 301 6025041
Email: drsharifuaf@yahoo.com

■Keywords

Synbiotic, Nutrient digestibility, Meat quality and Antibody titer.

Submitted: 07/September/2020
Approved: 28/February/2021

ABSTRACT

The study aimed to explore the effect of dietary supplementation of synbiotics on growth performance, carcass characteristics and nutrient digestibility in broiler chicken. For this purpose, three hundred 1-day-old Cobb-500 broiler chicks were purchased from the hatchery and randomly distributed into five dietary treatment groups. Each treatment had six replicates, each containing 10 chicks. The experimental diets were supplemented with 0, 700, 1200, 1700 or 2200 g/ton of feed synbiotics and respectively designated as A, B, C, D and E, with A being the control diet. Feed intake, weight gain and feed conversion ratio data were recorded on a weekly basis. At the research trial's end, two birds from each pen were randomly selected and slaughtered to get data on carcass characteristics. Results showed that group C's feed intake was reduced ($p<0.05$) when compared to control. Body weight was similar ($p>0.05$) among all treatments. However, feed conversion ratio was significantly improved ($p<0.05$) in group C as compared to other dietary treatments. Nutrient digestibility was improved ($p<0.05$) in group B and C, as compared to control. Carcass characteristics were not significantly affected and remained the same across all treatments. However, liver weight decreased in birds fed diet C. Meat quality and antibody titer were not affected in any of the dietary treatments. It is concluded that synbiotics can be safely used up to 1200 g/ton of feed, improving bird performance without harmful effects on bird health.

INTRODUCTION

Pakistan's poultry industry is continuously growing, making a marvelous contribution to bridging the gap between the supply and demand of animal protein requirements. In spite of this, per capita consumption of meat is only 7.20 kg in Pakistan, while developed countries have a 40 kg per capita consumption (PPA., 2019).

Although the poultry industry is potentially growing to meet nutrient requirements, it is facing various problems in the form of diseases, due to extensive production. That is why the use of antimicrobial and antibiotic growth promoters (AGPs) for therapeutic and prophylactic purposes has become popular since 1940 (Edens, 2003; Pelicano *et al.*, 2004; Castanon, 2007). Growing antibiotic resistance and ban on AGPs in many countries have led to a great concern in finding alternatives to antibiotics in chicken production (Obajuluwa *et al.,* 2021). An alternative to therapeutic and prophylactic antibiotics is the usage of prebiotics, probiotics or the combination of both, known as synbiotics (Hassan *et al.*, 2018). Probiotics are described as live microbes present in gut that improve host health by supporting beneficial bacteria (Mizock, 2015). Ahmad (2006) found the most appropriate level of Probiotic (*Bacillus toyoi*) to be 1 g/kg of feed, which improved digestibility of protein, fat, and dry matter. In another study, Nawaz (2014) concluded that Probiotics (50 g/100 kg of diet) improved the dressing and breast meat yield. Most beneficial organisms are *Lactobacillus* species, *Bifidobacterium* species and yeasts (*Saccharomyces cerevisiae* and *Saccharomyces boulardii*) (Patterson & Burkholder, 2003; Macfarlane *et al.*, 2008). Probiotic supplementation in broiler diets is suggested as an economical and growth-promoting agent that leaves no residual effect like antibiotic growth promoters (Irshad, 2014). *Saccharomyces cerevisiae* (SC) is one of the extensively commercialized species (Ezema & Ugwu, 2015). It contains crude protein (40-45%) and various other water soluble vitamins like pantothenic acid, niacin, and biotin (Khan & Naz, 2013), increasing the nutrition quality of the compound feed. *Saccharomyces cerevisiae* secretes numerous other enzymes, which helps digestive enzymes increase the productive response, nutrient digestibility Jin e*t al.* (2000), feed conversion ratio (FCR), and growth rate performance (Gibson *et al.*, 2017).

Prebiotics are described as "substrate act[ing] as a fertilizer by supporting the colonization of beneficial bacteria" (Gibson *et al.*, 2017). Abundantly used prebiotics are carbohydrates and oligosaccharides that should be non-digestible (Gaggìa *et al.*, 2010). Prebiotic includes mannan-oligosaccharides (MOS), fructo-oligosaccharides (FOS), xylo-oligosaccharides (XOS), inulin, lactulose, stachyose, and raffinose (Macfarlane *et al.*, 2008). Prebiotic potentially promote host health by interacting with beneficial bacterial growth as well as preventing enteric infections (Sugiharto, 2016). Ramzan (2014) reported that prebiotic supplementation in diets improved birds' growth performance in comparison to the control diet.

Synbiotics are the combination of probiotics and prebiotics. Probiotics usually depend on the substrate known as Prebiotic. Probiotics' viability are therefore improved with the supplementation of appropriate non-digestible Prebiotics (Sekhon & Jairath, 2010). Prebiotics improve gut health and the beneficial bacterial count, reduce pH and boost the host animal's immunity (Haq, 2018). Using synbiotics as a feed supplement could increase feed efficiency in comparison to prebiotics and probiotics used separately (Abdel-Raheem *et al.*, 2012; Tayeri *et al.*, 2018). The removal of AGPs from the compound feed resulted in poor feed conversion and growth performance, increasing production costs in about 3% and leaving poultry more vulnerable to mortality and diseases. Safe and economic strategies capable of reducing the microbial load are of utmost importance to poultry producers (Hruby & Cowieson, 2006). Due to extensive poultry production and the increased concern with safer and healthier chicken, efforts have been continuously made to use AGP alternatives as feed supplements. Most of the studies made an effort to use probiotics and prebiotics separately on broilers, experimenting with different combinations. Limited data is available on synbiotics' (Synerall™) effect on broiler chickens' digestibility and to which extent it could be used without compromising bird performance. This research was conducted to evaluate the impact of different levels of a synbiotic product (Synerall™) with a unique combination (*Saccharomyces cerevisiae*, mannanoligosaccharide and galacto-oligosaccharide) on growth performance, carcass characteristics, and nutrient digestibility of broiler chickens.

MATERIALS AND METHODS

Location and duration

The research trial was conducted at the Poultry Research Center, University of Agriculture Faisalabad, during the months of February and March 2019. Birds were initially weighed on delivery and after that weekly body weight, feed intake and feed conversion ratio were determined. Mortality was recorded on a daily basis. This trial lasted for 35 days.

Experimental birds and management

Day-old Cobb 500 broiler birds (300) were obtained from a local hatchery and were randomly distributed among five different treatments, with 6 replicates per treatment, each of them containing 10 birds. All distributed birds remained in the separate pens till the end of the trials. The broiler birds were raised in 30 different pens measuring 4×3 sq. feet. The birds were divided into five experimental groups (Figure 1) and were reared on commercial starter (Table 1) and grower feed (Table 2). The poultry shed maintenance for broiler production was conducted 10 days before chick's arrival. House preparation initially consisted of shed cleaning and white washing, followed by pen structuring using iron mesh. Equipment was cleaned using tap water and subsequently placed in the sunlight to dry. Sawdust was used in each pen as bedding material, having a depth of about 3 inches. Chick paper was cut and placed according to pen requirements. All equipment was placed inside the poultry house. Fumigation and sanitization of the house were performed with formalin and a $KMnO_4$ solution, using a ratio of 35 ml and 17.5 g for every 100 cubic feet, respectively.

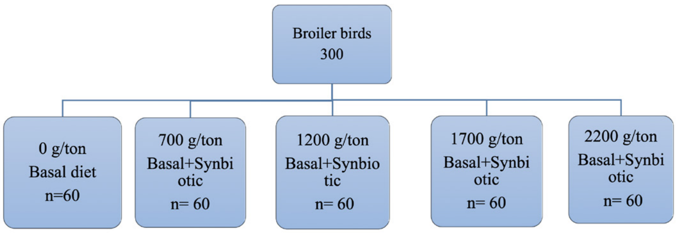

Figure 1 – Experimental layout.

Data recording for performance parameters

Feed intake was measured at the difference between offered refused feed on a weekly basis. Weekly feed intake per replicate helps finding the feed intake per bird every week through the following formula:

Feed intake (g) = Feed offered – Feed refused

Body weight was initially measured when chicks arrived at the poultry shed. However, weekly body weight was measured at the end of each week. Weight gain after each week for each treatment was calculated by subtracting the initial weight. Average weight gain per bird was also determined by dividing the total pen weight by the number of birds in a pen at the end of each week.

The feed conversion ratio (FCR) was used to determine bird's growth efficiency. The FCR per bird was initially determined using weekly data, and then using the following formula for the overall research period:

$$FCR = \frac{\text{Feed intake in grams}}{\text{Weight gain in grams}}$$

Nutrient digestibility analysis

The indirect method was used to determine nutrient digestibility. External marker acid insoluble ash (Celite®)

Table 1 – Ingredient/nutrient composition of basal diet for COBB-500 broilers (1-21 days).

Ingredients	Treatment				
	A	B	C	D	E
Corn	56.52	56.52	56.52	56.52	56.52
SBM 46%	35.92	35.92	35.92	35.92	35.92
Fish Meal	1.95	1.95	1.95	1.95	1.95
Molasses	0.50	0.50	0.50	0.50	0.50
Vegetable Oil	1.90	1.90	1.90	1.90	1.90
Synerall ™	0.00	0.070	0.120	0.170	0.220
Limestone	0.80	0.80	0.80	0.80	0.80
Di-Calcium phosphate	1.60	1.60	1.60	1.60	1.60
Sodium bicarbonate	0.10	0.10	0.10	0.10	0.10
Common salt	0.22	0.22	0.22	0.22	0.22
Lysine Sulphate, 55%	0.17	0.17	0.17	0.17	0.17
DL-Methionine, 99%	0.20	0.20	0.20	0.20	0.20
L-Threonine	0.02	0.02	0.02	0.02	0.02
Vitalink®	0.05	0.05	0.05	0.05	0.05
Nutrimin®	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100
Nutrient composition					
CP	21.99	21.99	21.99	21.99	21.99
ME (KCal/Kg)	3009.11	3009.11	3009.11	3009.11	3009.11
EE	4.53	4.53	4.53	4.53	4.53
CF	2.54	2.54	2.54	2.54	2.54
Lysine, digestible	1.19	1.19	1.19	1.19	1.19
Methionine, digestible	0.51	0.51	0.51	0.51	0.51
M+C, digestible	0.82	0.82	0.82	0.82	0.82
Threonine, digestible	0.78	0.78	0.78	0.78	0.78
Tryptophan, digestible	0.25	0.25	0.25	0.25	0.25
Sodium	0.15	0.15	0.15	0.15	0.15
Calcium	0.95	0.95	0.95	0.95	0.95
Phosphorous, available	0.45	0.45	0.45	0.45	0.45

Synerall ™ is a synbiotic developed by Global Nutritech, Richmond, VA, USA.

Vitalink® is a vitamins premix; each Kg of it supplied the following: Vitamin A 20000 KIU; Vitamin D_3 5400 KIU; Vitamin E 48000 mg; Vitamin K_3 4000mg; Vitamin B_1 4000 mg; Vitamin B_2 9000 mg; Vitamin B_6 7600 mg; Vitamin B_{12} 20 mg; Niacin 60000 mg; Pantothenic acid 20000 mg; Folic acid 1600 mg; Biotin 200 mg

Nutrimin® is a minerals premix; each Kg of it supplied the following: Iron 10000 mg; Zinc 120000 mg; Manganese 140000 mg; Copper 12000 mg; Iodine 1800 mg; Cobalt 400 mg; and Selenium 360 mg

Table 2 – Ingredient and nutrient composition of basal diet for Cobb-500 broilers (22-35 days).

Ingredients	Treatment				
	A	B	C	D	E
Corn	62.95	62.95	62.95	62.95	62.95
SBM 46%	28.00	28.00	28.00	28.00	28.00
Fish Meal	2.20	2.20	2.20	2.20	2.20
Molasses	1.00	1.00	1.00	1.00	1.00
Vegetable Oil	3.30	3.30	3.30	3.30	3.30
Synerall ™	0.00	0.070	0.120	0.170	0.220
Limestone	0.50	0.50	0.50	0.50	0.50
Di-Calcium phosphate	1.35	1.35	1.35	1.35	1.35
Sodium bicarbonate	0.09	0.09	0.09	0.09	0.09
Common salt	0.20	0.20	0.20	0.20	0.20
Lysine Sulphate, 55%	0.12	0.12	0.12	0.12	0.12
DL-Methionine, 99%	0.19	0.19	0.19	0.19	0.19
Vitalink®	0.05	0.05	0.05	0.05	0.05
Nutrimin®	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100
Nutrient composition					
CP	19	19	19	19	19
ME (KCal/Kg)	3170.61	3170.61	3170.61	3170.61	3170.61
EE	6.05	6.05	6.05	6.05	6.05
CF	2.33	2.33	2.33	2.33	2.33
Lysine, digestible	0.97	0.97	0.97	0.97	0.97
Methionine, digestible	0.47	0.47	0.47	0.47	0.47
M+C, digestible	0.74	0.74	0.74	0.74	0.74
Threonine, digestible	0.66	0.66	0.66	0.66	0.66
Tryptophan, digestible	0.21	0.21	0.21	0.21	0.21
Sodium	0.14	0.14	0.14	0.14	0.14
Calcium	0.76	0.76	0.76	0.76	0.76
Phosphorous, available	0.39	0.39	0.39	0.39	0.39

Synerall ™ is a synbiotic developed by Global Nutritech, Richmond, VA, USA.

Vitalink® is a vitamins premix; each Kg of it supplied the following: Vitamin A 20000 KIU; Vitamin D_3 5400 KIU; Vitamin E 48000 mg; Vitamin K_3 4000mg; Vitamin B_1 4000 mg; Vitamin B_2 9000 mg; Vitamin B_6 7600 mg; Vitamin B_{12} 20 mg; Niacin 60000 mg; Pantothenic acid 20000 mg; Folic acid 1600 mg; Biotin 200 mg

Nutrimin® is a minerals premix; each Kg of it supplied the following: Iron 10000 mg; Zinc 120000 mg; Manganese 140000 mg; Copper 12000 mg; Iodine 1800 mg; Cobalt 400 mg; and Selenium 360 mg

was thoroughly mixed in diets (1%). Feces samples were collected from each pen on the 21st and 35th days. Polythene sheets were used to collect feces twice a day. Samples were preserved at -10°C until further analysis. Nutrient digestibility was determined using the following equation:

$$\text{Digestibility coefficient} = 100 - 100 \times \frac{\%\ \text{marker in feed}}{\%\ \text{marker in feces}} \times \frac{\%\ \text{nutrient in feces}}{\%\ \text{nutriente in feed}}$$

Antibody titer and meat quality investigation

At the end of trial, two birds from each experimental pen were selected randomly and slaughtered to get data on carcass characteristics and antibody titer. After the slaughter, collected blood serum samples were immediately transferred to the laboratory for investigation of antibody titer against Newcastle disease using the standard HA/HI method (Majiyagbe & Hitchner, 1977).

After the slaughter, breast meat samples were collected and conveyed to the National Institute of Food and Technology (NIFSAT), University of Agriculture, Faisalabad, to study the breast meat's water holding capacity and pH. Meanwhile, crass characteristics including dressing percentage, breast and thigh yield, and weight of visceral organs were determined immediately after carcass dressing.

Statistical Analysis

Results were analyzed with the use of JMP software (version 5.0.1a; SAS Institute, 2000). Analysis of Variance (ANOVA) technique under Completely Randomized Design was employed and means were compared using Tukey's test.

RESULTS AND DISCUSSION

In the recent study era, most efforts have been focused on producing feed additive products that have a positive effect on growth performance, feed intake, FCR, and gut health of birds. At this point, synbiotics have gained more importance as growth promoters due to the positive effects of enhancing broiler performance, increasing the resistance against intestinal bacterial infection, and improving the immune status in broiler chickens (Deraz, 2018).

Feed intake

The feed intake was not affected in birds fed diet A, B, C, D and E during both starter and finisher phase (Table 3). However, feed intake was significantly reduced in birds offered diet C ($p<0.05$) for the whole period of 35 days. The present study was in line with the findings of Al-Sultan *et al.* (2016), who found that supplementation of synbiotics in broiler diet significantly reduced the feed intake at 35 days of age ($p<0.05$). These additives improved feed efficiency by growing intestinal microflora population, improving intestinal integrity, and stimulating the immune system. Contrasting results were found by Sarangi *et al.* (2016), who reported that synbiotic supplementation at 500 g/ton of feed has no effect on feed intake. The studies have demonstrated that dietary synbiotic supplementation could improve intestinal integrity and barrier function, a key factor in nutrient utilization and adsorption, by inhibiting the colonization of pathogenic bacteria and stimulating the proliferation of beneficial bacteria in the intestine, beneficial consequences that may eventually contribute to the enhanced nutrient utilization (Cheng *et al.*, 2017). Abdel-Raheem *et al.* (2012) found that synbiotic supplementation in broiler diets significantly increased the feed intake as compared with the control group ($p<0.05$). This increase in feed intake might be due to the different management or feed nutrient profile.

Body weight

Body weight during the starter and finisher phases remained unaffected (Table 3). This could be due to the proper direct-fed microbial supplementation that promotes favorable intestinal conditions for the colonization of beneficial microflora, which in turn facilitate a better growth performance in broiler chicks (Sarangi *et al.*, 2016). In agreement with our findings, Yalçinkaya *et al.* (2012) and Khalaji *et al.* (2011) also showed that MOS (0.5, 1 and 1.5 g/kg) had no significant effect on growth performance of broiler chicks. However, in contrast to our results, Al-Sultan *et al.*, 2016 found that synbiotics significantly increased the birds' weight gain as compared to the control group. The findings of Bozkurt *et al.* (2014) were also that MOS at 1 g/kg improved the body weight gain in broilers. It could be postulated that a synbiotic or prebiotic may provide a healthy environment in the broiler intestine (e.g. balanced intestinal microflora) and consequently improve growth performance. This is due to the multiplication of useful bacteria because of probiotics' beneficial effects against the adverse effects of the harmful microbial populations in the digestive system (Abdel-Hafeez *et al.*, 2017).

Feed conversion ratio

In the present study, feed conversion ratio was improved ($p<0.05$) at the 35th day of age in birds offered diet B and C, as compared to other dietary

Table 3 – Growth performance for finisher phase (22-35) and overall period (1-35) of broilers fed varying levels of synbiotics.

Parameters	Day	Dietary Treatments						
		A	B	C	D	E	SEM	*p*-value
Feed intake (g)	1-21	1292	1285	1245	1308	1309	10.9	0.35
	22-35	2050^{a}	1917^{ab}	1909^{b}	1922^{ab}	1958^{ab}	18.7	0.010
	1-35	3343^{a}	3202^{ab}	3154^{b}	3158^{ab}	3196^{ab}	22.2	0.032
Body weight (g)	1-21	844	918	873	901	891	9.79	0.14
	22-35	1150	1142	1178	1085	1071	16.2	0.165
	1-35	1994	2061	2052	1986	1961	17.8	0.329
Feed conversion ratio	1-21	1.53	1.40	1.42	1.45	1.47	0.01	0.26
	22-35	1.79	1.68	1.63	1.71	1.77	0.02	0.066
	1-35	1.68^{a}	1.55^{ab}	1.54^{b}	1.59^{ab}	1.63^{ab}	0.01	0.029
Mortality (%)	1-21	0.00	3.33	0.00	1.67	0.00	0.73	0.53
	22-35	1.67	1.67	3.33	1.67	0.00	0.692	0.705
	1-35	0.167	5.00	0.333	0.333	0.000	0.951	0.553

SEM = Standard error of mean.
Diet A, B, C, D and E having synbiotic supplementation 0, 700, 1200, 1700 and 2200g/ton of feed, respectively.
Values having different super-scripts show significant difference ($p<0.05$)

treatments (Table 3). The feed conversation ratio was not affected by the treatment during the starter and finisher phases. Similar results were found by Nikpiran e*t al.* (2013), and they reported that FCR was increased by 1.5%. Similar results were also reported by Dizaji e*t al.* (2013), who found that prebiotic (MOS) and synbiotic (Amax) supplementations at 1 g/kg in the diet resulted in better FCR in broiler birds. Nawaz e*t al.* (2016) reported that FCR was improved with the incorporation of microbial or yeast-based probiotics. The improvement in feed conversion ratios might be due to the feeding of synbiotics to which are attributed better nutrient digestibility (Pelicano e*t al.*, 2004) and improvement of morphologic characteristics viz. increased villus height, villus width and their ratio in the small intestine (Al-Sultan e*t al.*, 2016). In contrast, Yalçinkaya e*t al.* (2012) reported that a prebiotic supplemented diet at 1 g/kg diet resulted in poor FCR in broiler birds. Awad *et al.*, 2009 reported no effect of synbiotic supplementation on broiler feed conversion ratio. Present findings conflict with Sarangi *et al.*, 2016, who reported that the addition of synbiotic neither improved nor negatively impacted the feed conversion ratio of broiler birds.

Nutrient digestibility

The results of the present study showed that the use of synbiotic at the levels of 700 and 1200 g/ton of feed significantly improved (p<0.05) broiler birds' nutrient utilization (Table 4). These findings are supported by Mountzouris e*t al.* (2010), who incorporated probiotic in diets and observed a significant increase in nutrient utilization. The present findings were further supported by the results of Yun *et al.*, 2017, who declared that the addition of synbiotic in broiler diets had significantly improved (p<0.05) nutrient digestibility. Findings of Yang e*t al.* (2008) are also in accordance with the present study, as they concluded that supplementation of MOS in broiler diets significantly improved starch and protein digestibility. Saleh e*t al.* (2015) reported that nutrient utilization increased when synbiotic (*Aspergillus awamori* + FOS) was added to the broiler diet. This increase in digestibility was due to the intake of live gut environment modulation microorganisms that improved the gut barrier function via fortification of the beneficial members of the intestinal microflora, the competitive exclusion of pathogens, and the stimulation of the immune system (Mountzouris *et al.*, 2010). Tuohy e*t al.* (2003) reported that an increase in the nutrient digestibility in broilers supplemented with an oligosaccharide diet was due to an improvement in gut health. It is assumed that an increase in villus height is compensated by improvements in the digestive and absorptive functions of the intestine, due to increased absorptive surface area, expression of brush border enzymes, and nutrient transport systems (Awad *et al.*, 2009).

Table 4 – Nutrient digestibility of broiler birds during starter and finisher phase fed varying levels of synbiotics.

Parameters (%)	Day	Dietary Treatments						
		A	B	C	D	E	SEM	p-value
Fat	21	83.51	82.44	82.26	82.02	82.16	0.906	0.184
	35	83.03	82.55	84.81	79.65	85.52	1.54	0.531
CP	21	60.37^{c}	73.1^{a}	69.25^{ab}	63.75^{bc}	60.66^{c}	1.30	0.000
	35	61.00^{b}	70.2^{ab}	77.29^{a}	69.07^{ab}	65.82^{b}	1.11	0.003

SEM = Standard error of mean.

Diet A, B, C, D and E having synbiotic supplementation 0, 700, 1200, 1700 and 2200g/ton of feed, respectively.

Values having different super-scripts show significant difference (p<0.05)

However, the results of this research contradicted the results of Sharifi e*t al.* (2012), who incorporated probiotic at 150 mg/kg in the diet that reduced nutrient digestibility in broiler birds. The present findings were also contradictory with the results of Kırkpmar & Açikgöz (2004), who revealed that prebiotic addition at 0.5% in diets resulted in a reduced nutrient utilization by broiler birds. The results of this research were also in contrast with Swamy & Upendra (2013), who reported that prebiotic addition in the diet at 0.05% resulted in poor nutrient utilization in broiler birds.

Carcass characteristics

The results of the present study showed no significant effects of synbiotic supplementation on broiler dressing percentage, breast meat yield, and thigh meat yield (Table 5). Similar findings were reported by Sarangi e*t al.* (2016), who showed that the supplementation of synbiotics did not affect the dressing percentage, breast meat yield, and thigh meat yield of broiler birds. Ashayerizadeh e*t al.* (2011) also reported similar results as they supplemented synbiotics (Primalac and Biolex-MB) in the broiler diet and found no significant change

Table 5 – Carcass parameters (at 35 days) of broilers fed varying levels of synbiotics.

Parameters (%)	Dietary Treatments						
	A	B	C	D	E	SEM	*p*-value
Dressing	62.81	63.58	63.65	63.88	63.0	0.42	0.942
Brest meat yield	36.33	41.39	37.23	37.90	37.05	0.74	0.220
Thigh meat yield	26.47	25.66	26.42	25.98	26.03	0.36	0.961
Heart weight	0.64	0.64	0.69	0.67	0.52	0.02	0.337
Liver weight	2.61^{a}	2.38^{ab}	2.09^{b}	2.22^{ab}	2.14^{b}	0.05	0.008
Gizzard weight	2.00	2.00	1.65	1.73	1.74	0.04	0.017
Spleen weight	0.34	0.28	0.26	0.33	0.27	0.02	0.846

SEM = Standard error of mean.

Diets A, B, C, D and E have synbiotic supplementation of 0, 700, 1200, 1700 and 2200g/ton of feed, respectively.

Values with different super-scripts show significant difference ($p<0.05$)

in the carcass, thigh meat yield, and breast meat yield percentages. Opposite results were found by Abdel-Raheem et *al.* (2012), as they reported that dressing percentage, breast meat yield, and thigh meat yield increased as compared with other treatment groups.

The results of the present study showed no significant effects of synbiotics on giblets relative to organ weight percentage, except liver weight, which decreased in birds offered diets having synbiotic at the concentration of 1200 g/kg (Table 5). Similar results were reported by Yun e*t al.* (2017). They found that the addition of synbiotics in broiler diets had no effect on giblet relative weight percentages. Salma e*t al.* (2007) reported that, with supplementation of probiotics, liver weight decreased significantly ($p<0.05$) as compared to other broiler birds' treatments.

The liver weight might be decreased, considering the reduced presence of serum enzymes, as their quantity in the serum can provide some indications of the degree of organ or tissue damage. The serum concentration of liver enzymes, such as alanine aminotransferase (ALT), agamma-glutamyl transpeptidase (GGT), and aspartate aminotransferase (AST) can be used to evaluate avian hepatic function because their synthesis occurs in the liver. Vahdatpour e*t al.* (2011) found that the activities of ALT and ALP were lower in female Japanese quails fed with prebiotics (Fermacto®), probiotics (Protexin®) or synbiotics (the combination of Fermacto® and Protexin®) than in control quails. A similar result was reported by Salarmoini & Fooladi (2011), whereas broiler chickens supplemented with a probiotic (Bioplus2) or fermented milk containing *L. acidophilus* exhibited lower levels of serum ALT and ALP than the control broiler chickens. The activities of ALT and ALP may also increase in the serum if there is a cellular injury in the liver or muscle caused by excessive stress. In this context, probiotics and prebiotics have been reported to reduce chicken stress (Tang *et al.*, 2017).

Meat quality

The results of the present study showed no effect of synbiotics on broiler meat water holding capacity (WHC) and pH at the varying levels included in broiler diets (Table 6). Similar results were found by Cheng *et al.*, 2017, who reported that the addition of synbiotics had no effect on breast meat pH as compared to the control group. Similar findings were also reported by Mehdipour *et al.*, 2013, who revealed that synbiotics at a concentration of 500 mg/kg added to quail diets had no effect on meat pH and WHC. Results of Park & Kim, 2014 were also in line with our findings, concluding that the supplementation of probiotics in broiler diets had no effect on broiler breast meat WHC and pH.

New castle disease virus (NDV) anti-body titer

The results of the present study found that broiler birds' immunity was not affected by supplementation of varying levels of synbiotics on day 35 (Table 6). Contrasting results were reported by Hassanpour *et*

Table 6 – Meat quality attributes and antibody titer of broiler birds (35 days)) fed varying levels of synbiotics.

Parameters	Dietary Treatments						
	A (Control)	B	C	D	E	SEM	*p*-value
Water holding capacity	36.66	36.41	36.41	36.41	36.01	0.618	0.99
pH	6.63	6.63	6.54	6.61	6.56	0.01	0.465
NDV	5.50	5.00	5.75	5.25	5.50	7.19	0.284

SEM = Standard error of mean.

Diets A, B, C, D and E have synbiotic supplementation of 0, 700, 1200, 1700 and 2200g/ton of feed, respectively.

al. (2013), who increased humoral immune response through the administration of the synbiotics Biomin and Protexin + TechnoMos. Midilli e*t al.* (2008) reported that the use of probiotic BioPlus, prebiotic BioMos and their combination did not have any effect on the concentration of IgG in broilers' serum. A possible explanation for the differences between findings of different investigators may the differing doses of probiotics, prebiotics and synbiotics applied, animal species and study populations (e.g. in age, weight or breed), strains of micro-organism used, and composition of diets.

CONCLUSIONS

The current research concluded that synbiotics can be safely used at up to 1200 g/ton of feed in broilers' diets to improve bird performance without any harmful effects on other health parameters.

REFERENCES

Abdel-Hafeez HM, Saleh ES, Tawfeek SS, Youssef IM, Abdel-Daim AS. Effects of probiotic, prebiotic, and synbiotic with and without feed restriction on performance, hematological indices and carcass characteristics of broiler chickens. Asian-Australas. Journal of Animal Science 2017; 30:672.

Abdel-Raheem SM, Abd-Allah SM, Hassanein KM. The effects of prebiotic, probiotic and synbiotic supplementation on intestinal microbial ecology and histomorphology of broiler chickens. International Journal of Agronomy and Veterinary Medicine Science 2012; 6:277-289.

Ahmad I. Effect of probiotics on broilers performance. International Journal of Poultry Science 2006; 56:593-597.

Al-Sultan SI, Abdel-Raheem SM, El-Ghareeb WR, Mohamed MH. Comparative effects of using prebiotic, probiotic, synbiotic and acidifier on growth performance, intestinal microbiology and histomorphology of broiler chicks. Japanese Journal of Veterinary Research 2016; 64:187-195.

Ashayerizadeh A, Dabiri N, Mirzadeh KH, Ghorbani MR. Effect of dietary supplementation of probiotic and prebiotic on growth indices and serum biochemical parameters of broiler chickens. Journal of Cell and Animal Biology 2011; 58:152-156.

Awad WA, Ghareeb K, Abdel-Raheem S, Böhm J. Effects of dietary inclusion of probiotic and synbiotic on growth performance, organ weights, and intestinal histomorphology of broiler chickens. Poultry science 2009; 1:49-56.

Bozkurt M, Aysul N, Küçükyilmaz K, Aypak S, Ege G, Catli AU, Akşit H, Çöven F, Seyrek K, Çınar M. Efficacy of in-feed preparations of an anticoccidial, multienzyme, prebiotic, probiotic, and herbal essential oil mixture in healthy and Eimeria spp.-infected broilers. Poultry Science 2014; 2:389-399.

Castanon J. History of the use of antibiotic as growth promoters in European poultry feeds. Poultry Science 2007; 86:2466-2471.

Cheng Y, Chen Y, Li X, Yang W, Wen C, Kang Y, Wang A, Zhou Y. Effects of synbiotic supplementation on growth performance, carcass characteristics, meat quality and muscular antioxidant capacity and mineral contents in broilers. Journal of the Science of Food and Agriculture 2017; 11:3699-3705.

Deraz SF. Synergetic effects of multispecies probiotic supplementation on certain blood parameters and serum biochemical profile of broiler chickens. Journal of Animal Health and Production 2018; 61:27-34

Dizaji BR, Zakeri A, Golbazfarsad A, Faramarzy S, Ranjbari O. Influences of different growth promoters on intestinal morphology of broiler chickens. European Journal of Experimental Biology 2013; 2:32-37.

Edens FW. An alternative for antibiotic se in poultry: probiotics. Brazilian Journal of Poultry Science. 2003; 52:75-97.

Ezema C, Ugwu CC. Yeast (Saccharomyces cerevisiae) as a probiotic of choice for broiler production. InBeneficial Microorganisms in Agriculture, Aquaculture and Other Areas. Springer 2015; 59-79.

Gaggìa F, Mattarelli P, Biavati B. Probiotics and prebiotics in animal feeding for safe food production. International journal of food microbiology 2010; 141:15-28.

Gibson GR, Hutkins R, Sanders ME, Prescott SL, Reimer RA, Salminen SJ, Scott K, Stanton C, Swanson KS, Cani PD, Verbeke K. Expert consensus document: The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of prebiotics. Nature reviews Gastroenterology & hepatology 2017; 14:8491-502.

Haq I. Effect of Mannan oligosaccharides and Saccharomyces cerevisea on growth, nutrient digestibility, hematology and immune response in broilers. M.Sc. (Hons.) Thesis. University of Agriculture Faisalabad, Pakistan 2018.

Hassan HM, Samy A, Youssef AW, Mohamed MA. Research Article Using Different Feed Additives as Alternative to Antibiotic Growth Promoter to Improve Growth Performance and Carcass Traits of Broilers. International Journal of Poultry Science 2018; 17:255-261.

Hassanpour H, Moghaddam AZ, Khosravi M, Mayahi M. Effects of synbiotic on the intestinal morphology and humoral immune response in broiler chickens. Livestock Science 2013; 116-122.

Hruby M, Cowieson AJ. The role of enzymes and betaine in antibiotic growth promoter free nutrition. Antimicrobial growth promoters 2006; 20:269-287.

Ikele OM, Ezeonu IM, Umeh CN. Prebiotic roles of Ocimum gratissimum extract in the control of colibacillosis in broilers. Journal of Animal Health and Production 2020;8(4):206-211.

Irshad MA. Comparative efficacy of probiotics (Yeast & Bacteria) on the performance and nutrient digestibility of broilers. M.Sc. (Hons.) Thesis. University of Agriculture Faisalabad, Pakistan 2014.

Jin LZ, Ho YW, Abdullah N, Jalaludin S. Digestive and bacterial enzyme activities in broilers fed diets supplemented with Lactobacillus cultures. Poultry science 2000; 89:886-891.

Khalaji S, Zaghari M, Nezafati S. The effects of mannan-oligosaccharides on cecal microbial populations, blood parameters, immune response and performance of broiler chicks under controlled condition. African Journal of Biochemistry Research 2011; 5:160-164.

Khan, R., and S. Naz. The applications of probiotics in poultry production. World's Poultry Science Journal 2013; 69:621-632.

Kırkpmar F, Açikgöz Z. Effect of antibiotic, prebiotic and enzyme mixture supplementation on performance and nutrient utilization of broilers. Journal of Applied Animal Research 2004; 25:13-16.

Macfarlane GT, Steed H, Macfarlane S. Bacterial metabolism and health-related effects of galacto-oligosaccharides and other prebiotics. Journal of applied microbiology 2008; 305-344.

Majiyagbe KA, Hitchner SB. Antibody response to strain combinations of Newcastle disease virus as measured by hemagglutination-inhibition. Avian Diseases 1977; 1:576-584.

Mehdipour Z, Afsharmanesh M, Sami M. Effects of dietary synbiotic and cinnamon (Cinnamomum verum) supplementation on growth performance and meat quality in Japanese quail. Livestock Science 2013; 154:152-157.

Midilli MU, Alp M, Kocabach N, Muglah OH, Turan N, Yilmaz H, Cakir SE. Effects of dietary probiotic and prebiotic supplementation on growth performance and serum IgG concentration of broilers. South African journal of animal science 2008; 38:21-27.

Mizock BA. Probiotics. Disease-a-month: DM. 2015 61; 259-290.

Mountzouris KC, Tsitrsikos P, Palamidi I, Arvaniti A, Mohnl M, Schatzmayr G, Fegeros K. Effects of probiotic inclusion levels in broiler nutrition on growth performance, nutrient digestibility, plasma immunoglobulins, and cecal microflora composition. Poultry science 2010; 89:58-67.

Nawaz H, Irshad MA, Ali M. Effect of probiotics on growth performance, nutrient digestibility and carcass characteristics in broilers. Journal of Animal & Plant Sciences. 2016; 26:342-350.

Nawaz MS. Influence of varying levels of probiotic on growth performance, nutrient digestibility and immune response in broilers. M.Sc. (Hons.) Thesis. Univiversity of Agriculture Faisalabad, Pakistan 2014.

Nikpiran H, Taghavi M, Khodadadi A, Athari SS. Influence of probiotic and prebiotic on broiler chickens performance and immune status. Journal of Novel Applied Sciences 2013; 2:256-259.

Obajuluwa OV, Sanwo KA, Egbeyale LT, Fafiolu AO. Carcass characteristics and meat quality of broiler chicken fed diets supplemented with Pausynistalia yohimbe and larvicide (Cyromazine). Journal of Animal Health and Production 2021;9(1):40-46.

Park JH, Kim IH. Supplemental effect of probioticBacillus subtilis B2A on productivity, organ weight, intestinalSalmonella microflora, and breast meat quality of growing broiler chicks. Poultry Science 2014; 93:2054-2059.

Patterson JA, Burkholder KM. Application of prebiotics and probiotics in poultry production. Poultry science 2003; 82:627-631.

Pelicano ER, De Souza PA, De Souza HB, Leonel FR, Zeola NM, Boiago MM. Productive traits of broiler chickens fed diets containing different growth promoters. Brazilian Journal of Poultry Science 2004; 6:177-182.

PPA. An overview of Pakistan poultry industry. https://pakistanpoultry.org/an-overview-of-poultry-industry 2019.

Salarmoini M, Fooladi MH. Efficacy of Lactobacillus acidophilus as probiotic to improve broiler chicks performance.2011; 165-175

Saleh AA, Hayashi K, Ijiri D, Ohtsuka A. Effect of feeding A spergillus awamori and canola seed on the growth performance and muscle fatty acid profile in broiler chicken. Animal Science Journal 2015; 86:305-311.

Salma U, Miah AG, Maki T, Nishimura M, Tsujii H. Effect of dietary Rhodobacter capsulatus on cholesterol concentration and fatty acid composition in broiler meat. Poultry Science 2007; 86:1920-1926.

Sarangi NR, Babu LK, Kumar A, Pradhan CR, Pati PK, Mishra JP. Effect of dietary supplementation of prebiotic, probiotic, and synbiotic on growth performance and carcass characteristics of broiler chickens. Veterinary world 2016; 319-313

Sekhon BS, Jairath S. Prebiotics, probiotics and synbiotics: an overview. Journal of pharmaceutical education and research 2010; 11:13.

Sharifi SD, Dibamehr A, Lotfollahian H, Baurhoo B. Effects of flavomycin and probiotic supplementation to diets containing different sources of fat on growth performance, intestinal morphology, apparent metabolizable energy, and fat digestibility in broiler chickens. Poultry Science 2012; 91:918-927.

Sugiharto S. Role of nutraceuticals in gut health and growth performance of poultry. Journal of the Saudi Society of Agricultural Sciences 2016; 15:99-111.

Tang SG, Sieo CC, Ramasamy K, Saad WZ, Wong HK, Ho YW. Performance, biochemical and haematological responses, and relative organ weights of laying hens fed diets supplemented with prebiotic, probiotic and synbiotic. BMC veterinary research 2017; 13:248.

Tayeri V, Seidavi A, Asadpour L, Phillips CJ. A comparison of the effects of antibiotics, probiotics, synbiotics and prebiotics on the performance and carcass characteristics of broilers. Veterinary research communications 2018; 42:195-207.

Tuohy KM, Probert HM, Smejkal CW, Gibson GR. Using probiotics and prebiotics to improve gut health. Drug discovery today 2003; 8:692-700.

Vahdatpour T, Nikpiran H, Babazadeh D, Vahdatpour S, Jafargholipour MA. Effects of Protexin®, Fermacto® and combination of them on blood enzymes and performance of Japanese quails (Coturnix Japonica). Annals of Biological Research 2011; 2:283-91.

Yalçinkaya I, Çinar M, Yildirim E, Erat S, Başalan M, Güngör T. The effect of prebiotic and organic zinc alone and in combination in broiler diets on the performance and some blood parameters. Italian Journal of Animal Science 2012; 11.298-302.

Yang Y, Iji PA, Kocher A, Mikkelsen LL, Choct M. 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 2008; 92:650-659.

Yun W, Lee DH, Choi YI, Kim IH, Cho JH. Effects of supplementation of probiotics and prebiotics on growth performance, nutrient digestibility, organ weight, fecal microbiota, blood profile, and excreta noxious gas emissions in broilers. Journal of Applied Poultry Research 2017; 26:584-592.