International Journal of Bio-resource and Stress Management https://ojs.pphouse.org/index.php/IJBSM

IJBSM May 2023, 14(5):780-788 Print ISSN 0976-3988 Online ISSN 0976-4038 Article AR3382

Research Article Natural Resource Management

DOI: HTTPS://DOI.ORG/10.23910/1.2023.3382

Effects of Fermented Wheat Bran on Blood Biochemical Parameters and Carcass Characteristics of Broiler Birds

Akash Paul[1], A. K. Samanta[1], B. K. Das[1], Gourab Debbarmma[1], Subhankar Paul[2] and Manisha Datta[3]

[1]Dept. of Animal Nutrition, C.V.Sc. & A.H., [2]Dept. of Livestock Production and Management, [3]Dept. of Veterinary Medicine, C.V.Sc. & A.H., Central Agricultural University, Selesih, Aizawl, Mizoram (796 014), India

Open Access

Corresponding akashpaul12011996@gmail.com

0009-0008-5074-6069

ABSTRACT

The experiment was conducted during 5th September 17th October, 2022 (42 Days) in the Department of Veterinary Microbiology and Immunology, College of Veterinary Sciences and Animal Husbandry, Central Agricultural University, Selesih, Aizawl, Mizoram, India to study the effect of feeding fermented wheat bran on blood biochemical parameter and carcass characteristics of broiler birds. Two hundred (200) numbers of day-old chicks were divided into five dietary groups with four replicates in each group. Each replicate contained 10 birds. Five dietary treatments: basal diet (Control); basal diet with Bacitracin methylene disalicylate (AGP) @ 0.5 g kg^{-1} of feed; basal diet with inclusion of 10% wheat bran; basal diet with inclusion of 10% fermented wheat bran; and basal diet with inclusion 15% fermented wheat bran. The feed and water were given at free choice to the birds. Fermented wheat bran was prepared by inoculating *Lactobacillus fermentum* using Solid-state fermentation technology. Blood biochemical parameters like total protein, albumin, globulin, triglyceride, cholesterol, LDL and HDL did not differ significantly among the experimental groups. However, the glucose level showed significantly higher (p<0.01) at 28th and 42nd days old birds, whereas HDL was significantly (p<0.05) higher at 42nd day in AGP, FWB-10 and FWB-15 group as compared to control and WB-10 group at old birds. Therefore, it was concluded that 15% fermented wheat bran can be incorporated in the diet of broiler chickens without any adverse affect.

KEYWORDS: Blood biochemical parameters, carcass characteristics, fermented wheat bran

***Citation* (VANCOUVER):** Paul et al., Effects of Fermented Wheat Bran on Blood Biochemical Parameters and Carcass Characteristics of Broiler Birds. *International Journal of Bio-resource and Stress Management,* 2023; 14(5), 780-788. HTTPS://DOI.ORG/10.23910/1.2023.3382.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

RECEIVED on 30th December 2022 RECEIVED in revised form on 17th April 2023 ACCEPTED in final form on 05th May 2023 PUBLISHED on 26th May 2023

1. INTRODUCTION

Poultry industry is the swiftly growing sectors of agricultural part in India at the growth rate of 8% to 10% annum^{-1} (Borah and Halim, 2014). Poultry meat as the most common meat in India and the poultry industry has been receiving upliftment through investments. However, poultry industries have been confronting several issues like non availability of conventional feeds stuffs, high feed cost, infectious diseases, strict regulations in the use of anti-microbials and high intensity production environments. Broiler raisers are always interested totally different approaches in feed formulation for better growth and economic production as feeding accounts for about 70% of total recurring expenditure in broiler production (Chamba et al., 2014). Maize which is traditionally included in the diet of the commercial broiler as a principal energy source, is becoming more expensive to use now a days at high level/amount in poultry feed because of its growing spate in human consumption and use in biofuel and starch industries. Therefore, there is an urgent need to investigate alternate feed ingredients as a replacement of maize. In many tropical nations, wheat bran may be a cost-effective and reliable source of energy (Picard et al., 1993). Wheat Bran could be an economical and alternate source of energy in many tropical countries. Wheat bran (WB), as the main by-product of wheat flour processing, contains a high amount of total dietary fibre (120 g kg^{-1}), and other relevant compounds including protein (160 g kg^{-1}), fat (47 g kg^{-1}), available carbohydrates (177 g kg^{-1}) and minerals (61.5 g kg^{-1}) (Souci and Kirchhoff, 2008). However, due to its high fibre and low protein content, high non-starch polysaccharides (NSP) contents as well as antinutritional elements including phytic acid, hemicelluloses, and xylan, it is prohibited to utilise wheat bran directly in several monogastric animals. (Zhang et al., 2022), these NSP components of wheat bran may inhibit nutrient digestion and absorption (Feng et al., 2020). Wheat bran may be an economical and nutritional alternative for animal feeding in many tropical countries (Mateos et al., 2012). This feedstuff is a by-product of the dry milling of wheat and consists of the hard outer layer of the grains. It has adequate protein content for poultry and high crude fiber levels (106 to 136.3 g kg^{-1}) (NRC, 1994), but lower metabolizable energy content than many ingredients such as corn, sorghum, and barley (NRC, 1994). Research studies have shown the positive effects of the use of WB and its products, combined or not with enzymes, on the growth performance, intestinal microflora, harmful lipids, egg production, and digestibility of some nutrients in poultry (Ali et al., 2008; Courtin et al., 2008). Wheat bran (WB), a byproduct of the milling process, is rich in insoluble fiber, consisting mainly arabinoxylans and, to a lesser extent, cellulose and β-glucans (Kamal-Eldin et al., 2009). Previous studies have mostly focused on how to eliminate the anti-nutritional effects of a high level of WB (Feng et al., 2019). However, with the development of research and exploration, the WB has been shown to be involved in the regulation of gastrointestinal physiology such as gastric emptying time and intestinal transit rate, which may consequently influence digestive function (De Mora Ruiz-Roso, 2015). Besides, some studies demonstrated that WB plays an important role in metabolic regulation (particularly in lipid metabolism) in rats and humans, which is associated with the digestion and absorption of nutrients (Liu et al., 2014 ; Jenkins et al., 2002). Solid-state fermentation has been reported as an effective approach for improving the nutritive value of by-products by reducing the cellulose content and improving the acid-soluble protein content (Teng et al., 2017, Yeh et al., 2018). In addition to improve the nutritional properties, fermentation helps in many ways like increasing the number of lactic acid bacteria, decreasing pH, and increasing the concentration of organic acid (Engberg et al., 2009, Chion et al., 2010, Canibe and Jensen, 2012). Micro-organisms like Lactobacillus spp and Bacillus spp were used to ferment the feed. Bacillus subtillis can secrete amylase, lipase and protease which improve the growth performance in broilers (Santoso et al., 2001). Reports suggested that complex carbohydrates are poorly metabolized by Lactobacillus spp (Dworkin et al., 2006). However, Lactobacillus could ferment low-molecular weight carbohydrates into lactic acid if complex carbohydrates were broken down into low-molecular weight carbohydrates through solid-state fermentation. (Chen et al., 2013). Therefore, single stage solid state fermentation by specific Lactobacillus spp. might have better result in terms of performance of broiler birds. As a result of the production of vitamins, organic acids, amino acids, and short peptides during the fermentation process, the nutritional value of by-products may be further increased (Feng et al., 2007; Chen, 2010). As an alternative to antibiotic growth promoter, probiotics or direct-fed microbes (DFM) and fermented feed have been used to improve growth performance and enhance the health status of poultry (Teng et al., 2017). Because of unstable effects of supplemental probiotics in broiler diets, fermented feed with probiotic bacteria have played a promising alternative to antibiotic growth promoter to improve the growth performance and health status of broilers. Therefore, present experiment was conducted to study the effected of fermented feed on blood biochemical parameters and carcass characteristics of broiler birds. So, the objective was to study the effects of feeding of fermented Wheat Bran on blood biochemical parameters and Carcass characteristics of broiler birds.

2. MATERIALS AND METHODS

2.1. Experimental site

The research study was carried out during 5th September 17th October, 2022 (42 Days), in the Department of Veterinary Microbiology and Immunology, College of Veterinary Sciences and Animal Husbandry, Central Agricultural University, Selesih, Aizawl, Mizoram, India.

2.2. Experimental birds and diet

Form a single hatch, total 200 numbers of day-old commercial broiler chicks of mixed sex with approximately equal body weight were purchased from the nearby market. By using a completely randomized block design, chicks were distributed evenly and randomly into five groups viz. Group-1, Group-2, Group-3, Group-4 and Group-5, each of which had 40 birds. All the groups of chicks were again sub-divided in to 4 replicates containing 10 numbers of birds in each replicate. Five dietary treatments: basal diet (Control); basal diet with Bacitracin methylene disalicylate (AGP) @ 0.5 g kg^{-1} of feed; basal diet with inclusion of 10% wheat bran; basal diet with inclusion of 10% fermented wheat bran; and basal diet with inclusion 15% fermented wheat bran. Fermented wheat bran was prepared by inoculating *Lactobacillus fermentum* using Solid-state fermentation technology.

2.3. Management, rearing and feeding of birds

All the group of birds were nursed under similar managemental condition and health care. The experimental shed, feeder and waterer were washed, cleaned and disinfected properly. Rice husk was used as litter material for chicks rearing. Plastic wire nets and wooden bars were used for separation of different pens. Continuous light was provided to the birds and proper ventilation was maintained during the overall experimental period. Brooding of all groups of birds were done up to 1st 7 days age. All the group of birds were vaccinated against NDV and IBD at 7th and 14th days of age, and booster dose vaccine against NDV was also done at 21st days of age.

All the birds of different groups were fed as per BIS (2007) specification, where three types of boiler diet were prepared i.e., boiler pre-starter (1–7 days of age), boiler starter (8–21 days of age) and boiler finisher (22–42 days of age).The diet of various treatment groups were presented below in Table 1.

2.4. Analysis of chemical composition of feed

Feed and faeces were analyzed (Anonymous, 2000) for dry matter (DM; method 934.01), CP (method 968.06; Kelplus, PelicanEquipments, Chennai, India), crude fiber (CF; Fibreplus, PelicanEquipments, Chennai, India) andether extract (EE; method 920.39; Socsplus, Pelican Equipments, Chennai, India).

2.5. Collection of blood and estimation of biochemical parameters

Blood sample of 2 ml of one bird from each replicate was collected on 28th and 42nd day of rearing from the wing vein with the help of sterile syringe and kept that syringe in slant position (15%) for 10 to 15 m for settle down of the RBC and separation of serum. Serum was taken out with the help of micropipette, kept in to eppendorf tube and kept in to -20°C for further estimation.

2.6. Carcass characteristics

For evaluation of carcass characteristics, one bird was

Table 1: Chemical composition (%) of pre-starter feed for experimental boiler birds

Attributes	Group-1 (Control)	Group- 2 (AGP)	Group-3 (WB-10)	Group-4 (FWB-10)	Group-5 (FWB-15)
DM (%)	89.12	89.19	89.05	89.67	89.59
CP (%)	23.01	23.12	23.21	23.25	23.26
EE (%)	2.94	3.05	3.21	3.17	3.12
CF (%)	2.89	2.92	2.98	2.95	2.94
TA (%)	6.13	6.14	6.17	6.15	6.16
NFE (%)	65.03	64.77	64.32	64.26	64.27
Ca (%)	1.33	1.34	1.33	1.33	1.32
P (%)	0.82	0.8	0.83	0.82	0.81
ME (kcal kg^{-1})*	2975.55	2975.55	2954.1	2988.9	2993.1
Lysine*	1.3	1.3	1.29	1.31	1.3
Methionine*	0.5	0.5	0.5	0.5	0.5

*Calculated value; C: Control; AGP: Antibiotic Growth Promoter; (WB-10): 10% Wheat Bran; (FWB-10): 10% Fermented Wheat Bran (with *Lactobacillus fermentum*); (FWB-15): 15% Fermented Wheat Bran (with *Lactobacillus fermentum*) randomly selected from each replicate on 42nd day of the experiment, and starved overnight in order to empty their crop. Birds were slaughtered by severing the jugular vein, eviscerated and dressed to determine carcass characteristics. The gizzard, heart, liver, thigh, breast, back, wing, neck, drum stick, were removed separately. Each cut-up part and organ were separately weighed using a sensitive electronic scale and expressed as a percentage of dressing weight.

2.7. Statistical analysis

Data were analysed applied one-way ANOVA method using SPSS in a completely randomized design as per statistical method described by Snedecor and Cochran (2004). Blood biochemical parameters between two periods were analyzed by applying paired t- test.

3. RESULTS AND DISCUSSION

3.1. Chemical composition of pre-starter, starter and finisher ration experimental broiler birds

The chemical composition (DM% basis) of broiler pre-starter, starter and finisher is presented in Table 1, 2 and 3 respectively. All the diets were made isocaloric and isonitrogenous. The nutrient composition of treatment diets given on the table was as per BIS, 2007 recommendation for broiler pre-starter, starter and finisher diets.

Table 2: Chemical composition (%) of starter feed for experimental boiler birds

Attributes	Group-1 (Control)	Group- 2 (AGP)	Group-3 (WB-10)	Group-4 (FWB-10)	Group-5 (FWB-15)
DM (%)	88.92	88.98	88.72	88.87	88.89
CP (%)	22.13	22.17	22.19	22.22	22.24
EE (%)	3.6	3.63	3.58	3.55	3.6
CF (%)	3.55	3.53	3.63	3.6	3.61
TA (%)	6.25	6.27	6.23	6.2	6.21
NFE (%)	64.47	64.4	64.3	64.18	64.06
Ca (%)	1.43	1.45	1.4	1.41	1.38
P (%)	0.89	0.86	0.91	0.9	0.89
ME (kcal kg^{-1})*	3132.5	3116	3095.5	3137.6	3112
Lysine*	1.21	1.2	1.19	1.2	1.21
Methionine*	0.5	0.5	0.5	0.5	0.5

*Calculated value; C: Control; AGP: Antibiotic Growth Promoter; (WB-10): 10% Wheat Bran; (FWB-10): 10% Fermented Wheat Bran (with *Lactobacillus fermentum*); (FWB-15): 15% Fermented Wheat Bran (with *Lactobacillus fermentum*)

Table 3: Chemical composition (%) of finisher diet for experimental boiler birds

Attributes	Group-1 (Control)	Group- 2 (AGP)	Group-3 (WB-10)	Group-4 (FWB-10)	Group-5 (FWB-15)
DM (%)	89.01	89.12	89.27	89.23	89.25
CP (%)	20.19	20.23	20.27	20.32	20.35
EE (%)	4.5	4.6	4.71	4.75	4.77
CF (%)	3.51	3.52	3.6	3.55	3.57
TA (%)	6.31	6.35	6.37	6.33	6.34
NFE (%)	64.38	65.21	64.92	64.95	64.82
Ca (%)	1.31	1.29	1.28	1.32	1.33
P (%)	0.98	0.92	0.93	0.97	0.98
ME (kcal kg^{-1})*	3213.45	3213.45	3150	3215.5	3216
Lysine*	1	1	1	1.1	1
Methionine*	0.45	0.45	0.45	0.45	0.45

*Calculated value; C: Control; AGP: Antibiotic growth promoter; (WB-10): 10% Wheat Bran; (FWB-10): 10% fermented wheat bran (with *Lactobacillus fermentum*); (FWB-15): 15% fermented wheat bran (with *Lactobacillus fermentum*)

3.2. Blood biochemical parameters

3.2.1. Glucose

Table 4 showed that on 28th and 42nd day blood glucose value was significantly (p<0.01) higher and same for AGP and FWB groups than the other groups. Compared to the control group average value of blood glucose at day 28 and 42 was found not significantly (p>0.05) different among the groups, but among these groups FWB has the higher blood glucose value.The effect of easily metabolizable sugars (glucose, xylose, fructose, maltose, cellobiose and lactose) on xylanase production by *Aspergillus tamarii* in solid-state fermentation (SSF) was studied using wheat bran, corn cob and sugar cane bagasse as substrate. The addition of different sugars at a concentration of 1% to sugar cane bagasse or corn cob media caused severe catabolic repression. In contrast, wheat bran systems were resistant to catabolic repression even at high concentrations of glucose (10%) (Souza et al., 2001). This finding was in agreement with other study, Chuang et al. (2021) reported that the glucose in blood increased from 201 to 237, 247, 255, and 276 mg dl^{-1} respectively in the control, 5% WB, 5% FWB, 10% WB, and 10% FWB groups (p<0.001).

3.2.2. Total protein

Total protein level was not significantly (p>0.05) different among the groups in both 28th, 42nd day of blood collection. But among these groups AGP and FWB groups showed higher blood protein level than the other groups. This finding is in agreement with other study, Shang et al. (2020) said that effects of WB supplementation on serum biochemical parameters in broilers on Day 21 and 42. On Day 21, there were no differences in serum concentrations of UN, HDL-C, LDL-C, TG, TP, ALB and GLU between treatments.

3.2.3. Albumin

Albumin level was not significantly (p>0.05) different

Table 4: Effect of fermented wheat bran with organism (*Lactobacillus fermentum*) on serum Glucose (mg dl^{-1}), total protein (g dl^{-1}), Albumin (g dl^{-1}) and Globulin (g dl^{-1}) in broiler birds

Attributes	Treatment					p value
	Control	AGP	W-10	FWB-10	FWB-15	
Glucose						
28th day	225.58±1.59^a	242.34±2.67^b	230.73±1.18^a	244.66±1.15^b	244.80±1.19^b	0.00**
42nd day	226.96±1.64^a	243.28±1.75^b	231.67±0.73^a	248.44±1.3^b	247.85±1.69^b	0.00**
p value	0.598	0.574	0.551	0.097	0.116	
Average	226.27±1.10	242.80±1.51	231.20±0.66	246.55±1.09	246.32±1.12	0.84
Total protein						
28th day	4.54±0.34	4.72±0.27	4.62±0.39	4.63±0.32	4.36±0.39	0.95
42nd day	4.47±044	4.61±0.34	4.43±0.50	4.63±0.24	4.63±0.27	0.99
p value	0.895	0.826	.0790	0.992	0.495	
Average	4.51±0.26	4.66±0.21	4.53±0.29	4.63±0.18	4.49±0.22	0.86
Albumin						
28th day	1.10±0.00	1.17±0.01	1.05±0.02	1.03±0.02	0.82±0.24	0.21
42nd day	1.16±0.02	1.18±0.01	1.11±0.00	1.12±0.00	1.15±0.01	0.09
p value	0.057	0.727	0.145	0.028*	0.255	
Average	1.13±0.01	1.18±0.01	1.08±0.01	1.08±0.02	0.98±0.12	0.34
Globulin						
28th day	2.49±0.04	2.49±0.04	2.43±0.01	2.50±0.01	2.42±0.01	0.47
42nd day	2.52±0.02	2.50±0.01	2.46±0.02	2.50±0.01	2.51±0.00	0.31
p value	0.305	0.727	0.170	0.81	0.007**	
Average	2.51±0.02	2.49±0.02	2.45±0.01	2.50±0.01	2.47±0.01	0.13

a,b,c means bearing different super scripts in the same row differ significantly (p<0.05); C: Control; AGP: Antibiotic growth promoter; (WB-10): 10% wheat bran; (FWB-10): 10% fermented wheat bran (with Lactobacillus fermentum); (FWB-15): 15% fermented wheat bran (with Lactobacillus fermentum); *: Means (p<0.05); **: Means (p<0.01) among the groups in 28th and 42nd day of blood collection. Among these groups control and AGP groups has higher blood albumin level than the other groups. This finding is in agreement with other study, Chu et al. (2017) was said that the effects of dietary supplementation with FWB on serum characteristics at 35 days of age. There were no significant differences in serum glutamic-oxalocetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT), total protein (TP) or albumin (ALB) levels among all treatment groups of broiler birds. Shang et al. (2020) reported that on Day 42, serum concentrations of HDL-C, TP, ALB and GLU still did not differ among treatments.

3.2.4. Globulin

Globulin level was not significantly (p>0.05) different among the groups in 28th and 42nd day of blood collection. Among these groups control and FWB groups showed the highest blood globulin value than the other groups. This finding is in agreement with other study, Shang et al. (2020) said that effects of WB supplementation on serum biochemical parameters in broilers on Day 21 and 42. On Day 21, there were no differences in serum concentrations of UN, HDL-C, LDL-C, TG, TP, ALB and GLU between treatments. However, birds fed WB had (p<0.05) lower serum TC concentration than those fed control. On Day 42, serum concentrations of HDL-C, TP, ALB and GLU still did not differ among treatments.

3.2.5. Triglycerides

Total triglycerides level was not significantly (p>0.05) different among the groups in 28th and 42nd day of blood collection. Among these groups FWB group showed the highest triglyceride value among compared to other groups (Table 5). This finding is in agreement with other study, Semjon et al. (2020) observed that the lower concentration of alkaline-phosphatase and calcium and higher total lipids and triglycerides in blood were observed in 10% of fermented feed (FF10) and additionally supported by

Table 5: Effect of fermented wheat bran on serum triglyceride (mg dl^{-1}), total cholesterol (mg dl^{-1}), LDL (mg dl^{-1}) and HDL (mg dl^{-1}) in broiler birds

Attributes	Treatment					p value
	Control	AGP	W-10	FWB-10	FWB-15	
Triglycerides						
28th day	45.09±3.14	49.67±2.86	49.70±5.14	51.14±4.74	56.47±3.88	0.34
42nd day	49.41±4.12	46.23±3.59	49.22±3.88	54.63±5.17	47.26±3.82	0.66
p value	0.00**	0.00**	0.00**	0.00*	0.00**	
Average	47.25±2.54	47.95±2.24	49.46±2.88	52.89±3.31	51.86±3.06	0.53
Cholesterol						
28th day	113.1±3.94	115.1±5.33	121.1±6.30	115.7±5.50	114.6±5.53	0.89
42nd day	120.9±3.94	126.5±4.89	122.9±7.80	123.0±3.73	124.4±3.99	0.92
p value	0.035*	0.006**	0.919	0.005**	0.554	
Average	117.06±2.97	120.87±3.90	122.03±4.50	119.36±3.37	119.52±3.66	0.90
LDL						
28th day	13.9±0.55	12.2±1.0	10.7±0.42	12.3±1.35	11.9±1.32	0.35
42nd day	21.72±0.89	21.48±1.07	21.55±1.22	22.19±1.22	22.96±1.23	0.88
p value	0.00**	0.00**	0.001**	0.00**	0.00**	
Average	17.81±1.39	16.85±1.69	16.12±2.49	17.24±2.05	17.47±2.23	0.98
HDL						
28th day	81.69±0.66	82.0±1.19	80.7±0.92	82.4±1.15	82.32±1.49	0.87
42nd day	84.29±0.60^{ab}	87.93±0.37^{bc}	83.33±1.11^{a}	88.7±2.21^{c}	89.14±1.81^{c}	0.02*
p value	0.00**	0.001**	0.362	0.002**	0.002**	
Average	82.99±0.60	85.00±1.13	82.02±0.87	85.58±1.66	85.73±1.68	0.20

a,b,c means bearing different super scripts in the same row differ significantly (p<0.05); C: Control; AGP: Antibiotic growth promoter; (WB-10): 10% wheat bran; (FWB-10): 10% fermented wheat bran (with Lactobacillus fermentum); (FWB-15): 15% fermented wheat bran (with Lactobacillus fermentum); *: Means (p<0.05); **: Means (p<0.01)

0.2% of agrimony extract (FF10+AE). Shang et al. (2020) said that birds fed WB had lower (p<0.05) serum total cholesterol concentration on Day 21, and lower (p<0.05) serum concentrations of low-density lipoprotein, total cholesterol and total triglyceride on Day 42.

3.2.6. Cholesterol

Blood cholesterol level was not significantly (p>0.05) different among the groups in 28th and 42nd day of blood collection. Among these groups WB group showed the highest cholesterol value among compared to other groups. This finding is in agreement with other study, Ali et al. (2008) found out that WB-diet alone or with 0.01% Xylam (E) significantly increased plasma antioxidant capacity while it decreased total plasma cholesterol compared to the control diet. Shang et al. (2020) said that birds fed WB had lower (p<0.05) serum total cholesterol concentration on Day 21, and lower (p<0.05) serum concentrations of low-density lipoprotein, total cholesterol and total triglyceride on Day 42.

3.2.7. LDL

LDL level was not significantly (p>0.05) different among the groups in 28th and 42nd day of blood collection. Among these groups control group showed the highest LDL value among compared to other groups. This finding is in agreement with other study, Shang et al. (2020) said that birds fed WB had lower (p<0.05) serum total cholesterol concentration on Day 21, and lower (p<0.05) serum concentrations of low-density lipoprotein, total cholesterol and total triglyceride on Day 42.

3.2.8. HDL

HDL level was significantly (p<0.05) different among the groups in 42nd day of blood collection. Among these groups FWB group showed the highest HDL value compared to other groups. This finding is in agreement with other study, Semjon et al. (2020) reported that between the groups of experimental groups of animals (FF10 and FF10+AE), a significant difference was determined between the obtained ALP blood variables (p<0.05). The FF10 group of animals had a higher average content of ALP, but in this variable, the highest standard deviation was also observed. Total lipids were significantly affected by the experimental diet (p<0.05). The increase of triglyceride (TG) content after the provision of the experimental diet to groups FF10 and FF10+AE was significant (p<0.05), but in the HDL blood variable, a significant decrease was observed (p<0.05). Shang et al. (2020) said that effects of WB supplementation on serum biochemical parameters in broilers on Day 21 and 42. On Day 21, there were no differences in serum concentrations of UN, HDL-C, LDL-C, TG, TP, ALB and GLU between treatments. However, birds fed WB had (p<0.05) lower serum TC concentration than those fed control. On Day 42, serum concentrations of HDL-C, TP, ALB and GLU still did not differ among treatments.

3.3. Carcass characteristics

Carcass characteristics of different experimental groups. It was observed that carcass characteristics of broilers were not significantly (p>0.05) different among the experimental groups (Table 6). This finding is in agreement with other studies (Santoso et al., 1995, Skrede et al., 2003, Sulhattin et al., 2016, Zhang et al., 2016). According to Santoso et al. (1995), broiler relative belly fat weight could increase when fed a dietary supplement containing fermented Bacillus subtilis product at a rate of 10 or 20 g kg^{-1} of feed. Skrede et al. (2003) discovered a rise in abdominal fat in broilers with increasing level of *Lactobacillus* strain AD2

Table 6: Effect of fermented wheat bran on carcass characteristics (%) in experimental broiler birds

Attributes	Control	AGP	WB-10	FWB-10	FWB-15	p value
Slaughter weight (g)	1917.8±14.71	1974.0±17.44	1919.0±14.89	1921.8±11.38	1922.8±13.97	0.07
Carcass weight (g)	1246.8±10.77	1288.2±12.47	1233.2±11.96	1244.5±20.58	1237.8±7.43	0.07
Dressing %	65.01±0.17	65.26±0.45	64.26±0.43	64.75±0.95	64.38±0.48	0.69
Breast wt (g)	361.5±17.59	398.7±10.78	346.7±16.30	355.2±13.10	351.5±12.96	0.13
Back (g)	336.4±28.40	339.6±12.90	357.6±27.88	346.4±24.92	353.2±17.55	0.96
Drumstick (g)	187.2±5.40	194.0±6.59	171.0±6.89	181.5±6.06	176.2±5.66	0.12
Wing (g)	146.0±3.08	148.0±5.11	142.2±3.17	144.2±4.64	145.2±4.53	0.90
Giblet (g)	112.9±2.42	109.0±3.24	114.2±1.79	109.5±1.55	108.0±3.48	0.40
Neck (g)	81.0±3.10	77.0±2.44	78.5±1.84	84.7±2.65	80.5±2.32	0.29
Abdominal Fat (g)	20.2±1.79	20.5±1.19	21.5±2.25	21.5±0.64	21.5±1.19	0.95

C: Control; AGP: Antibiotic growth promoter; (WB-10): 10% wheat bran; (FWB-10): 10% fermented wheat bran (with *Lactobacillus fermentum*); (FWB-15): 15% fermented wheat bran (with *Lactobacillus fermentum*) fermented barley in administered feeds. Fermented diet fed to broiler birds generated more carcasses than those fed unfermented cereals, according to research by Sulhattin et al. (2016). Zhang et al. (2016) reported that on 56 day old broiler chickens, inclusion of 6% fermented feed into the diet resulted in increased abdominal fat percentage than the control group.

5. CONCLUSION

Up to 15% fermented wheat bran was found suitable in the diet of broiler chicken as an alternative feed that gave no adverse effect on blood biochemical parameters and carcass characteristics.

6. REFERENCES

Ali, M.N., Abou, M.S., El-Kloub, M., 2008. Incorporation of wheat bran in broiler diets. International Journal of Poultry Science 7(1), 6–13.

Anonymous, 2000. Official methods of analysis (17th Edition). Association of official analytical chemists (AOAC), Washington, DC, USA.

Anonymous, 2007. Livestock feed and equipment systems sectional committee, Bureau of Indian Standards, FAD 5.

Borah, M., Halim, R.A., 2014. Dynamics and performance of livestock and poultry sector in India: A temporal analysis. Journal of Academia and Industrial Research 3(1), 1–9

Canible, N., Jensen, B.B., 2012. Fermented liquid feed: microbial and nutritional aspects and impact on enteric diseases in pig. Animal Feed Science and Technology 173, 17–40.

Chamba, F., Puyalto, M., Ortiz, A., Torrealba, H., Mallo, J.J., Riboty, R., 2014. Effect of partially protected sodium butyrate on performance, digestive organs, intestinal villi and E. coli ICRA. International Journal of Poultry Science 13(7), 390–396.

Chen, Q.T., 2010. Application of fermented palm kernel meal and coconut meal in diet of laying hens. Feed Research 10, 11–12.

Chen, W., Zhu, X.Z., Wang, J.P., Wang, Z.X., Huang, Y.Q., 2013. Effects of bacillus subtillis var. natto and Saccharomyces cerevisiae fermented liquid feed on growth performance, realative organ weight, intestinal microflora, and organ antioxidant status in Landes geese. Journal of Animal Science 91, 978–985.

Chion, P.W.S., Yn, B., Chen, C.C., Shih, Y.C., 2010. Evaluating nutritional quality of single stage and two stage fermented soybean meal. Asia-Australasian Journal of Animal Sciences 23, 598–606.

Chu, Y.T., Lo, C.T., Chang, S.C., Lee, T.T., 2017. Effects of *Trichoderma* fermented wheat bran on growth performance, intestinal morphology and histological findings in broiler chickens. Italian Journal of Animal Science 16(1), 82–92.

Chuang, W.Y., Lin, L.J., Hsieh, Y.C., Chang, S.C., Lee, T.T., 2021. Effects of *Saccharomyces cerevisiae* and phytase co-fermentation of wheat bran on growth, antioxidation, immunity and intestinal morphology in broilers. Animal Bioscience 34(7), 1157.

Courtin, C.M., Broekaert, W.F., Swennen, K., Lescroart, O., Onagbesan, O., Buyse, J., Decuypere, E., De Wiele, T., Marzorati, M., Verstraete, W., Huyghebaert, G., Delcour, J.A., 2008. Dietary inclusion of wheat bran arabinoxylooligosaccharides induces beneficial nutritional effects in chickens. Cereal Chemistry 85(5), 607–613.

De Mora Ruiz-Roso, B.C., 2015. Positive effects of wheat bran for digestive health; Scientific evidence. Nutrición Hospitalaria 32, 41–45.

Dworkin, M., Falkow, S., Schleifer, K.H., Rosenberg, E., Stackebrandt, E., 2006. The genera Lactobacullus and Carnobacterium. The prokaryotes. Vol. 4, 3rd ed. New york, springer Verlag, 320–403.

Engberg, R.M., Hammershj, M., Johansen, N.F., Abousekken, M.S., Steen Feldt, S., Jensen, B.B., 2009. Fermented feed for laying hens: effects on egg production, egg quality, plumage condition, and composition and activity of the intestinal microflora. British Poultry Science 50, 228–239.

Feng, J., Lin, X., Xn, Z.R., Lu, Y.P., Lin, Y.Y., 2007. Effect of fermented soybean meal on intestinal morphology and digestive enzyme activities in weaned piglets. Digestive Disease and Science 52, 1845–1850.

Feng, Y., Wang, L., Khan, A., Zhao, R., Wei, S., Jing, X., 2020. Fermented wheat bran by xylanase-producing *Bacillus cereus* boosts the intestinal microflora of broiler chickens. Poultry Science 99(1), 263–271.

Feng, Y., Wang, L., Khan, A., Zhao, R., Wei, S., Jing, X., 2019. Fermented wheat bran by xylanase-producing Bacillus cereus boosts the intestinal microflora of broiler chickens. Poultry Science 99, 263–271.

Jenkins, D.J., Kendall, C.W., Augustin, L.S., Martini, M.C., Axelsen, M., Faulkner, D., Vidgen, E., Parker, T., Lau, H., Connelly, P.W., 2002. Effect of wheat bran on glycemic control and risk factors for cardiovascular disease in type 2 diabetes. Diabetes Care 25, 1522–1528.

Kamal-Eldin, A., Lærke, H.N., Knudsen, K.B., Lampi, A., Piironen, V., Adlercreutz, H., Katina, K., Poutanen, K., Aman, P., 2009. Physical, microscopic and chemical characterisation of industrial rye and wheat brans from the Nordic countries. Food Nutrition Research 53, 1912.

Liu, G., Xiao, L., Fang, T., Cai, Y., Jia, G., Zhao, H., Wang, J., Chen, X., Wu, C., 2014. Pea fiber and wheat bran fiber show distinct metabolic profiles in rats as investigated by a 1 H NMR-based metabolomic approach. PLoS ONE 9, e115561.

Mateos, G.G., Jimenez-Moreno, E., Serrano, M.P., Lazaro, R.P., 2012. Poultry response to high levels of dietary fiber sources varying in physical and chemical characteristics. Journal Applied Poultry Research 21(10), 156–174.

NRC- National Research Council. Nutrient requirements of poultry. 9th ed. Washington: Academy Press; 1994.

Picard, M., Sauveur, B., Fenardji, F., Angulo, I., Mongin, P., 1993. Ajustements technico-economiques possibles de l'alimentation des volailles dans les pays chauds. Prod. Animal 6(2), 87–103.

Santoso, U., Tanaka, K., Ohaniand, S., Saksida, M., 2001. Effect of fermented product from Bacillus subtilis on feed efficiency, lipid accumulation and ammonia production in broiler chicks. Asian-Australasian Journal of Animal Science 14, 333–337.

Santoso, U., Tanaka, K., Ohtania, S., 1995. Effect of dried *Bacillus subtilis* culture on growth, body composition and hepatic lipogenic enzyme activity in female broiler chicks. British Journal of Nutrition 74, 523–529.

Semjon, B., Bartkovsky, M., Marcincakova, D., Klempova, T., Bujnak, L., Hudak, M., Marcincak, S., 2020. Effect of solid-state fermented wheat bran supplemented with agrimony extract on growth performance, fatty acid profile, and meat quality of broiler chickens. Animals 10(6), 942.

Snedecor, G.W., Cochran, W.G., 2004. Statistical Methods, 1st East-West Press ed. Affiliated East-West Private Ltd. New Delhi.

Souci, S.W., Kirchhoff, E., 2008. Food composition and nutrition tables. 7th ed. Stuttgart Germany: Medpharm Scientific Publ.

Souza, D.F., de Souza, C.G.M., Peralta, R.M., 2001. Effect of easily metabolizable sugars in the production of xylanase by *Aspergillus tamarii* in solid-state fermentation. Process Biochemistry 36(8–9), 835–838.

Sulhattin, Y., Muhammed, S.G., Yavuz, G., 2016. Performance of broilers fed raw or fermented and redried wheat, barley and oat grains. The Turkish Journal of Veterinary and Animal Sciences 40, 313–322.

Yeh, R.H., Hsieh, C.W., Chen, K.L., 2018. Screening lactic acid bacteria to manufacture two-stage fermented feed and pelleting to investigate the feeding effect on broilers. Poultry Science 97(1), 236–246.

Zhang, A.R., Wei, M., Yan, L., Zhou, G.L., Li, Y., Wang, H.M., Liang, Y.X., 2022. Effects of feeding solid-state fermented wheat bran on growth performance and nutrient digestibility in broiler chickens. Poultry Science 101(1), 402.

Zhang, J., Zhu, J., Sun, J., Li, Y., Wang, P., Jiang, R., 2016. Effect of fermented feed on intestinal morphology, immune status, carcass and growth performance of Emei Black chicken. FASEB Journal 30, 240.