The Pharma Innovation Journal 2022; 11(8): 1696-1700

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(8): 1696-1700
© 2022 TPI
www.thepharmajournal.com
Received: 12-05-2022
Accepted: 19-06-2022

Anuj Kumar
Research Scholar, Department of Livestock Production Management, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

DK Singh
Department of Livestock Production Management, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Amit Kumar
Department of Livestock Production Management, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Ahmad Fahim
Department of Livestock Production Management, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Ajit Kumar
Department of Animal Nutrition, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Koushlesh Ranjan
Department of Veterinary Physiology and Biochemistry, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Vipul Thakur
Department of Veterinary Medicine, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Akhilesh Kumar Verma
Department of Livestock Product Technology, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Abhishek Kumar
Research Scholar, Department of Livestock Production Management, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Corresponding Author:
Anuj Kumar
Research Scholar, Department of Livestock Production Management, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Effect of dietary supplementation of rice based Distiller Dried Grains with Solubles (rDDGS) on haemato-biochemical parameters and carcass traits of Kuroiler Chicken

Anuj Kumar, DK Singh, Amit Kumar, Ahmad Fahim, Ajit Kumar, Koushlesh Ranjan, Vipul Thakur, Akhilesh Kumar Verma and Abhishek Kumar

Abstract
An experiment on 160 day old chicks for eight weeks was conducted and were randomly divided into four equal groups (n=40, with four replicate of 10 birds per group). Feeding trial was designed into four dietary groups *viz*. T_0 (Control, without rDDGS), T_1 (7.5% rDDGS), T_2 (15% rDDGS) and T_3 (22.5% rDDGS) in different dietary groups along with basal corn soyabean diet. The study revealed that all the haemato-biochemical parameters were found to be non-significantly ($p>0.05$) influenced by feeding rDDGS except cholesterol which was found significantly ($p<0.05$) affected by varying levels of feeding rDDGS. Similarly, all the carcass traits were found to have non-significant ($p>0.05$) variations except gizzard which remained significantly ($p<0.05$) affected by feeding rDDGS. No significant ($p>0.05$) effect of feeding rDDGS was recorded for cut-up parts in Kuroiler chicken. Therefore, incorporation of rDDGS as alternative protein source can replaced soybean meal up to 15% in the diet of Kuroiler chicken without any effect on hematobiochemical and carcass traits.

Keywords: Carcass, dietary group, haemato-biochemical, kuroiler, rDDGS

1. Introduction
Presently, India possesses total poultry population as 851.81 million including various avian species (BAHS, 2019) [4]. It is well known that feed is the chief component of poultry production constituting 65 to 75% of total production cost. Soybean meal is the major source of protein supplementation used in poultry diet. Because of inadequacy of soybean at reasonable price, there is need to utilize locally available alternate protein ingredients in the feed. Rice stands the first in total cereal production of the country. As a fact, nearly 92% of total rice produced is consumed by human population and rest 8% is used for livestock and poultry feed in form of deoiled rice bran. Rice bran, rice polish and broken rice. Rice production in our country was around 118.43 MT in 2019-20, and rice ranks first among the country's overall cereal production (Agriculture statistics, 2020). In the changing scenario, several non-conventional rice-based by-products are easily and sufficiently available at reasonable price that can be utilized as protein sources from rice processing and beverages industries such as rice-based distillers dried grain with solubles (DDGS) and rice gluten meal (RGM). Many food processing, beverages, slaughter and pharmaceuticals industries leaves few by-products with appreciable nutritive values that is being utilized by the poultry feed manufacturers to make the cost effective poultry feed. Rice Distillers Dried Grains with Solubles (rDDGS) is a by-product of ethanol production which is used as alternative protein source in the poultry diet. DDGS is a good source of protein (48%) as well as energy, water soluble vitamins, minerals, amino acids, and other nutrients, it may be considered a potential feed stuff as a substitute of energy and protein. Hematology deals with the study of blood, is crucial to growth and nutritional physiology. The nutritional condition and clinical investigation of an individual can be aided by blood and serum metabolites. Blood and serological parameters are indications of a bird's health status, and they are impacted by the type of feed, nutrients, concentration of crude fiber in feed, their amino acid composition and type of incriminating factors present in the feed play pivotal role affecting blood and serum parameters. It is well known that ultimate aim of rearing meat type chicken is to obtain edible meat of good quality protein for human consumption.

Since the majority of study has only been done on DDGS made from barley, wheat, corn and sorghum. Regarding the effects of feeding rDDGS to poultry, there are incredibly few studies accessible in the literature.

2. Materials and Methods

The present investigation was carried out under the Department of Livestock Production Management at Poultry Research and Training Centre (PRTC) of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (UP). The study was conducted from 24th January 2021 to 22nd March 2021 and entire length of the experiment was eight weeks. All of the procedures carried out and animal welfare were reviewed and approved by the Institutional Animal Ethics Committee of the, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, India (IAEC/SVPUAT/2020/39). The experimental diets were formulated as per nutrient requirement recommendation of ICAR (2013) [14] for coloured starter and finisher broiler with inclusion of rDDGS at 0, 7.5, 15 and 22.5 % of diet as control T_0 and treatment groups T_1, T_2 and T_3, respectively. The Ingredient and nutrient composition for starter and finisher diet with different inclusion levels of rDDGS in Kuroiler chicken is given in Table 1. The chicks were reared in deep litter system under an ambient, healthy and hygienic environment conditions. Experimental diets were offered ad-libitum, as mash to all groups of Kuroilers for an entire experimental period of eight weeks. 160 day old Kuroiler chicks were procured from Kegg Farms Pvt. Ltd., Gurgaon. (Haryana). Day old Kuroiler chicks were randomly divided into four equal groups (n=40, with four replicate of 10 birds per group) T_0 (Control, without rDDGS) and T_1, T_2 and T_3 included rDDGS as 7.5, 15 and 22.5 percent in different dietary groups, respectively. Serum glucose, total protein, albumin, globulin, cholesterol, creatinine, blood urea nitrogen, serum glutamate pyruvate transaminase (SGPT) and serum glutamate oxaloacetate transaminase (SGOT) were estimated using standard procedures through ERBA diagnostics Mannheim Germany diagnostic kits. Gizzard development and various carcass traits *viz* Dressing yield (weight of carcass after defeathering), Eviscerated yield (weight of carcass after evisceration), Giblet yield (heart, liver and gizzard), Yield of individual cut-up parts (thighs, drumsticks, breast, back, neck, wings) as percent of dressed carcass weight were estimated. All the data obtained in the above experiment were statistically analyzed as per the standard statistical procedure (Snedecor and Cochran 1994) [22] using IBM Statistical Package for the Social Sciences (IBM SPSS, version 20). Significant differences ($p<0.05$) among treatment means and separation of homogenous subset was determined as per Duncan's multiple range test (Duncan 1955). The analysed data were considered to be significant at $p<0.05$ and declared as trend at $0.05 < p \leq 0.10$.

Table 1: Ingredient and nutrient composition for starter and finisher diet with different inclusion levels of rDDGS in Kuroiler chicken

Ingredients	**Starter**				**Finisher**			
Feed Ingredients	**T_0**	**T_1**	**T_2**	**T_3**	**T_0**	**T_1**	**T_2**	**T_3**
Maize	57.135	55.825	55.735	54.345	61.125	60.395	60.625	58.935
Rice bran Oil	2.000	1.800	1.300	1.200	2.900	2.500	2.000	1.900
Soyabean meal	34.700	26.600	18.600	10.600	30.300	22.300	14.400	6.300
rDDGS	0.000	7.500	15.000	22.500	0.000	7.500	15.000	22.500
DORB	1.500	3.500	4.500	6.400	1.500	3.000	3.600	5.900
L-Lysine	0.130	0.280	0.420	0.560	0.140	0.310	0.430	0.570
DL-Methionine	0.300	0.260	0.210	0.160	0.240	0.200	0.150	0.100
Salt	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
Soda NaHCO3	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Choline Chloride 60%	0.120	0.120	0.120	0.120	0.080	0.080	0.080	0.080
Dicalcium Phosphate (DCP)	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Limestone powder (LSP)	1.500	1.500	1.500	1.500	1.100	1.100	1.100	1.100
Feed additives premix*	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Nutrient composition of diets								
M.E. (Kcal/kg)	2956	2956	2956	2960	3056	3053	3058	3057
Crude Protein (CP), %	21.61	21.60	21.61	21.62	20.01	20.05	20.06	20.05
Ether Extract (EE), %	4.24	4.22	3.95	4.03	5.17	4.98	4.71	4.78
Crude Fibre (CF), %	3.39	3.57	3.65	3.83	3.25	3.39	3.43	3.65
Calcium, %	1.17	1.20	1.23	1.26	1.01	1.04	1.07	1.10
Available Phosphorus, %	0.46	0.44	0.42	0.41	0.45	0.44	0.42	0.40
Lysine, %	1.21	1.20	1.19	1.19	1.10	1.12	1.09	1.08
Methionine, %	0.60	0.60	0.60	0.60	0.52	0.53	0.52	0.52
Cost/Quintal, Rs.	3022	2896	2739	2622	2992	2852	2696	2574

* include Trace minerals, Vitamins, Toxin binder, Coccidiostat, Phytase

3. Results and Discussion

3.1 Haemato-biochemical parameters

The data pertaining to effect of different levels of rDDGS feeding to Kuroilers on haemato-biochemical parameters have been presented in Table 2. Effect of feeding rDDGS in Kuroiler on haemato-biochemical parameters were found to be non-significant ($p>0.05$) in all the dietary groups except cholesterol which was observed significant ($p<0.05$). Total protein was estimated highest in T_0 (without rDDGS) followed by T_1, T_3 and T_2 with various levels of rDDGS as 7.5, 22.5 and 15%, respectively. Higher protein in control group may be due to slightly higher content of protein in soybean as compared to rDDGS. Among all the dietary group creatinine content was found to be almost similar showing

non-significant differences by feeding rDDGS except T_1 (7.5% rDDGS) which may be due to metabolic reasons. Similarly, glucose level being statistically non-significant ($p>0.05$) for incorporation of rDDGS at different levels in the diets for all the dietary treatments. Effect of rDDGS on blood urea nitrogen was remained nearly static among the dietary groups which may be reasonably due to association between total blood protein content and blood urea nitrogen. It also reflects better kidney health. Maximum albumin was found in the diet without having rDDGS (T_0) with the estimate as 1.47 followed by T_1, T_2, and T_3 computing the value as 1.40, 1.39 and 1.24, respectively. It is clearly showing the decreasing trend with the increased inclusion level of rDDGS in the diets. Highest globulin content was found in T_3 group incorporated 22.5% rDDGS which indicates the better immune-modular properties and better disease resistance ability. Gupta *et al.* (2017) stated that 10% inclusion levels of rice DDGS had significantly ($p<0.01$) higher effect on albumin, total protein, glucose value and significantly ($p<0.01$) lowering effect on serum lipid profile. Dinani *et al.* (2019) [8] found that glucose, total protein and albumen levels decreased significantly ($p<0.01$) due to feeding of rDDGS and RGM at the levels of 12.5% and 15%. Effect of feeding rDDGS have significant ($p<0.05$) effect on cholesterol between all the dietary treatments. However, effect of varying levels of rDDGS incorporated in experimental diets have non-significant ($p>0.05$) effect on cholesterol in T_1, T_2 and T_3 as compared to T_0 that may be reasonably due to higher fat content in rDDGS in comparison to soybean basal diet. Similar findings for increased level of cholesterol were also reported by Youssef *et al.* (2013) [26], Abd El-Hack *et al.* (2015) [1], Gacche *et al.* (2016) [10] and Ghaly *et al.* (2017) [11] in broiler chickens. However, Mir *et al.* (2017) [18] reported that broiler diet with 10% flaxseed and 10% DDGS had reducing effect on cholesterol levels in broilers. Similarly, Dinani *et al.* (2018) [7] reported decreasing serum cholesterol level in chicken after inclusion of 15% rDDGS in diet. In this study ALT/SGPT was also estimated for T_0, T_1, T_2 and T_3 as 11.06, 11.37, 15.19 and 13.28. Similarly, AST/SGOT was estimated as 184.75, 194.59, 172.50 and 265.51 for T_0, T_1, T_2 and T_3, respectively in all the dietary groups. The enzymes serum glutamate pyruvate transaminase (SGPT) and serum glutamate oxaloacetate transaminase (SGOT) are fairly specific indicators of acute liver cell injury and clinical manifestations of liver failure. When the liver cells are damaged, SGPT and SGOT are released into the bloodstream, therefore any abnormal increase in their levels could indicate liver dysfunction.

Table 2: Effect of feeding different levels of rDDGS on various haemato-biochemical parameters in Kuroiler

Parameters	Dietary groups*				SEM	P-Value
	T_0	T_1	T_2	T_3		
Total protein (g/dl)	5.12	5.11	4.76	5.03	0.14	0.25
Creatinine (mg/dl)	1.15	1.32	1.13	1.15	0.06	0.10
Cholesterol (mg/dl)	126.41[a]	166.05[b]	162.46[b]	166.06[b]	6.14	<0.001
Glucose (mg/dl)	208.25	205.70	206.63	205.87	0.97	0.24
BUN (mg/dl)	6.14	6.18	5.22	5.47	0.40	0.23
Albumin (g/dl)	1.47	1.40	1.39	1.24	0.07	0.22
Globulin (g/dl)	3.65	3.71	3.37	3.79	0.17	0.37
ALT/SGPT (IU/L)	11.06	11.37	15.19	13.28	3.14	0.75
AST/SGOT (IU/L)	184.75	194.59	172.50	265.51	54.62	0.62

[abc]Means with different superscripts in a row differ significantly ($p<0.05$)

* T_0: Control; T_1: rDDGS-7.5%; T_2: rDDGS-15%; T_3: rDDGS-22.5%

3.2 Carcass traits

The data pertaining to effect of different levels of rDDGS feeding to Kuroilers on carcass traits have been presented in Table 3. Dressed weight was found to be non-significantly ($p>0.05$) affected by the feeding of different levels of rDDGS in the present study. Results indicated that highest dressing percentage was remained in T_0 (without rDDGS) followed by T_1 (7.5%), T_2 (15%) and T_3 (22.5%) rDDGS dietary groups. Decreasing trend for this parameter among the varying inclusion levels of rDDGS probably may be due to individual metabolic rate and sex (male or female) of the Kuroiler birds. Eviscerated weight of the experimental birds under different treatments group were ranged from 967.99 to 1068.47 g. There was no significant ($p>0.05$) variation in the mean eviscerated weight of the carcass in various treatments groups. The highest and lowest eviscerated weight was observed for T_1 (7.5% rDDGS) and T_3 (22.5% rDDGS), respectively. Descending order for eviscerated weight with incorporation of increased levels of rDDGS may be due to the similar trend as obtained for live weight just prior to slaughter. The weight of gizzard in different groups having varying levels of rDDGS found to be ($p<0.05$) significant. Highest weight was observed in 15% rDDGS group, while lowest were recorded for dietary group having 7.5% rDDGS. Although, T_0 and T_1 were found to have non- significant ($p>0.05$) variations with each other and similar results were observed for T_2 and T_3. Non- significant ($p>0.05$) variation in average relative weights for liver in relation to dressed weight of the Kuroilers under different treatments groups were ranged from 2.88 to 3.26 percent and highest and lowest values for this parameter being recorded in T_3 and T_0 groups, respectively. Effect of incorporated varying levels of rDDGS in Kuroilers were found to be non-significant ($p>0.05$) among all the dietary groups for heart weight. However, slight improvement in the heart percent was observed with the increased levels of rDDGS in T_0, T_1, T_2 and T_3 groups. Swiatkiewicz and Koreleski (2006) [23] reported no significant effect on inclusion of DDGS in the diet. Wang *et al.* (2007) [25] reported no adverse effects on carcass traits when broiler diets containing 15% DDGS fed throughout the entire feeding period of 1 to 42 d of age. Tang *et al.* (2011) [24] observed no differences ($p>0.05$) in dressing percentages and carcass parts yields (% of carcass weight) among treatments. Lukasiewicz *et al.* (2014) reported that replacement of soybean meal with DDGS at 5% and 7% levels had no significant effect on dressing percent in broiler chickens. Kaya and Tarkan (2012) [15] found that supplementing broiler rations with different amounts of DDGS (5, 10, 15 %) had no effect ($p>0.05$) on the

weight of the liver or heart, but the groups did vary in terms of the weight of the gizzard (p>0.05). ICAR CARI (2015) [13] which showed that addition of rDDGS up to 10% level did not exert any adverse effect on carcass traits in broiler. Borah *et al.* (2020) [5], Damasceno *et al.* (2020) [6], Saikia *et al.* (2020) [20], Palanivel and Rao (2021) [19] were also reported there findings that supported our results for various carcass traits considered at different levels of DDGS included in poultry diets. However, Gacche *et al.* (2016) [10] and Kumar *et al.* (2017) [16] reported contrary findings to the present results for various carcass traits.

Table 3: Effect of feeding different levels of rDDGS on carcass traits in Kuroiler

Parameters	Dietary groups*				SEM	P-Value
	T_0	T_1	T_2	T_3		
Live weight (g)	1816.00	1836.00	1752.00	1734.80	79.65	0.77
Dressed %	74.46	74.27	73.55	71.56	0.93	0.15
Eviscerated wt (g)	1047.51	1068.47	1003.11	967.99	57.48	0.61
Gizzard %	3.10[a]	2.91[a]	3.82[b]	3.75[b]	0.21	0.01
Liver %	2.88	3.06	3.05	3.26	0.14	0.35
Heart %	0.55	0.55	0.58	0.61	0.30	0.46

[abc]Means with different superscripts in a row differ significantly (p<0.05)
* T_0: Control; T_1: rDDGS-7.5%; T_2: rDDGS-15%; T_3: rDDGS-22.5%

3.3 Cut-up parts

The data pertaining to effect of different levels of rDDGS feeding to Kuroilers on cut-up parts have been presented in Table 4. Comparing the values for various cut-up parts estimated for control (without rDDGS) with the dietary groups having incorporation of rDDGS (7.5, 15 and 22.5%) has no significant (p>0.05) effect of supplemented rDDGS on cut-up parts. Shim *et al.* (2011) [21] reported that leg and wing percentages were not significantly affected with different dietary treatments. Dinani *et al.* (2018) [7] found that carcass traits in terms of immune organ weight, cut up parts and feather did not show any significant (p>0.05) difference as compared to control. Addison *et al.* (2018) shows that carcass traits, cut-up parts, giblets yield and relative organ weights were not influenced by dietary inclusion 15 % level of DDGS.

Table 4: Effect of feeding different levels of rDDGS on cut-up parts in Kuroiler

Parameters	Dietary groups*				SEM	P-Value
	T_0	T_1	T_2	T_3		
Shank %	5.65	5.48	6.06	5.32	0.23	0.91
Neck %	5.18	4.78	5.27	4.94	0.29	0.63
Wing %	8.97	8.77	9.07	8.63	0.29	0.71
Leg %	24.73	24.28	25.08	24.81	0.53	0.76
thigh %	12.25	11.90	12.25	12.23	0.28	0.76
Drumstick %	12.86	12.27	12.81	12.50	0.30	0.49
Breast %	22.24	22.68	20.31	21.31	0.62	0.07
Back %	16.26	17.70	17.79	18.57	0.70	0.17

[abc]Means with different superscripts in a row differ significantly (p<0.05)
* T_0: Control; T_1: rDDGS-7.5%; T_2: rDDGS-15%; T_3: rDDGS-22.5%

4. Conclusion

Thus, it is concluded that Rice distillers dried grains with Solubles can replace soybean meal and safely incorporated at the inclusion level of 15% in Kuroiler diet without any adverse effect on haemato-biochemical and carcass traits in Kuroiler chicken.

5. References

1. Abd El-Hack ME, El-Hindawy MM, Attia AI, Mahrose KM. Effects of feeding dried distillers grains with solubles with or without enzyme or vitamin E supplementation on productive performance of Hisex Brown laying hens. Zag. J. Agric. Res. 2015;42:71-79.
2. Addison MP, Sarathchandra G, Gnanaraj PT, Valavan SE, Preetha SP. Effect of supplementation of distiller's dried grain with soluble (DDGS) on desi-chicken performance and carcass characteristics. International Journal of Livestock Research. 2018;8(10):327-337.
3. Agricultural Statistics. Directorate of Economics & Statistics. Department of Agriculture, Cooperation and Farmers welfare. Government of India, New Delhi, 2020.
4. BAHS (Basic Animal Husbandry Statistics) Department of Animal Husbandry, Dairying and Fisheries, Government of India, 2019.
5. Borah TK, Kalita N, Begum K, Saikia AK, Ali A. Effect of feeding different levels of distillers dried grains with solubles (DDGS) on the carcass quality of commercial broiler chicken. The Pharma Innovation Journal. 2020;9(1):143-146.
6. Damasceno JL, Rocha CS, Eyng C, Broch J, Souza C, Wachholz L, *et al.* Effect of feeding dried distillers' grains with solubles (DDGS) to broiler chickens from day 0 to 21. Livestock Science. 2020;241:104232.
7. Dinani OP, Tyagi PK, Mandal AB, Tyagi PK, Tyagi JS, Popat DS. Effect of feeding rice based distillers dried grains with solubles (rDDGS) on haematological, serum biochemical and carcass traits in broilers. Indian Journal of Pure & Applied Biosciences. 2018;6(2):1085-1090.
8. Dinani OP, Tyagi PK, Mir NA, Mandal AB, Tyagi PK, Tiwari SP, Giri AK. Effect of feeding rice distillers dried grains with solubles and rice gluten meal with or without enzyme supplementation on the haematology and serum biochemistry of broiler chickens. International Journal of Livestock Research. 2019;9(1):254-261.

9. Duncan DB. Multiple Range and Multiple F-Test. Biometrics, 1955;11:1-5.
10. Gacche SM, Kanduri AB, Patil PV, Gaikwad NZ. Extent of replacement of soybean meal with distillers dried grains with solubles (DDGS) on carcass yield, dressing percentage and feed cost in broiler chickens. Animal Science Reporter. 2016;10(3):109-114.
11. Ghaly KA, El-bogdady AH, El-latif AA, El-hameed ASA. Effects of using DDGS and avizyme enzyme in the broiler diets on some physiological responses. Egyptian Poultry Science Journal. 2017;37(2):363-377.
12. Gupta SL, Tyagi PK, Tyagi PK, Mandal AB, Dinani OP, Rokde JJ. Feeding effect of rice based dry distillers grains with soluble on haemato-biochemical and egg sensory attributes during 45th to 54th week of laying. Indian Journal of Pure & Applied Biosciences. 2017;5(6):1521-1527.
13. ICAR-CARI. ICAR-Central Avian Research Institute Annual report. 2015, 6.
14. ICAR. Nutrient requirements of animals-poultry (ICAR-NIANP), 2013, 13-16.
15. Kaya O, Tarkan S. Effects of different levels of distillers dried grains with solubles on growth performance, carcass quality and some blood parameters in broilers. University Scientific Research fund commission under the Project No: 2010- VF54, 2012.
16. Kumar S, Sihag ZS, Sihag S, Singh N. Effect of substituting soybean meal with DDGS on nutrient metabolizability and carcass traits of broiler chicken. Haryana Vet. 2017;56(1):50-54.
17. Lukaszewicz E, Kowalczyk A. Slaughter yield and breast meat quality of chicken broilers in relation to sex and level of dietary maize distillers dried grains with solubles (DDGS). Revue de Medecine Veterinaire. 2014;165(5-6):176-182.
18. Mir NA, Tyagi PK, Biswas AK, Tyagi PK, Mandal AB, Kumar F, *et al.* Effect of feeding broken rice and distillers dried grains with solubles in a flaxseed-based diet on the growth performance, production efficiency, carcass characteristics, sensory evaluation of meat and serum biochemistry of broiler chickens. Turkish Journal of Veterinary and Animal Sciences. 2017;41:583-589.
19. Palanivel M, Rao SVR. Composition of 'new generation' dried distillers' grains with solubles and its dietary effect on the performance of commercial vanaraja chickens. Indian Journal of Veterinary and Animal Sciences Research. 2021;50(1):1-9.
20. Saikia AK, Bhuyan R, Saikia BN, Mahanta JD, Borah S, Islam, R. Effects of feeding distillers dried grains with solubles (DDGS) with or without enzymes on carcass characteristics of indigenous chicken. Advances in Research. 2020;21(10):127-136.
21. Shim MY, Pesti GM, Bakalli RI, Tillman PB, Payne RL. Evaluation of corn distillers dried grains with soluble as an alternative ingredient for broilers. Poultry Science. 2011;90:369-376.
22. Snedecor GW, Cochran WG. Statistical Methods. 9th edn. Affiliated East-West Press, lOW A State University Press, 1994.
23. Swiatkiewicz S, Koreleski J. The use of distillers dried grains with solubles (DDGS) in poultry nutrition. World's Poultry Science Journal. 2006;64(02):257-266.
24. Tang SC, Zulkifli I, Ebrahimi M, Alimon AR, Soleimani AF, Filer K. Effects of feeding different levels of corn dried distillers grains with solubles on growth performance, carcass yield and meat fatty acid composition in broiler chickens. International Journal of Animal and Veterinary Advances. 2011;(3):205-211.
25. Wang Z, Cerrate S, Coto C, Yan F, Waldroup PW. Effect of rapid and multiple changes in level of distillers dried grain with solubles (DDGS) in broiler diets on performance and carcass characteristics. International Journal of Poultry Science. 2007;6(10):725-731.
26. Youssef AW, Abd El-Azeem NA, El-Daly EF, El-Monairy MM. The impact of feeding graded levels of distillers dried grains with solubles (DDGS) on broiler performance, haematological and histological parameters. Asian Journal of Poultry Science. 2013;7(2):41-54.