EFFECT OF DIETARY SUPPLEMENTATION OF ANIMAL BLOOD PLASMA POWDER ON PRODUCTION PERFORMANCE, DRESSED WEIGHT AND IMMUNE RESPONSE OF BROILER

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ABSTRACT: Enhancing economical poultry production using low-cost animal blood plasma powder incorporated in poultry rations is a good step toward sustainable poultry production. The purpose of the present study was to evaluate the effect of dietary supplementation of animal blood plasma powder on production performance, dressed weight, and immune response of broilers. Bovine plasma was separated from the whole blood through centrifugation. A total of 240 day-old broiler chicks having uniform body weights were randomly assigned into 4 treatment groups (AP0, AP1, AP2, and AP3). Each group had three replicates of 20 chicks (n=3; 20 birds/replicate). Ross broiler management guidelines were followed for feeding, watering, and vaccination. broiler starter ration (23.2% CP and 2990kcalME/kg) was provided during the brooding stage and switched to the grower diet (20.08% CP and 3112 kcal/kg ME) up to 28 days and finisher (18.86% CP and 3208 kcal/kg ME). Animal blood plasma powder supplemented into the diet at different levels AP1 (0.5g/kg), AP2 (1g g/kg), AP3 (1.5g g/kg), and AP0 (Control 0g/kg) for different groups. The treatment was continued for seven weeks. Significantly lower ($P<0.05$) feed intake (2809.3g±5.36) and high body weight gain (1513.3g±9.83) were found for the higher supplemented group compared to the non-supplemented group (1441.0g ±4.04). Overall FCR was significantly ($p< 0.05$) lower for supplemented groups compared with the control group. The decreasing ($p< 0.05$) trend in FCR in supplemented groups was increasing the level of bovine animal blood plasma supplementation in the diet. The dressing percentage was significantly ($P<0.05$) higher for supplemented groups as compared to the control. Non-significant differences were observed in haemagglutination inhibition (HI) antibody titer against Newcastle disease and mortality among groups. It was concluded that animal blood plasma could be safely used in broiler ration for better performance without any loss to antibodies titer and mortality. Animal blood plasma has more capability to be used as an alternative and cheap source of protein in poultry ration.

Keywords: Animal blood plasma; antibodies titer; broiler; Newcastle disease; performance.

INTRODUCTION

Poultry is the second largest enterprise in Pakistan. 1.7 million People are earning their livelihood from the poultry industry. Currently, total investment in this sector has reached up to 1190 billion rupees with a growth rate of 15-20 percent (Abbas *et al*., 2020a). Shares of the poultry industry in the national GDP are 1.7 percent (Abbas, 2020d; Abbas *et al*., 2021). Feed cost is one of the major hurdles associated with poultry raring (Abbas *et al*., 2020b; Haq and Akhtar, 2004). Rich source of protein like soybean is inadequate in Pakistan, resulting in an increased demand for animal protein ingredients like animal plasma, meat and bone meal, and other non-conventional protein sources for poultry (Abbas *et al*., 2023; Abbas *et al*., 2022; Mahmood *et al*., 1996). The estimated feed cost of poultry production is somewhat 60-70 percent, which shows that a high amount of revenue is spent on feed (Abbas, 2020). Therefore, research in the poultry sector should focus on such type of feed that is cost-efficient and quality ration (Abbas *et al*., 2020c). This type of feed may be found in the substitution of locally accessible feed ingredients both non-traditional and traditional (Abbas *et al*., 2022; *et al*., 2023). To make it possible, the feedstuffs added into poultry ration be non-competitive to the feed consumed by humans to ensure food security.

Poultry feed ingredients especially animal-origin protein is being very expensive and scarce these days because there is constant competition for consumption of these deed resources among humans, livestock, and poultry. This has increased the cost of these protein ingredients. Similarly, fish meal is the only conventional animal-origin protein used for poultry feed but many issues like its scarcity, high price, and most importantly its quality is questionable (Akpodiete and Inoni, 2000; Etuk *et al*., 2003; Karimi, 2006). So there is a dire need to find out cost-efficient protein sources which can greatly boost sustainable poultry production (Okah and Onwujiariri, 2012). Therefore, the current study focuses on exploring the dietary effect o alternate economical protein sources like animal blood plasma on the production performance of broilers.

Animal plasma is “the product obtained by spray drying plasma which has been separated away from the cellular matter (red and white blood cells) of fresh whole blood by chemical and mechanical processing (Amy *et al*., 2008). Animal plasma usually contains around 7-8% moisture and has a high protein content of nearly 80%. It contains very little fat or fiber (trace amounts), and minerals (ash) are low at less than 10% of the total. The protein portion of this product is primarily albumin, globulin, and fibrinogen-type proteins (Leigh *et al*., 2002). Since liquid animal plasma is a highly perishable and bioactive fluid, precautions regarding handling and stabilization are an everyday concern. Conversely, in a dry state, plasma is relatively stable, though slightly hygroscopic, so it must be stored in a cool and dry place (Hardwick, 2008).

Spray-dried animal plasmas have been studied in different animal feeding, where it resulted in improved performance of animals, in terms of increased weight gain and better feed conversion ratio (Coffy and Cromwell, 2001). These beneficial effects are most likely related to high molecular weight fractions like immunoglobulin and biologically active peptides. Spray-dried animal plasma protein is commonly used as a source of protein in the livestock industry, which is highly digestible and results in an improved gain in body weight and a better feed efficiency ratio. More recently De-Rouchey *et al*., (2001) reported that spray-dried blood meal or animal plasma in diets resulted in improved growth performance of laboratory animals. In poultry, many researchers including Campbell *et al*. (2003; 2004) studied the effect of spray-dried animal plasma in broilers and turkeys and reported an improvement in feed intake, growth rate, and feed efficiency. The animal’s dried plasma has been reported to have a good effect on gut morphology and health and resulted in increased weight gain of broilers in highly antigenic environmental conditions of a shed (King *et al*., 2005). It has a favorable palatability profile and a neutral to beneficial effect on stool consistency. It has been shown to increase dry matter digestibility (Quigley *et al*., 2004).

In Pakistan slaughter-houses by-products (blood) are usually wasted whereas it is encouraging to use this by-product as a source of protein in poultry diets, because of its high amino acids profile. Very limited work has been reported regarding the usage of animals' dried plasma protein in broiler feeding. Therefore the objective of the present study was to check the effect of animal blood plasma on performance, immune response, and economics of production of broilers.

MATERIALS AND METHODS

Ethical considerations: This study was pre-approved by the Departmental Board of Study meeting on ethics, methodology, and welfare of birds, KP Agriculture University Peshawar, Pakistan.

Study site and plasma powder collection: The present study aimed to investigate the effect of feeding animal blood plasma powder (ABPP) on production performance, dressing percentage, antibody titer, and economics of broiler production. The study was conducted in the poultry farm complex of the Department of Poultry Science, The University of Agriculture, Peshawar, Pakistan. For this purpose, sound and healthy cattle were identified at slaughterhouses before slaughtering. These cattle were washed before slaughtering (Halal method under standard protocol) to minimize the chances of contamination. Blood was collected from animals immediately after slaughtering in the abattoir (hygienic measures were followed). Plasma was obtained from the whole blood by collecting blood in sterile bottles having ethylene di amine tetra acetic acid (EDTA) solution as an anticoagulant. Bottles were kept in an ice box and brought to the lab within 15 minutes. Plasma was separated from the blood through centrifugation @ 4000x g for 10 minutes. The plasma obtained was shifted to a microwave oven for 48 hours at 40 degrees centigrade. Dried plasma was powdered by a grinder and stored for further use.

Experimental design and chicks selection: A total of 280 chicks were procured from a local market and were brooded collectively for one week. Out of these 280 chicks, 240 chicks of almost similar body weight were selected and divided into four groups of 60 chicks each. Each group was further divided into three replicates (n=20/replicate) shown in Table 2. Chicks in all replicates were maintained in 10x10 ft^2 separate wooden cages. Isonitrogenous and isocaloric broiler starter ration (Table 1) was provided during the brooding phase, similarly, Isonitrogenous and isocaloric grower feed were offered up to 28 days after brooding and the finisher was offered from the 29^{th} day till the end of the study. Diets were formulated (table 1) by calculating the estimated chemical composition of ingredients [CP%, ME (Kcal/Kg), Crude fiber%, crude fat%, calcium%, phosphorus%, Lysine%, Methionine%, Threonine%, and Tryptophane%] used on as such basis. The duration of the study was seven weeks. Chicks in one group were offered feed having no animal plasma (AP0) while chicks in the other three groups were provided feed containing 0.5,1.0 and 1.5g animal blood plasma powder per kg. All cages were placed in open-sided houses providing an optimum environment. Separate feeders and drinkers were arranged for each cage. The required concentration of dried animal blood plasma powder was mixed with poultry ration. Daily offered feed was separated from feed bags and was treated with the required plasma concentration and uniformly mixed before being offered to the birds. Uniform mixing was ensured through a feed mixer. Water and feed were offered *ad libitum*.

Table .Experimental diet for broiler

Ingredients %	Requirements		
	Starter	Grower	Finisher
Corn	46.95	51.2	52.5
Soybean meal	38.12	29.3	26.8
Meat meal	2.90	2.00	1.50
Canola meal	0.00	5.00	4.00
Soyabean oil	2.00	2.10	3.00
DCP	1.71	1.72	1.72
$Caco_3$	1.33	1.33	1.33
Wheat	5.51	8.00	10.0
Salt	0.45	0.45	0.45
Vitamin premix[1]	0.10	0.10	0.10
Mineral premix[2]	0.20	0.20	0.20
L-Lysine	0.32	0.32	0.32
Dl-Methionine	0.32	0.32	0.32
Phytase[3]	0.005	0.005	0.005
Mixed enzyme[4]	0.03	0.03	0.03
Antimycotoxin[5]	0.01	0.01	0.01
Cocidiostate[6]	0.02	0.02	0.02
Probiotic[7]	0.006	0.006	0.006
Total	100	100	100
Calculated analysis (%)			
Crude protein	23.2	20.08	18.86
ME per kg	2990	3112	3208
Crude fat	4.90	5.00	3.80
Crude fiber	4.90	8.00	8.10
Calcium	1.33	0.99	0.99
Phosphorus	0.46	0.46	0.46
Sodium	0.10	0.10	0.10
Lysine	1.37	1.37	1.37
Methionine+Cysteine	1.01	1.02	1.12
Threonine	0.81	0.73	0.68
Tryptophan	0.19	0.17	0.17

[1]A, 82,000 IU; D3, 12500 IU; B2, 45 mg; B1, 4 mg; B6, 8 mg; B12, 40 µg; E, 20 mg; niacin, 60 mg
[2]Contained: Ca, 32%; Mn, 0.44%; P, 6%; I, 150 ppm; Zn, 0.33%; Cu, 250 ppm; Fe, 2000 ppm; calcium pantothenate, 12.5 mg. [3]PHY Axtra 10,000 FTU/g. [4]COMBO Enzyme Blend consists of the following: cellulase, 75,000 CU units/kg; fungal amylase 30,000, SKB units/kg; fungal protease, 1,000,000 HUT units/kg; neutral protease, 100,000 PC units/kg; alkaline protease, 1.2 Anson units/kg; xylanase, 20,000 × U units/kg; beta-glucanase, 20,000 BG units/kg; hemicellulase, 20,000 HCU units/kg; and lipase, 75,000 FIP units/kg. [5]MYCOFIX deactivation of mycotoxins to improve performances. [6]Diclazuril 500 mg, (ATco pharma). [7]ENVIVA Pro 202 GT, *Bacillus subtilis* 2.5E CFU/gm.

Determining the production performances: Daily feed intake was calculated by subtracting the amount of feed refused from feed offered with the formula; Feed intake = feed offered - feed refused. Body weight gain was recorded at the end of each week. For this chicks were weighed at the start of the experiment and the end of each week. The gain in body weight was recorded by subtracting the initial body weight from the final body weight during each week. The total weight gain was calculated at the end of the study by adding the weekly weight gain. The feed conversion ratio was calculated for each week. At the end of the study total feed conversion ratio was calculated by using the formula; FCR = Feed intake/ Weight gain. Mortality was recorded for each replicate and was also maintained throughout the experiment.

Dressing percentage: At the end of the experiment, two birds from each replicate were randomly selected to record the live weight and then slaughtered to determine the dressed weight. The dressing percentage was calculated by the formula as reported by Paik (1991); Dressing percentage = dressed weight/live weight x 100.

Economic of broiler production: The economics of broiler production fed varying levels of dietary inclusion animal blood plasma powder was calculated as cost-incomed of the experimental chicks from total expenditures used on a collection of animal blood plasma powder, feed intake, operational costs (medicine and vaccine costs, gross return, and net profit.

Determining the antibody titer against ND: Despite routine immunization, NDV outbreaks frequently occur, resulting in huge mortalities and financial losses (Absalon *et al.*, 2019). As a result, the following technique will be used in the current study to find out the antibody titer against Newcastle disease in birds offered different levels of powder animal blood plasma. At the end of this experiment, two birds (sound, healthy, standard weight, bright eye, and have no reason on the body) from each replicate were selected to collect blood samples for the determination of antibodies titer against Newcastle disease virus. Haemagglutination(HA) was used to determine the 4HA unit and the haemagglutination inhibition (HI) test was used to determine antibodies titer (Allan *et al.*, 1983).

Statistical Analysis: The data were statistically analyzed with the standard procedure of analysis of variance (ANOVA) using a Completely Randomized Design. Means were compared for the significance of differences by least significant difference (Jan *et al.* 2009) using Statistical Package for the Social Sciences (SPSS), 2014.

Table 2. Experimental layout.

Group	Dose level g /kg	Replicates		
		Rep 1	Rep 2	Rep 3
AP 0	0	20	20	20
AP 1	0.5	20	20	20
AP 2	1.0	20	20	20
AP 3	1.5	20	20	20

AP1=*animal plasma offered 0.5g/kg of ration*. AP2= *animal plasma offered 1g/kg of ration.* AP3= *animal plasma offered 1.5g/kg of ration*. Rep= *replicate*

RESULTS

Growth performance of broiler supplemented with ABPP: Table 3 shows the growth performance of broilers supplemented with different levels of ABPP in their diet. Animal blood plasma is a rich source of protein and has positive effect growth parameters of birds. Economically improved feed intake ($P \leq 0.05$) was recorded in ABPP-supplemented groups. Feed intake in the supplemented group was significantly affected due to treatments (See Table 3). The group fed with a diet supplemented with 1.5g/kg of animal plasma powder (AP3) showed lower ($P \leq 0.05$) feed intake (2809.3±5.36) followed by AP2 (2832.0±3.21) and AP1 (2864.7±6.74). Significant ($P \leq 0.05$) improvement was noted in the body weight gain of experimental birds (See Table 3). The highest body weight (1513.3±9.83) was recorded for the AP3 group, supplemented highest amount of ABPP whilst the lowest body weight (1441.0±4.04) was observed for the control group having no supplementation of ABPP (See Table 3). Similarly**,** ABPP supplementation had a positive effect on the FCR of broilers. Significantly improved ($P \leq 0.05$) FCR was recorded in broiler raised (1.85±0.01) in a group that offered a high level of ABPP. Poor FCR was observed in birds raised in the control group (2.00±0.00). FCR for AP1 and AP2 was (1.94±0.01) and (1.89±0.01) consecutively.

Immunity, mortality, and dressing percentage of broilers supplemented with ABPP: Antibodies titer (HI) against ND of the experimental birds was found to be statistically non-significant (See Table 4) however; difference among the groups was recorded and the highest level of antibodies was determined in the AP3 group (6.33±0.88) followed by AP2 group (5.66±0.667). Whereas ABPP supplementation has a significant impact on the dressing percentage of the experimental birds ($P \leq 0.05$) as shown in Table 4. The mean value of dressing percentage for the AP3 group was the highest (65.88±0.37) while the lowest value was calculated for the control group i.e. (64.52±0.14). Similarly, the dressing percentage for AP2 and AP3 groups was (65.45±0.18) and (64.91±0.09), respectively. There was a non-significant difference in mortality among control and ABPP-supplemented groups (See Table 4). The mean value for percent mortality for control and AP3 was similar i.e. (3.33±3.33).

Economics of Animal Plasma Supplementation in Broilers (PKR): The economics of broiler production supplemented with different levels of ABPP were measured in terms of feed cost, plasma cost, and operational cost (depreciation cost, labor cost, medicine cost, vaccine, vaccination cost, mortality, and litter cost) presented in Table 5. Economic of broiler production supplemented with ABPP was significantly affected ($P \leq 0.05$). Gross return and net profit were significantly higher ($P \leq 0.05$) for group AP3 (61.49±1.70) followed by the AP2 group (58.56±1.67) and AP1 group (54.81±1.28) whereas the lowest return (50.47±0.84) was calculated for the control group (See table. 5). Highest gross return and net profit in group AP3 may be attributed to the quality (amino acid composition) of protein in the animal plasma.

Table 3. Mean Feed Intakes, Mean Body Weight and Mean Feed Conversion Ratio of the Broilers Supplemented with Animal Blood Plasma Powder.

Group	Feed Intake Mean±SE	Body Weight Gain Mean ±SE	Feed Conversion Ratio Mean ±SE
Control	2891.0^{a}±5.50	1441.0^{c}±4.04	2.00^{a}±0.00
AP1(0.5g/kg)	2864.7^{b}±6.74	1469.7^{b}±6.11	1.94^{b}±0.01
AP2(1g/kg)	2832.0^{c}±3.21	1492.7^{ab}±9.52	1.89^{c}±0.01
AP3(1.5g/kg)	2809.3^{d}±5.36	1513.3^{a}±9.83	1.85^{c}±0.01
P-value	0.000	0.001	0.00

AP1=animal plasma offered 0.5g/kg of ration. AP2= animal plasma offered 1g/kg of ration. AP3= animal plasma offered 1.5g/kg of ration. SE= *standard deviation. Mean bearing different superscripts within the same column differ significantly* when $P<0.05$.

Table. 4. ND titer and dressing percentage of Broilers fed diets containing ABPP.

Group	Mortality	HI Antibodies titer	Dressing percentage
	Mean±SE	Mean±SE	Mean±SE
Control	3.33±3.33	5.33 ± 0.33	64.516[c]±0.14
AP1 (0.5g/kg)	0.00±0.00	4.66±0.667	64.913[bc]±0.087
AP2 (1g/kg)	0.00±0.00	5.66±0.667	65.456[ab]±0.18
AP3 (1.5g/kg)	3.33±3.33	6.33±0.88	65.886[a]±0.37
P value	0.595	0.409	0.000

AP1=*animal plasma offered 0.5g/kg of ration.* AP2= *animal plasma offered 1g/kg of ration.* AP3= *animal plasma offered 1.5g/kg of ration.* SE= *standard deviation* HI=*heamaggluination inhibition test. Mean bearing different superscripts within the same column differ significantly* P<0.05. *Mean without superscripts is significantly similar to Pα0.05*

Table 5.Economics broiler production of experimental diets.

Group	Feed cost Mean±SE	Plasma cost Mean±SE	Op: Cost Mean±SE	Total Exp Mean±SE	Gross return Mean±SE	Net profit Mean±SE
Control	130.09[a]±0.0	0.000[d]±0.0	50±0.0	180.63±0.24	230.56[c]±0.64	50.46[c]±0.84
AP1	128.91[b]±0.0	1.432[c]±0.0	50±0.0	180.33±0.30	235.15[b]±0.97	54.81[bc]±1.28
AP2	127.44[b]±0.0	2.832[b]±0.0	50±0.0	180.26±0.14	238.83[ab]±1.52	58.56[ab]±1.67
AP3	126.40[c]±0.0	4.214[a]±0.0	50±0.0	180.09±0.25	242.12[a]±1.58	61.49[a]±1.70
P=0.05	0.00	0.000	0.000	0.515	0.001	0.003

AP1=animal plasma offered 0.5g/kg of ration. AP2= animal plasma offered 1g/kg of ration. AP3= animal plasma offered 1.5g/kg of ration. SE= *standard deviation. Mean bearing different superscripts within the same column differ significantly* (P<0.05). *The mean without superscripts is significantly similar to Pα 0.05. EXP=expenditure. OP= operational. PKR= Pakistani rupee (U$ 1= R.s 104.7)*

DISCUSSION

Protein is an important ingredient of poultry feed. The protein source used in feed highly affects the cost of poultry feed and ultimately the cost of poultry production. A high cost of production is a major challenge due to its direct effect on economics and the competitive human population. Animal blood plasma powder is usually can be prepared from slaughterhouse wastes and hence may be helpful for sustainable poultry production. Birds offered diets containing ABPP showed significantly lowered feed intake as compared to the control group. The probable explanation for lowered feed intake of birds supplemented with ABPP may be due to the good nutrient profile of ABPP which caused dietary satisfaction. Similar results are also reported in a previous study conducted by King *et al*. (2005) as they reported that bovine plasma powder supplementation had a significantly good effect on the feed intake of the chicks. King *et al*. (2001) also showed a similar finding. They suggested that spray bovine colostrum (SBC) can enhance feed intake compared to spray bovine plasma protein (SBPP) supplementation in broiler chicks. The probable reason behind the low feed intake of broiler chicks supplemented with SBPP may be due to the high concentration of total digestible protein in animal plasma.

During our experiment, significantly higher (P<0.05) weight gain was recorded for birds supplemented ABPP. The finding of the present study is in line with the results of research conducted by Henn *et al*. (2013) as they observed that spray-dried bovine plasma powder supplementation in a broiler diet improved the body weight gain of birds. Similarly, Campbell *et al*., (2003), Bregendahl *et al*., (2005) and Remus *et al*., (2013) concluded that apart from FCR and dressing percentage ABPP supplementation can also improve weight gain in growing chicks compared to chicks fed with a common diet. The probable reason behind this increase in weight gain might be the efficient utilization of ABPP supplemented in their ration by the chicks and the peak value of protein in plasma powder.

The feed conversion ratio of the broilers supplemented with ABPP was improved (P<0.05). The finding of the present study is in line with the result of Brengedal *et al*. (2005). They concluded that the birds supplemented with ABPP improved breast meat yield and FCR of the birds. Similarly, Henn *et al*. (2013), Bhuiyan *et al*. (2014) Coffy and Cromwell *et al*. (2001) and Everts *et al*. 2001 reported similar finding tour study as they suggested that ABPP has a significant effect on the growing broiler chick’s performance. They observed an enhanced growth rate and FCR in experimental chicks as compared to control chicks. This increased FCR might be due to the high protein level and better amino acid profile of ABPP.

ABPP supplementation showed a non-significant effect on mortality (P>0.05) of the broiler chicks. The finding of this study is similar to the findings of Henn *et al*. (2013) observed that the consumption of spray-dried plasma decreases the mortality rate and health status of animals and poultry. Similarly, Bregendahl *et al*. (2005) also reported that mortality and morbidity were high in the groups which are not fed a diet containing ABPP. Similarly, Borg *et al*., (1999) and Quigley and Drew, (2000) observed that ABPP in diet helped to reduce the morbidity and mortality rate in broilers. The probable reason for this low mortality and morbidity may be due to the enhanced cellular immunity in response to supplementation with a high-protein diet.

Broiler chicks supplemented with animal plasma showed a non-significant effect (P>0.05) on HI antibodies titer. All groups of the experimental flock have almost the same mean value of HI antibodies titer. The non-significant effect of plasma on anti-bodies titer might be due to the lower concentrations of ABPP in rations. Supplementation of animal blood plasma to broilers flock showed a significant effect P< (0.05) on dressing percentage. The arguments of this study are in line with that of Bregendahl *et al*. (2005). They reported that sprayed dried bovine plasma improved carcass weight and specifically breast meat. Providing extra protein improved the dressing percentage of the chicks as compared to the control group (Bilgili *et al*., 1992). The reason behind the high dressing percentage may be due to the high digestible protein profile of ABPP which is easily deposited in the body tissues of broilers.

Economics of the flocks supplemented with animal blood plasma: Gross return and net profit were significantly higher (P<0.05) for group AP3 followed by group AP2 and AP1 and the lowest return was the AP0 control group. The findings of the present study are consistent with the findings of Campbell *et al.* (2008). They found that ABPP supplementation is more economical as compared to other sources of dietary protein. It has more capacity to enhance growth and body tissue deposition than the ordinary source of protein.

Conclusion: Dietary supplementation of ABPP was found to be helpful to get better weight gain, feed conversion ratio, and feed intake of broilers. Supplementation had no adverse effect on birds' health as reflected by the mortality and antibodies titer analysis of the study. Moreover, supplementation of ABPP @1.5g/kg in broiler feed showed the best result and net profit.

Recommendations: The present study recommended the use of ABPP supplementations (1.5g/kg) in broilers' diets to tackle the problem of the high cost of protein. For this, some high-cost protein sources may be replaced with ABPP to decrease the cost of poultry feed. Similar studies should also be designed in layers and breeders to justify the quality and efficiency of animal blood plasma.

Statement of ethical approval of the study: It is worth mentioning that the research was prior approved by the faculty ethical committee for scientific research and animal welfare.

Conflict of Interest: The authors have no conflict of interest.

Authors' Contribution: Sarzamin Kha, Waqas Alam, Asad Sultan, and Rafiullah khan designed the project/study. Ghulam Abbas, Naseer Ahmad, Abdul Jabbar Tanweer, Muhammad Ali and Faisal Shahzad critically revised the manuscript for significant intellectual content and approved the final version.

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