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EFFECT OF SYNBIOTIC SUPPLEMENTATION OF HIGH FIBRE DIET ON GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY, INTESTINAL MICROBIAL ECOLOGY AND HISTOMORPHOLOGY OF BROILER CHICKENS

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In a 35 days feeding trial, a total of 320 three weeks old chicks were assigned to eight treatments (T1 - T8) and each treatment was replicated four (4) times consisting of 10 birds per replicate in a 2×2×2 factorial design. The factors were two agro-industrial by-products, at two inclusion levels, with or without synbiotic (containing mannan oligosaccharide and *Saccharomyces cerevisae*) supplementation. Birds on T1 to T4 received wheat offal based diet at 20% (without synbiotic), 20% (with synbiotic), 40% (without synbiotic) and 40% (with synbiotic) respectively, while those on T5 to T8 received palm kernel cake based diet at 20% (without synbiotic), 20% (with synbiotic), 40% (without synbiotic) and 40% (with synbiotic) respectively. There was no significant effect of fibre source and fibre source level on all performance parameters except for feed intake, but synbiotic supplementation lowered ($P<0.05$) final body weight, body weight gain and increased feed conversion ratio. There was a significant decrease ($P<0.05$) in the *E. coli* colony count in the small intestine of the non-supplemented group compared to the supplemented group but no significant difference ($P>0.05$) was observed in the lactobacillus colony count in the small intestine between the supplemented and non-supplemented groups. Birds fed diets without synbiotic had higher ($P<0.05$) villi height, crypt depth and full mucosal in the jejunum than the birds fed diets supplemented with synbiotic. It was concluded that synbiotic had negative effect on the growth performance and intestinal health of broilers fed high fibre diets.

Keywords: synbiotic, fibre source, intestinal histomorphometrics, microbial ecology

The use of cereal by-products and other agro-industrial by-products high in dietary fibre is a common practice in swine and poultry feeding due to the high cost of protein and energy concentrates/feedstuffs in developing countries. However, these agro-industrial by-products consist of plant cell tissues such as lignin, hemicellulose and cellulose, which are resistant to enzymatic digestion in the small intestine of poultry birds and thus resulting in poor performance of the birds. Previous studies on the use of antibiotics as growth promoters in broiler diets high in agro-industrial by-products have indicated that, antibiotics enhanced the utilisation of fibrous feedstuffs which were poorly digested by birds (Onifade and Babatunde, 1997; Onifade and Odunsi, 1998), but the continuous use of antibiotics as a growth promoter has come under close scrutiny in the poultry industry due to antibiotic resistance in humans and drug residues in animal products (Dipeolu *et al.*, 2004).

There is increased interest in prebiotics, probiotics, phytobiotics, synbiotics, essential oils and organic acids as an alternative to in-fed antibiotics in farm animal diets. A synbiotic is, in its simplest definition, is a combination of probiotics and prebiotics in a single preparation (Collins and Gibson, 1999). A prebiotic is a non-digestible feedstuff mainly carbohydrate (such as inulin, fructo-oligosaccharide and mannan oligosaccharide), that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon and thus improves health (Gibson and Roberfroid, 1995). Prebiotics are known to be non-digestible to the host's digestive enzymes in gastro-intestinal tracts, thus they serve as substrates for beneficial bacteria mainly located in the hind gut. Simon (2005) defined probiotics 'as viable micro-organisms, which after sufficient oral intake, lead to beneficial effects for the host by modifying the intestinal microbiota'.

Synbiotic containing mannan oligosaccharide and *Saccharomyces cerevisae* has been reported to enhance growth performance and gut health of broilers fed low fibre diets (less than 3% crude fibre; Sherief *et al.*, 2012). Similarly, Abeer et al. (2013) reported that synbiotic and digestive enzyme mixture containing *Lactobacillus*, Bifidiobacteria, mannan-oligosaccharides, cellulase and amylase supplementation of broilers diet at 0.025% or 0.05% improved the body weight gain, feed conversion ratio and reduced abdominal fat of 35-day old broiler chicken when compared to the non-supplemented control. In contrast, Zarei et al. (2011) reported that, feed intake, feed conversion ratio, egg production, egg weight and egg mass were not significantly affected by dietary 0.05% synbiotic supplementation containing mannan-oligosaccharides, S*accharomyces cerevisae* and *Lactobacillus spp.* in layer chickens diet fed for 6 weeks. However, the probable beneficial effect of synbiotic has not been systematically investigated using high fibre diets in broilers. The objective of the present study was to determine, the effect of synbiotic supplementation on the growth performance, intestinal microbial ecology and histomorphology of broiler chicken fed high fibre diets based on palm kernel cake and wheat offal meals.

MATERIALS AND METHODS

Animal, housing and management

A total of three hundred and (320) three-weeks old broiler chicks were used for this study, consisting of eight (8) treatments (T1-T8) replicated four (4) times and ten (10) birds per replicate. The experimental design was a 2×2×2 factorial design, consisting of two agro-industrial by-products at two inclusion levels (table 1) with or without synbiotic supplementation and the study lasted for five weeks. The synbiotic preparation was a commercial product containing mannan oligosaccharide and *Saccharomyces cerevisae*. The synbiotic was supplemented at 1g/kg of feed at the expense of maize and birds on T1-T4 received wheat offal based diet at 20% (without synbiotic), 20% (with synbiotic), 40% (without synbiotic) and 40% (with synbiotic) respectively, while T5-T8 received palm kernel cake based diet at 20% (without synbiotic), 20% (with synbiotic), 40% (without synbiotic) and 40% (with synbiotic) respectively. Wheat offal at 20% and 40% level of inclusion resulted in 4.5% and 5.81% calculated crude fibre content respectively, while that of palm kernel cake at 20% and 40% level of inclusion had 4.74% and 6.28% respectively. Birds were weighed individually with precision scale at the onset of the study and weekly till the end of the experiment and feed intake was measured weekly, while feed conversion ratio was calculated and mortality was recorded as it occurred.

Digestibility Trial

Digestibility trial was carried out at the end of the fourth week. Three birds that had weight representative of each treatment were selected and adapted in metabolic cages for seven days. Feed and water were provided in the troughs *ad libitum*. A known quantity of fresh feed was served every day and the residue measured to calculate the feed intake. Birds were fasted for 16 hours before excreta collection to clear their gut and for the same length of tim Nutrient Digestibility (%) = e before the final excreta collection. The moisture content of fresh excreta samples was determine immediately after collection and the remaining samples collected daily were bulked for five days in the freezer till the samples were oven dried and analyzed for proximate composition. Digestibility was calculated with the formula below:

$$\text{Nutrient Digestibility}(\%) = \frac{\text{Nutrient intake (g)}}{\text{Nutrient voided (g)}} X100$$

Gut Morphology and Morphometrics

Three birds with weight representative of each treatment were fasted for 12 hours and slaughtered and the jejunum and ileum sections were excised for

Table 1. Gross composition of experimental diets (%, as fed basis)

Feed Ingredients (%)	T1	T2	T3	T4	T5	T6	T7	T8
Maize	52.58	52.48	29.35	29.25	54.35	54.25	39.65	39.55
Soybean meal	10	10	8	8	10	10	5	5
Groundnut cake	10.5	10.5	10.45	10.45	10.45	10.45	10.4	10.4
Wheat offal	20	20	40	40	-	-	-	-
Palm kernel cake	-	-	-	-	20	20	40	40
Palm oil	1.77	1.77	7	7	-	-	-	-
Synbiotic	-	0.10	-	0.10	-	0.10	-	0.10
Fixed ingredients[1]	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Total	100	100	100	100	100	100	100	100
Calculated values (%)								
ME, Kcal/kg	2850	2850	2844	2844	2865	2865	2800	2800
Crude protein	18.0	18.0	17.9	17.9	18.8	18.8	18.0	18.0
Crude fibre	4.49	4.49	5.81	5.81	4.74	4.74	6.28	6.28
Analysed values (%)								
Crude protein	19.06	19.06	18.68	18.68	19.31	19.31	18.94	18.94
Crude fibre	4.58	4.58	5.92	5.92	5.08	5.08	7.00	7.00
Ash	5.31	5.31	5.17	5.17	4.94	4.94	6.73	6.73
Ether extract	5.38	5.38	10.35	10.35	4.51	4.51	6.27	6.27

[1]2% fish meal, 2% bone meal, 0.5% oyster shell, 0.1% DL-methionine, 0.1% L-lysine, 0.25% Vitamin/mineral premix, 0.25% salt; T=Treatments.

histomorphological examination. The jejunum sample of 2cm length was collected 5cm distal to the end of duodenal loop, while ileum sample of 1cm length was collected up to 5cm proximal to the ileo-caecal junction. Jejunum and ileum samples were fixed into 10% neutral buffered formalin solution. The fixed intestinal sections were subsequently dehydrated by transferring through a series of alcohol with increasing concentrations (70, 80, 90 and 100%), cleared with xylene, and embedded in paraffin wax. Tissue sections (5µm) were cut by microtome, placed on glass slides, and stained with hematoxylin and eosin. The photographs of the slides were taken using a laboratory microscope (connected with a monitor screen and computer) at 40× magnification and measurements of histomorphological parameters were made using the Open office.org™3. Ten well-oriented villi height, crypt depth, full mucosal and sub mucosal from jejunum and ileum were measured. The villus height (VH) was measured from the crypt-villus junction to the brush border at the tip. The crypt depth (CD) was measured from the base near the lamina propria to the crypt-villus junction. All measurements were made to the nearest micrometer.

Microbial count

For microbial enumeration, twenty four birds were slaughtered at the end of the feeding trial and the intestinal contents from the small intestine (excised from Merkel diverticulum to ileo-caecal junction) and caecum were collected separately and immediately after slaughtering of birds into sterile foil paper. Digesta from different parts of the small intestine was mixed thoroughly to ensure homogeneity. The sealed containers were kept in the refrigerator at 4°C till enumeration of microbial population. The microbial analysis was carried out using the procedure of Sherief et al. (2012).

RESULTS

Growth performance

The performance of broiler chickens fed high fibre diets with or without synbiotic

Table 2. Growth performance of Broiler chickens fed high fibre diets with or without synbiotic supplementation

Parameters	IBW (g)	FBW (g)	DWG (g)	DFI (g)	FCR	Mortality (%)
T1 (WO20%)	503.67	1708.27	32.52	93.27	2.87	0
T2 (WO20%+)	504.48	1532.83	27.76	88.55	3.19	0
T3 (WO40%)	504.17	1644.96	30.65	95.13	3.11	0
T4 (WO40%+)	505.1	1555.85	28.81	97.567	3.39	5
T5 (PKC20%)	504.67	1720.5	32.21	86.68	2.75	7.94
T6 (PKC20%+)	503.75	1544.39	27.01	84.32	3.16	2.5
T7 (PKC40%)	503.65	1588.58	29.26	89.24	3.05	7.5
T8 (PKC40%+)	504.13	1484.35	25.83	88.12	3.42	7.5
Pooled SEM	7.36	50.2	0.58	1.12	0.16	1.01
P-values						
Syn	0.97	0.01	0.01	0.46	0.02	0.96
Fibre	0.92	0.48	0.47	0.02	0.48	0.02
level	0.92	0.17	0.16	0.02	0.02	0.27
F×L	0.91	0.91	0.62	0.88	0.72	0.24
S×F	0.91	0.30	0.41	0.54	0.81	0.96
S×F×L	0.97	0.92	0.91	0.96	0.96	0.96

T=Treatments; SEM=Standard error of mean; S=Synbiotic; S×F×L=interaction between synbiotic × fibre × level; IBW= initial body weight; FBW = final body weight; DWG = Daily weight gain; DFI = Daily feed intake; FCR = Feed conversion ratio.

supplementation is presented in table 2. There was no significant effect of fibre source and fibre level on the final body weight and daily weight gain, but synbiotic supplementation had a significant effect on these two parameters. Birds fed synbiotic supplemented diets did not differ (P>0.05) in feed intake from the non-supplemented groups but synbiotic supplementation decreased (P<0.05) final body weight (1529 vs.1669 g), daily weight gain (27.4 vs. 31.0 g) and resulted in higher (P<0.05) feed conversion ratio (3.29 vs. 2.96), irrespective of the level of inclusion of the fibre source. Birds fed wheat offal based diets (WO) had higher (P<0.05) feed intake (93.6 vs. 87.1 g) than those fed palm kernel cake (PKC) based diets. Also, feed intake increased (P = 0.03) as the level of fibre source was increased from 20 to 40% inclusion level (irrespective of fibre source) and birds fed 40% fibre source had 4.75% higher feed intake compared to those fed 20% fibre source. However, birds fed PKC based diet had higher (P<0.05) mortality than those fed WO based diet.

Nutrient digestibility

The nutrient digestibility of broiler chickens fed high fibre diet with or without synbiotic supplementation is shown in table 3. Synbiotic supplementation decreased (P<0.05) the digestibility of all proximate constituents except that of crude ash. There was no significant effect of fibre source on all proximate constituents except for dry matter digestibility, which was significantly lower on PKC diets (60.0 vs. 67.3%) compared to WO diets. Fibre level had a significant effect on dry matter, crude fibre and ether extract digestibilities. There was a significant decrease in dry matter and crude fibre digestibilities as the fibre 0source increased from 20 to 40%, while ether extract digestibility increased with increase in the fibre source level from 20 to 40%.

Table 3. Nutrient digestibility of Broiler chickens fed high fibre diets with or without synbiotic supplementation (%).

Treatments	Dry matter	Ash	Crude fibre	Ether extract	Crude protein
T1 (WO20%)	75.72	51.77	72.86	84.11	76.44
T2 (WO20%+)	69.01	60.82	60.02	76.03	57.48
T3 (WO40%)	63.83	61.85	67.15	87.57	68.1
T4 (WO40%+)	61.04	59.93	59.79	81.06	67.84
T5 (PKC20%)	68.49	68.15	71.98	81.88	77.58
T6 (PKC20%+)	58.17	63.25	56.27	73.86	63.37
T7 (PKC40%)	59.5	54.61	61.18	90.09	57.27
T8 (PKC40%+)	52.04	59.08	52.24	87.06	54.81
SEM	1.86	1.99	1.68	1.51	2.32
P-values					
Syn	0.03	0.58	0.01	0.02	0.03
Fibre	0.01	0.38	0.05	0.68	0.28
Level	0.01	0.48	0.03	0.01	0.10
F×L	0.70	0.04	0.31	0.21	0.06
S×F	0.46	0.53	0.61	0.72	0.86
S×F×L	0.95	0.1	0.88	0.73	0.65

T = Treatments; SEM = Standard error of mean; Syn = Synbiotic; S × F × L= interaction between synbiotic × fibre × level; F × L= interaction between fibre and level; F × S = interaction between fibre and synbiotic.

Intestinal microbial ecology

The microbial count in the gut of broilers fed high fibre diet with or without synbiotic supplementation is shown in table 4. Birds fed synbiotic supplemented diets (irrespective of fibre source or level of inclusion) had 17.86% higher (P=0.01) colony count of enterobacteria in caeca compared to non-supplemented group. Similarly, *E. coli* counts in both caeca and small intestine of the supplemented group were higher (P<0.05) compared to non-supplemented group (11.69 vs. 9.29 log cfu/g and 7.72 vs. 6.61 log cfu/g respectively). Birds fed wheat offal based diet had higher (P<0.05) enterobacteria and *E. coli* colony count in the caecum than those fed PKC based diets. However there was higher (P<0.05) count of *E. coli* colony in the small intestine of birds fed PKC based diet compared to those fed WO based diet. Birds fed WO based diet recorded higher (P<0.05) lactobacillus colony count in the caecum than those fed PKC based diet.

Intestinal histomorphology

Table 5 shows the intestinal Histomorphometry of broiler chickens fed high fibre diets with or without synbiotic supplementation. Birds on synbiotic supplemented diets were 12% lower (P=0.04*)* in villi height (VH) of the jejunum compared to the non-supplemented group. Birds on 40% fibre source had significantly =0.04*)* higher VH than those fed 20% fibre source (2113 vs. 1859µm). The crypt depth (CD) of the jejunum of birds on synbiotic supplemented diets was smaller (P=0.01) compared to the non-supplemented group (357 vs. 479µm), whereas fibre source and fibre level had significant effect on the CD in the ileum. The CD was higher in birds on WO diets compared to those on PKC (323 vs. 262µm) and higher in birds on 40% fibre source than 20% fibre source (225 vs. 329µm). Fibre source also had a significant effect on submucosa in jejunum and ileum and birds on WO had higher values than those on PKC.

Table 4. Intestinal microbial ecology of broiler chickens fed high fibre diets with or without synbiotic supplementation (log colony forming unit)

Treatments	Enterobacteria		*Escherichia coli*		Lactobacillus	
	Caecum	Small intestine	Caecum	Small intestine	Caecum	Small intestine
T1 (WO20%)	10.21	6.05	9.53	5.1	14.23	9.83
T2 (WO20%+)	13.92	9.52	13.38	8.89	14.93	10.18
T3 (WO40%)	10.23	5.34	8.87	14.5	14.33	12.76
T4 (WO40%+)	14.57	7.91	13.69	7.05	14.59	12.15
T5 (PKC20%)	11.26	9.49	10.19	8.25	10.19	13.01
T6 (PKC20%+)	10.13	8.17	9.01	8.15	12.72	10.26
T7 (PKC40%)	9.52	9.78	8.57	8.59	12.08	10.35
T8 (PKC40%+)	11.56	7.17	10.68	6.77	11.93	10.33
SEM	0.43	0.08	0.44	0.36	0.01	0.33
P-values						
Synbiotic	0.01	0.25	0.01	0.02	0.12	0.16
Fibre	0.01	0.07	0.01	0.01	0.01	0.65
Level	0.87	0.12	0.88	0.05	0.68	0.28
S×F	0.01	0.01	0.01	0.01	0.50	0.25
F×L	0.66	0.40	0.84	0.42	0.52	0.01
S×F×L	0.26	0.83	0.23	0.78	0.29	0.09

T = Treatments; SEM = Standard error of mean; Syn = Synbiotic; S × F × L= interaction between synbiotic × fibre × level; F × S = interaction between fibre and synbiotic.

DISCUSSION

Birds fed diets supplemented with synbiotic had slower growth rates compared to those fed non-supplemented diets irrespective of the fibre source (WO or PKC) and the level of the fibre source in the diet (20/40%). This result is in contrast to that of Jung *et al*. (2008), who reported that, there was no effect of synbiotic supplementation (containing a combination of 0.6% galacto-oligosaccharides and 12% pure culture of *Bifidobacteria lactis*) on the growth performance of broiler chickens of age 7, 28 and 40 days. Similarly, Sherief *et al.* (2012) reported that 0.5% synbiotic supplementation (containing mannan-oligosaccharide and *Saccharomyces cerevisae*) in broilers diet containing less than 3% crude fibre improved daily weight gain, cumulative final body weight and feed conversion ratio in broilers reared up to 42 days. Birds fed wheat offal based diets had significantly higher feed intake than those fed palm kernel cake (PKC) based diets. The higher feed intake on WO diets may be due to its lower density compared to PKC diets, as earlier reported that diets of lower density enhance gut capacity to increase feed intake (Meremikwu *et al.*, 2013). Higher level of fibre source (40%) also resulted in higher *(P<0.05)* feed intake. This result is in consonance with the findings of previous researchers who reported increased feed intake with increasing levels of dietary fibre source (PKC) in broliers diet (Ezieshi and Olomu, 2004; Kperegbeyi and Ikperite, 2011). Also, Ezieshi and Olomu, (2008) reported increase in feed intake with increasing levels of millet offal. According to Sundu *et al.* (2006), fibrous feedstuffs tend to increase the contraction of the gizzard and may speed up the peristaltic movement of digesta in the duodenum and throughout the small intestine. This may have shortened the residence time of the digesta in the intestine. However, higher inclusion of fibre source depressed body weight in the present study. Reduction in

Table 5. Intestinal histomorphometrics of broiler chickens fed high fibre diets with or without synbiotic supplementation (μm)

Treatments	Villi height		Crypt depth		Full mucosal		Sub mucosal		Villi crypt ratio	
	Jejenum	Ileum	Jejenum	Ileum	Jejenum	Ileum	Jejenum	Ileum	Jejenum	Ileum
T1 (WO20%)	1792	851	643	288	2409	1153	305	338	3.09	2.96
T2 (WO20%+)	1400	643	379	249	1926	868	284	337	3.66	2.60
T3 (WO40%)	2165	913	534	474	2644	1265	279	458	4.11	1.96
T4 (WO40%+)	2173	596	266	283	2592	846	247	299	8.14	2.13
T5 (PKC20%)	2223	674	368	193	2576	849	275	251	6.08	3.72
T6 (PKC20%+)	2020	747	403	292	2314	1053	191	340	5.02	2.53
T7 (PKC40%)	2277	732	369	275	2582	1069	235	286	6.47	2.62
T8 (PKC40%+)	1841	796	380	287	2254	1076	194	281	4.89	2.97
SEM	74.1	36	27.7	18.4	55.37	41.9	13.2	16	0.37	0.17
P-values										
Syn	0.04	0.19	0.01	0.22	0.02	0.09	0.09	0.45	0.28	0.42
Fibre	0.08	0.85	0.06	0.02	0.72	0.77	0.04	0.01	0.07	0.1
Level	0.04	0.67	0.12	0.01	0.07	0.25	0.32	0.56	0.01	0.11
F×L	0.01	0.76	0.2	0.14	0.04	0.59	0.79	0.29	0.01	0.54
S×F	0.58	0.03	0.01	0.01	0.89	0.01	0.47	0.02	0.01	0.6
S×F×L	0.18	0.73	0.89	0.50	0.27	0.83	0.59	0.52	0.04	0.43

T = Treatments; SEM = Standard error of mean; Syn = Synbiotic; S × F × L= interaction between synbiotic × fibre × level; F × L= interaction between fibre and level; F × S = interaction between fibre and synbiotic.

body weight gain with increasing fibre source to 40% inclusion levels in diets may be attributed to the lower nutrient digestibility associated with high fibre level intake by the birds. It is well known that dietary fibre has a nutrient diluent property and also reduces the residence time of the nutrients at the upper intestine resulting in the overflow of nutrients to the lower intestine and poor nutrient digestibility (Sundu and Dingle 2003).

Wheat offal based diets resulted in improved dry matter digestibility compared to PKC based diets. The result in the present study is in consonance with the findings Ezieshi and Olomu (2004), who reported that 50% inclusion level of PKC in broilers' diet (with crude fibre level of 7.28%) depressed dry matter and crude protein digestibilities in broiler chickens. Differences in the digestibilities of PKC and WO based diets may also be due to the different fibre fractions in wheat offal and palm kernel meal. Fibre with high lignin (17.36%) and cellulose (33.69%) as found in PKC generally have low digestibility in non-ruminant digestive system compared to wheat bran of low level of lignin (2.98%) and cellulose (6.99%) (Saenphoom *et al.,* 2011; Hossain *et al.,* 2013). Increasing the level of fibre source from 20% to 40%, which also increased the fibre levels in diets by 30% and 38% in WO and PKM based diets respectively, depressed the nutrient digestibility values of proximate constituents in 40% fibre source diets and this depression was not ameliorated by synbiotic supplementation. It is well known that high fibre level in poultry diet increases the passage rate of digesta in the intestine, reduces nutrient retention in the upper intestine and consequently reduces the rate at which dietary components are exposed to enzymatic digestion, which in turn result in poor digestion of feed (Ezieshi and Olomu 2004; Sundu *et al.,* 2006; Meremikwu, 2013).

Synbiotic supplementation increased the population of enterobacteria and *E. coli* colony in the caecum of birds and

Table 6. Mean separation of significant factors of growth performance, digestibility, microbial ecology and intestinal histomorphometrics.

		Synbiotic		Fibre source		Level	
		Non-suppl.	Suppl.	WO	PKC	20%	40%
Performance							
FBW (g/bird)		1659.66^{a}	1529.36^{b}	-	-	-	-
DWG (g/bird)		30.99^{a}	27.35^{b}	-	-	-	-
DFI (g/bird)		-	-	93.55^{a}	87.12^{b}	87.95^{b}	92.34^{a}
FCR		2.96^{b}	3.29^{a}	-	-	3.02^{b}	3.25^{a}
Mortality (%)		-	-	1.43^{b}	6.25^{a}	2.42^{b}	5.33^{a}
Digestibility (%)							
Dry matter		66.81^{a}	60.06^{b}	67.33^{a}	59.55^{b}	67.77^{a}	59.10^{b}
Ash		-	-	-	-	-	-
Crude fibre		68.29^{a}	57.08^{b}	-	-	65.28^{a}	60.09^{b}
Ether extract		85.91^{a}	79.50^{b}	-	-	78.97^{b}	86.45^{a}
Crude protein		69.85^{a}	60.88^{b}	-	-	-	-
Microbial ecology (cfu/g)							
Entero	Caec	10.30^{b}	12.54^{a}	12.23^{a}	10.61^{b}	-	-
	SI	-	-	-	-	-	-
E. coli	Caec	9.29^{b}	11.69^{a}	11.37^{a}	9.61^{b}	-	-
	SI	6.61^{b}	7.72^{a}	6.38^{b}	7.94^{a}	-	-
Lacto	Caec	-	-	14.52^{a}	11.73^{b}	-	-
	SI	-	-	-	-	-	-
Intestinal histophometrics (µm)							
VH	Jej	2114.12^{a}	1858.45^{b}	-	-	1858.66^{b}	2113.90^{a}
	Ile	-	-	-	-	-	-
CD	Jej	478.50^{a}	356.71^{b}	-	-	-	-
	Ile	-	-	323.32^{a}	261.66	225.54^{b}	329.44^{a}
FM	Jej	2552.80^{a}	2271.37^{b}	-	-	-	-
	Ile	-	-	-	-	-	-
SM	Jej	-	-	278.80^{a}	223.83	-	-
	Ile	-	-	357.87^{a}	289.50	-	-
V/C	Jej	-	-	-	-	4.46^{b}	5.90^{a}
	Ile						

FBW - final body weight; DWG - Daily weight gain; DFI - Daily feed intake; FCR - Feed conversion ratio, Entero – Enterobacteria, Lacto – Lactobacillus, VH - Villi height, CD - Crypt depth, FM - Full mucosal, SM - Sub mucosal and V/C - Villi crypt ratio

Escherichia coli colony in the small intestine. This may be partly due to the low nutrient retention on synbiotic supplemented diets, which served as substrate for the growth and proliferation of these bacteria (Hughes, 2007). The inclusion of palm kernel cake in broilers' diet lowered the population of enterobacteria and *E. coli* colony count in the caecum, while wheat offal based diets improved lactobacillus colony count in the caecum. The lower counts of enterobacteria and *E. coli* may be attributed to the strong prebiotic property of the mannan oligosaccharide in palm kernel meal (Sundu *et al*., 2006).

Synbiotic supplementation reduced villi height, crypt depth, resulting in lower full mucosa in jejunum of the birds irrespective of fibre source. This was not in agreement with the findings of Awad *et al*. (2009), who reported that 0.1% supplementation of synbiotic containing *Lactobacillus* and mannan-oligosaccharide increased both villi height and crypt depth of 5-week old broilers fed low fibre diet compared with those of probiotic or control group. It is well known (Awad *et al*., 2009; Potturi *et al*., 2005) that, the villus condition is a criteria to measure the effects of nutrition on gut physiology and increase in villus height reflects more surface area for nutrient absorption. Decrease in villi height of birds fed synbiotic supplemented diets could be associated to the poor nutrient digestion resulting in inadequate activity of the absorptive cells (enterocytes) and decrease in absorptive capacity of the villi. The villi of birds fed synbiotic supplemented diets appear to be stunted and narrow with shallow crypts. The reduced crypt depth in synbiotic supplemented birds may be an indicative of low proliferation of enterocytes resulting from the reduction in the activity of those cells at the brush border of the villi as a consequence of impaired nutrient retention (Geyra *et al*., 2001).

Inclusion of wheat offal in diet increased crypt depth and sub-mucosal in ileum and sub-mucosal in the jejunum. The observed result in this study could be attributed to the improved nutrient digestibility of the birds fed wheat offal based diet which resulted in increase proliferation of the absorptive cells in the crypts. Increasing the levels of fibre source caused a linear increase in villi height, crypt depth and villi:crypt ratio. This could be attributed to the presence of coarse large particle size and dietary fibre in diet which may have increased the villi height and crypt depth in the jejunum of the birds, as reported by Dahlke *et al*. (2003).

CONCLUSION

It was concluded that synbiotic supplementation had negative effect on the growth performance, nutrient digestibility and intestinal health of broilers fed high fibre diets.

REFERENCES

1. Abeer H., Razek A. & Tony M. A. (2013) Effects of dietary supplementation of a mixture of synbiotic and some digestive enzyme on performance behaviour and immune status of Broiler Chickens. International Journal of Animal and Veterinary Advances 5(2): 75 -81
2. Awad W. A., Ghareeb K., Abdel-Raheem S. & Böhm J. (2009) Effects of dietary inclusion of probiotics and synbiotics on growth performance, organ weights and intestinal histomorphology of broiler chickens. Poultry Sci., 88: 49-56.
3. Dahlke F., Ribeiro A. M. L., Kessler A. M., Lima A. R. & Maiorka A. (2003) Effects of corn particle size and physical form of the diet on the gastrointestinal structures of broiler chickens. Brazil Journal of Poultry Science, N1: 61–67
4. Dipeolu M. A., Adebayo A. J., & Oke O. M. (2004) Residues of streptomycin antibiotic in commercial layers in Abeokuta and Ibadan metropolis. Nig. J. Anim. Prod., 31: 130-134.
5. Ezieshi E.V. & Olomu J. M. (2008) Biochemical evaluation of millet offal as feeds for broiler chickens. Pakistan Journal of Nutrition 7(3):421-425.
6. Ezieshi E.V. & Olomu J.M. (2004) Comparative performance of broiler chickens fed varying levels of palm kernel cake and maize offal. Pakistan Journal of Nutrition 3(4):254-257.
7. Kperegbeyi J. I. & Ikperite S. E. (2011) The effectiveness of replacing maize with PKC in broilers' diet staeter. Journal of environmental Issues and agriculture in developing countries, 3(1): 145-149.
8. Geyra A., Uni Z. & Sklan D. (2001) Enterocyte dynamics and mucosal development in the post hatch chick. Poultry Science 80: 776-782.
9. Gibson G. R. & Roberfroid M. B. (1995) Dietary modulation of the human colonic microbiota: introducing the concept of prebiotics. Journal of Nutrition 125, 1401-1412.
10. Gordon D. T., Williford K. & Ellersieck M. R. (1983) The action of cellulose on the intestinal mucosa and element absorption by the rat. Journal of nutrition 113:2545-56

11. Hossain K., Ulven C., Glover K., Ghavami F., Simsek S., Alamri M. S., Kumar A. & Mergoum M. (2013) Interdependence of cultivar and environment of fibre composition in wheat bran. Australian Journal of Crop Science 7(4):525-531.
12. Hughes R. J. (2007). The rate of passage of digesta influences energy metabolism in broiler chickens. Proceedings of Australian Poultry Science 16:63–66.
13. Jung S. J., Houde R., Baurhoo B., Zhao X. & Lee B. H. (2008) Effects of Galacto-Oligosaccharides and aBifidobacteria lactis-Based Probiotic Strain on the Growth Performance and Fecal Microflora ofBroiler Chickens. Poultry Science 87: 1694 - 1699.
14. Meremikwu V. N., Ibekwe H. A. & Essien A. (2013) Improving broiler performance in the tropics using quantitative nutrition. World’s Poultry Science Journal, 69: 633 - 638.
15. Onifade A. A. & Babatunde G. M. (1997) Comparative response of broiler chicks to a high fibre diet supplemented with four antibiotics. Animal Feed Science and Technology 64: 337 - 342
16. Onifade A. A. & Odunsi A. A. (1998) Efficacy of procaine penicillin as a growth promoter in broiler chicks fed low and high fibre diets in the tropics. Arch. Zootec. 47: 621 - 628.
17. Potturi P. V., Patterson J. A. & Applegate T. J. (2005) Effects of delayed placement on intestinal characteristics in turkey. Poult. Sci., 84: 816-824.
18. Saenphoom P., Liang J. B., Ho Y. W., Loh T. C. & Rosfarizan M. (2011) Effect of enzyme treatment on chemical composition and production of reducing sugarsin palm kernel expeller. African Journal of Biotechnology vol.(10) 68, pp.15372-15377.
19. Sherief M. A., Sherief M. S. & Khaled M. A. (2012) Effects of Prebiotic, Probiotic and synbiotic supplementation on intestinal microbial ecology and histomorphology of broiler chickens. IJAVMS, Vol. 6, Issue 4, 2012: 277 - 289.
20. Simon O. (2005) Mikroorganismen als Futterzusatzstoffe: Probiotika Wirksamkeit und Wirkungsweise. 4. BOKU-Symposium Tierernährung: Tierernärung ohne Antibiotische Leistungsförderer. Vienna Austria, pp.10-16.
21. Sundu, B. & Dingle J. (2003) Use of enzymes to improve the nutritional value of palm kernel meal and copra meal. Proceed. Queensland Poultry Science. Symposium Australia, 1(14): 1-15.
22. Sundu B., Kumar A. & Dingle J. (2006) Palm kernel meal in broilers diets: effect on chicken performance and health. World’s Poultry Science Journal, 62: 316-325.
23. Zanu H. K., Abangiba J., Athur-Badoo W., Akparibo A. D. & Sam R. (2012) Laying chickens’ response to various levels of palm kernel cake in diets. International Journal of livestock production vol 3(1):12-16
24. Zarei M., Ehsani M & Torki M. (2011) Dietary inclusion of probiotics, prebiotics and synbiotic and evaluating performance of laying birds. American Journal of Agricultural and Biological Sciences 6(2): 249-255.

