Int.J.Curr.Microbiol.App.Sci (2018) *7*(11): 1389-1400

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 11 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.711.161

Feeding Value of Distillers Dried Grain with Soluble for Poultry

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Keywords

Feeding value, Distillers, Dried grain, Poultry

Article Info

Accepted:
12 October 2018
Available Online:
10 November 2018

A B S T R A C T

Distillers dried grains with solubles (DDGS) is co-product of the ethanol industry produced during dry milling process. Its availability is increasing due to higher demand for ethanol as biofuel. The DDGS is high energy and high protein feed. Distillers dried grain with soluble (DDGS) in poultry diet may be done for economic poultry production replacing costly protein ingredient soybean meal. Level of DDGS in poultry diet depends upon species and age of poultry birds, type of cereal involved in its production, method of drying after fermentation, level of fiber *etc.* In general, DDGS can be incorporated at the inclusion level of 7.5 to 10% for economic poultry production.

Introduction

Distillers dried grains with solubles (DDGS) is co-product of the ethanol industry produced during dry milling process. Its availability is increasing due to higher demand for ethanol as biofuel. Corn, wheat, sorghum, barley, rice cereals are commonly used as fermentation substrates for ethanol production. Cereal yields about one third ethanol, one third carbon di oxide gas and one third DDGS. DDGS contain 65% distillers grains and 35% distillers solubles on dry matter basis (AAFCO, 2005). DDGS contain all the nutrients from grain in a concentrated form except for the majority of the starch, which has been utilized in the fermentation process during ethanol production (Babcock *et al.*, 2008). So, it concentrates all nutrients about three fold present in the cereal since two third to three fourth portion of cereal content is starch (Swiatkiewicz and Koreleski, 2008). Thus, DDGS is very low in starch but higher in non-starch poly saccharides (NSP) content as compared to their parent grains used in ethanol production. DDGS is higher in gross energy than parent grain but lower in metabolizable energy due to higher NSP content. Dry milling process used for ethanol production leads to maillard reaction further reduce the lysine availability as compared to their parent grains used in ethanol production. Thus, lysine is the first limiting amino acid in DDGS. Dry milling process also leads to reduction in moisture content. So, DDGS is suitable for longer storage due to low moisture content (Jacob *et al.*, 2008). DDGS contain approximately 6% yeast biomass, which is rich in mannan, there may be antinutritional effects associated with mannans (Radfar *et al.,* 2013). The enhanced availability and potential cost-benefit of DDGS represents a substantial economic value as it is less expensive than other protein sources like soybean meal (He *et al.,* 2013).

Chemical composition of DDGS

Energy value and amino acid composition of DDGS fed to poultry (kcal/kg) reported by different researchers are given in the Table 1 and 2. Chemical composition of different sources of DDGS (%) is given in the Table 3. Chemical composition of rice DDGS (%) on as such basis is given in the Table 4.

DDGS feeding on meat and egg production

Conflicting reports are available on the effect of different levels of DDGS in diet on meat and egg production.

Masa'deh *et al.,* (2012) reported feeding up to 12.5% DDGS had no negative effect on growth performance, N and P retention levels in pullet diet. Guney *et al.,* (2013) reported that corn DDGS up to 20% inclusion levels in broiler diet had no detrimental effects on performance parameters compared with a standard corn-soybean diet. Olofintoye and Bolu (2013) reported layer fed 20% dietary corn DDGS had better hen day production as compared to 0% corn DDGS. Wamsley *et al.,* (2013) reported that digestible lysine interaction with low levels of DDGS (4% Starter, 5% Grower, 10% Finisher) showed best growth performance. Wen Jiang *et al.,* (2013) reported DDGS up to 10% with vitamin E (200 mg/kg) in laying hen diets can be fed without adverse effects on laying performance. Zhang *et al.,* (2013) reported that diets containing 20% DDGS decreased the growth phase in broilers. Addition of DDGS up to 10% level did not exert any adverse effect on growth, carcass traits and development of immune organs of broiler chickens and thus could safely include for profitable broiler production (ICAR-CARI, 2015). Min *et al.,* (2015) conducted an experiment to determine the effects of feeding 0, 15, or 30% DDGS with or without 0 or 5% glycerine on growth performance and meat yield. The results of this study demonstrate that 15% DDGS of known nutritional quality can be utilized in diets for growing broilers with no negative effects on growth performance and meat yield if the diets are formulated on a digestible amino acid basis and meet the nutritional requirements of broilers. Hack *et al.,* (2015) reported DDGS substitution level more than 75% decreased ($P \leq 0.01$) values of body weight gain in brown laying hens. Hassan and Aqil (2015) reported DDGS can safely be added at the level of 10% without affecting growth performance of broiler chicks from 0 to 35 days and 20% without affecting productive performance in laying hen from 30 to 42 weeks of age. Trupia *et al.,* (2016) reported that regular and low-fat DDGS addition up to 20% to layer diets did not influence egg production and egg weight. Gacche *et al.,* (2016) reported that DDGS can be incorporated in broiler feed up to 20% in replacement of soybean meal without affecting the performance but DDGS at 30 % level adversely affected the performance of the broilers in terms of weight gain. Gupta (2016) reported higher body weight gain were in layers fed (between 26^{th} to 35^{th} wk of age) diet containing 5, 7.5 and 10% rice DDGS in comparison to those fed diet containing 0% DDGS. Kim *et al.,* (2016) reported that finishing broilers (28 to 56 days) can tolerate up to 24% low fat DDGS in the later phase of production without any detrimental effects on live performance and carcass parameter. Rao *et al.,* (2016) reported rice DDGS improved body weight gain (BWG) at 5% compared to those fed the SBM control diet at 21 d of age in broiler. Body weight gain (BWG) at 35d of age was not affected by incorporating rice DDGS up to 10%, but depressed significantly at 15% level. Rao *et al.,* (2016) also reported in layer egg production and egg mass were not affected at 7.5% level of rice DDGS but depressed at 15% level during 24 to 47 weeks of age. Ranjan *et al.,* (2017) reported that 75% replacement of soybean meal with rice DDGS have higher egg production and superior egg quality traits in duck. Dinani *et al.,* (2018a) concluded that the feeding of rice DDGS levels of 12.5% and 15%, respectively with or without enzyme supplementation do not have any adverse effects on the carcass traits, but xylanase supplementation improved abdomen fat and giblet weight of broiler chicken at 42 days.

Effect of DDGS on feed intake

Conflicting reports are available on the effect of different levels of DDGS in diet on feed intake. Swiatkiewicz *et al.,* (2013) reported DDGS at the level of 200 g/kg with enzyme (xylanase and phytase) in the diet had no effect on feed intake may be incorporated in the diet of laying hens without any negative effects. Zhang *et al.,* (2013) reported that diets containing 20% DDGS decreased average daily feed intake in broiler. Hongyu *et al.,* (2014) reported feed intake was adversely affected by the highest level of DDGS in the diet (50%) during the first 12 weeks period of laying. Hack *et al.,* (2015) reported DDGS substitution level more than 75% decreased ($P \leq 0.01$) values of feed intake in brown laying hen. Trupia *et al.,* (2016) reported that regular and low-fat DDGS addition up to 20% to layer diets did not influence feed intake. Gacche *et al.,* (2016) reported that DDGS at 30 % level adversely affected the feed intake. Gupta (2016) reported dietary inclusion of 5, 7.5 and 10% rice DDGS showed significantly ($P<0.05$) higher feed intake in 10 weeks of production (phase I) in layers as compare to control group. Rao *et al.,* (2016) reported feed intake (FI), FI per egg and FI per egg mass were not affected by rice DDGS at 7.5% level but at 15% level depressed during 24 to 47 weeks in layer. Ranjan *et al.,* (2017) reported that 75% replacement of soybean meal with rice DDGS showed significantly ($P<0.05$) decreased dry matter intake in duck.

Effect of DDGS on feed conversation ratio (FCR)

Conflicting reports are available on the effect of different levels of DDGS in diet on FCR. Świątkiewicz *et al.,* (2013) reported DDGS at the level of 200 g/kg with enzyme (xylanase and phytase) in the diet had no effect on feed conversion ratio may be incorporated in the diet of laying hens without any negative effects. Wen Jiang *et al.,* (2013) reported DDGS up to 20% with vitamin E (200 mg/kg) in laying hen diets significantly reduced FCR ($P < 0.05$) but can be fed to laying hens at levels up to 10% without adverse effects on laying performance. Addition of DDGS up to 10% level did not exert any adverse effect on FCR of broiler chickens and thus could safely include for profitable broiler production (ICAR-CARI, 2015).

Min *et al.,* (2015) conducted an experiment to determine the effects of feeding 0, 15, or 30% DDGS with or without 0 or 5% glycerine on growth performance and meat yield. Higher dietary levels of DDGS may be acceptable, but feed conversion may be reduced unless pellet quality can be improved. Hack *et al.,* (2015) reported DDGS substitution level more than 75% decreased ($P \leq 0.01$) values of FCR in brown laying hen. Trupia *et al.,* (2016) reported that regular and low-fat DDGS addition up to 20% to layer diets did not influence feed efficiency. Gacche *et al.,* (2016) reported that DDGS at 30 % level adversely affected the performance of the broilers in terms of weight gain, feed intake and FCR. Rao *et al.,* (2016) reported rice

DDGS significantly improved feed efficiency at 5 and 10% levels as compared to those fed the SBM control diet at 21 d of age but at 15% level feed efficiency was depressed significantly compared to control.

Effect of DDGS on blood biochemical parameters

Ghazalah *et al.,* (2011) reported there was no significant (P>0.05) difference among treatment groups for all hematological parameters, except Hb%, total protein and total lipids at 50% substitution for SBM. Wen Jiang *et al.,* (2013) reported AST, ALT, Ca, HDL, LDL, CHO, and α-tocopherol concentrations in serum were not significantly influenced by DDGS. However, increasing DDGS from 10 to 20% in laying hen diets significantly (P<0.05) increased P content in serum compared with 0% DDGS. Youssef *et al.,* (2013) evaluated the effect of DDGS (0, 5, 10 and 15%) on hemato-biochemical property of broiler. Result showed that DDGS insignificantly (P>0.05) affected the hematological parameter and DDGS inclusion in the diet significantly (P<0.05) decreased glucose concentration. Gacche *et al.,* (2015) reported that no adverse effect on haematological (haemoglobin, packed cell volume, total erythrocyte count, total leukocyte count and differential leukocyte count) and serum biochemical (total protein, albumin, aspartate amino transferase, alanine amino transferase and creatinine) profile on the replacement of soybean meal with DDGS up to 30% in broiler rations. Gupta (2016) reported that different levels of rice DDGS (5, 7.5 and 10%) had significant higher effect on serum albumin, total serum protein (P<0.01), A/G ratio (P<0.05) and significantly (P<0.01) lowering effect on serum lipid profile (total serum cholesterol, triglycerides, HDL, LDL and VLDL). Dinani *et al.,* (2018b) concluded that rDDGS can safely incorporated at the inclusion level of 12.5% in broiler diet without any adverse effect on haematological, serum biochemical and carcass traits.

Effect of DDGS on immunocompetance

Barekataina *et al.,* (2013) conducted an experiment to investigate effect of 20% sorghum DDGS with or without a combination of protease and xylanase in broiler chickens, under a necrotic enteritis disease challenge. Result showed that incorporation of DDGS to the diets improved (P<0.01) the IgA and IgG titer at d 13 but interacted with the disease challenge, reducing the concentration of IgA at d 21 and IgM at d 35 in the infected birds. Min *et al.,* (2015) reported that DDGS reduced serum superoxide dismutase (SOD), and total antioxidant activity, whereas increased IgA, IgG and malondialdehyde (MDA) of 21 days old broiler. Thus, 15% dietary DDGS inclusion has the beneficial effects on immune functions for broilers. Alizadeh *et al.,* (2016) reported diet containing 10% of DDGS stimulated cell-mediated immune response indicating the immunomodulatory activities of these products following immunization with non-inflammatory antigens in broiler chickens. Gupta (2016) reported that immune response in terms of cell mediated immune response (CMI) and haemagglutinin antigen (HA) titre were found non-significant (P>0.05), when rice DDGS were included in the diets at varying level (5, 7.5 and 10%).

Effect of DDGS on gut health

Hahn (2010) reported diets containing DDGS had significantly (P<0.05) higher count of *Lactobacillus* compared to diets containing meat cum bone meal (MBM). Yan *et al.,* (2013) reported corn DDGS (30%) and rye were detrimental to broiler performance and NSP degrading enzymes improved growth performance and gut health of broilers when rye or rye with DDGS were present.

Table.1 Energy value of DDGS fed to poultry (kcal/kg)

AMEn	TMEn	Species	Authors
2880	-	Turkey	Potter (1966)
2480	2864	Poultry	NRC (1994)
2756	2800	Turkey	Roberson (2003)
-	2905	Broiler	Lumpkins *et al.*, (2004)
-	2831	Layer	Batal and Dale (2004)
2760	2980	Turkey	Noll and Brannon (2005)
2770	2884	Layer	Roberson *et al.*, (2005)
-	2863	Layer	Parsons *et al.*, (2006)
-	2820	Layer	Batal and Dale (2006)
-	2871	Layer	Fastinger *et al.*,(2006)
2770	2851	Broiler	Waldroup *et al.*, (2007)
-	2904	Broiler	Hong *et al.*, (2008)
2526	-	Broiler	Applegate *et al.*, (2009)
2810	-	Broiler	Shim *et al.*,(2011)
-	3150	Broiler	Guney *et al.*,(2013)
3,394	-	Broiler and Turkey	Adebiyi and Olukosi (2015)
3070	-	Broiler	Hassan and Aqil (2015)
2615	-	Broiler	Kim *et al.*, (2016)
2883	-	Layer	Gupta (2016)

Table.2 Amino acid composition (%) of DDGS of various cereals

Amino Acids %	Rice DDGS1	Rice DDGS2	Rice DDGS3	Corn DDGS	Sorghum DDGS	Wheat DDGS
Indispensable AA						
Arginine	1.42	1.47	3.06	1.16	1.06	1.53
Histidine	-	1.01	1.04	0.72	0.68	0.92
Isoleucine	1.12	0.93	1.89	1.00	1.31	1.35
Leucine	2.02	2.94	3.60	3.12	4.02	2.66
Lysine	0.99	0.64	1.23	0.78	0.66	0.65
Methionine	0.52	0.61	1.19	0.55	0.51	0.53
Phenylalanine	1.35	1.28	2.32	1.32	1.62	1.92
Threonine	1.24	0.92	1.67	1.06	1.03	1.21
Tryptophan	-	0.24	-	0.21	0.34	0.40
Valine	1.53	1.39	2.64	1.34	1.59	1.70
Dispensable AA						
Alanine	1.81	1.84	2.56	1.90	2.79	1.48
Aspartic acid	2.26	1.94	3.91	1.82	2.09	1.92
Cysteine	0.61	0.62	0.98	0.53	0.47	0.73
Glutamic acid	4.52	4.08	7.48	4.28	6.08	9.81
Glycine	1.23	1.10	1.92	1.02	0.99	1.62
Proline	1.22	1.86	2.10	2.06	2.41	4.11
Serine	1.21	1.34	2.20	1.16	1.35	1.88
Tyrosine	-	1.08	-	1.01	-	-
CP	23.1	28.55	45.0	27.27	31.50	40.67

References- Rice DDGS1 (Luu *et al.*, 2000), Rice DDGS2 (Gupta, 2016), Rice DDGS3 (Xue *et al.*, 2012) Corn DDGS (Pahm *et al.*, 2008), Sorghum DDGS (Urriola *et al.*, 2007) and Wheat DDGS (Lan *et al.*, 2008)

Table.3 Chemical composition of different sources of DDGS (%)

Nutritional values	Rice DDGS	Corn DDGS	Wheat DDGS	Sorghum DDGS
Protein	42-45	25-30	44	26
Moisture (max.)	10	10	10	10
Fiber	4 - 7	4 - 7	7.9	-
Fat	3 - 5	3 - 5	3.5	8.1
Sand Silica (max.)	3	3	3	3
Appearance	Medium Brown powder	Yellowish Granular form	-	-

Source: (Gupta, 2016), Adebiyi and Olukosi (2015), Hancock *et al.*, (1995)

Table.4 Chemical composition of rice DDGS (%) on as such basis

Moisture	9.1	14.6	9.21	-	10.5	8.28
Crude protein	23.1	28.2	28.55	19.1	30.00	45.00
Crude fiber	-	2.3	10.85	-	9.05	4.89
Ether extract	9.9	-	6.44	7.8	7.11	4.49
Ash	4.7	1.97	-	0.5	4.89	10.22
NDF	15.4	-	43.07	-	41.43	27.12
ADF	-	-	17.39	-	16.29	-
Calcium	0.55	-	0.75	-	0.09	0.73
Phosphorus	0.35	-	0.41	-	0.42	0.77
Gross energy (kcal/kg)	4784	-	4513	-	-	4097
DE (Mcal/kg)	-	-		-	3.42	-
ME (Mcal/kg)	-	-		-	3.00	2.88
NE (Mcal/kg)	-	-		-	1.78	-
References	Luu *et al.*, (2000)	Taysayavong and Preston (2010)	Xue *et al.*, (2012)	Choi (2014)	Patil *et al.*, (2015)	Gupta (2016)

Min *et al.*, (2013) reported that up to 15% DDGS inclusion level showed better villus height, crypt depth and ratio of villus height to crypt depth in duodenum, jejunum and ileum on day 42 in male broiler. Therefore, diet added with DDGS can improve intestinal morphology up to 15% DDGS level for broiler starter and grower age. In a companion study of Wang *et al.*, (2015) male chicks were used to investigate the interaction among the protein source DDGS and meat cum bone meal diet (MBM) on small intestine morphology. In conclusion, DDGS diet may facilitate small intestine longitudinal growth in broilers, which may subsequently improve dietary nutrient absorption. In addition, broiler chicks with shallow intestinal crypts exhibited better growth performance. Gupta (2016) reported that inclusion of 7.5 and 10% level of DDGS significantly ($P<0.05$) lower the TVC in crop as compare to 0 and 5% inclusion level of DDGS, while TVC significantly ($P<0.01$) lowered in jejunum at all three levels of DDGS as compare to 0% inclusion level. However *Lactobacillus* have significant ($P<0.01$) effect at 5, 7.5 and 10% levels of DDGS with maximum effect at 10% level of DDGS in jejunum but have no significant (P>0.05) effect on crop region. Ranjan *et al.,* (2017) reported that no significant (P>0.05) difference in villus length and crypt depth in duodenum, jejunum and ileum in duck fed various levels of rice DDGS up to 75% replacement of soybean meal. Dinani *et al.,* (2018c) concluded that rDDGS can safely be incorporated in broiler diet at the inclusion level of 12.5% with better humoral immunity, gut health and without any adverse effect on intestinal histomorphometry.

Maximum safe inclusion level of DDGS

DDGS is used efficiently by broilers at inclusion rates below 20% (Wang *et al.*, 2015). However, some authors reported a reduction of broiler growth performance and/or feed efficiency at rates such as 18% (Lumpkins *et al.*, 2004) or 25% and above (Wang *et al.*, 2007). There are some reports of decreased performance when 9 or 12% DDGS were included in the diet (Shalash *et al.*, 2009) while in other cases levels as high as 24% did not impair broiler performance (Shim *et al.*, 2011). Comparison of DDGS samples differing in quality (darkness) showed that dark samples led to lower growth performance, with a high correlation between luminance value and weight gain (Cromwell *et al.*, 1993). High inclusion rates (30%) can also lead to problems of pellet quality that could explain lower performance (Wang *et al.*, 2007, 2015). Meat quality did not affected by DDGS in diets except at high inclusion rates that may lead to a higher content in unsaturated fatty acids in the meat, which is a nutritional advantage but may represent an increased risk of lipid oxidation (Corzo *et al.*, 2009). In conclusion, optimal inclusion rates are 6% in starters and 12 to 15% in growers and finishers (Lumpkins *et al.*, 2004). Rao *et al.*, (2016) reported rice DDGS can be safely incorporated 10% in broiler. Dinani *et al.*, (2018a, b, c, d) concluded that rDDGS can safely incorporated at the inclusion level of 12.5% in broiler diet without any adverse effect on growth performance haematological, serum biochemical and carcass traits.

In layers, DDGS was tested successfully at inclusion rates up to 25% (Masa'deh *et al.*, 2011). The eggs quality parameters were improved by DDGS addition (Loar *et al.*, 2010). In contrast, some experiments reported a slight decrease in egg production at inclusion rate above 10% (Roberson *et al.*, 2005; Shalash *et al.*, 2010). Gupta (2016) reported that rice DDGS can safely incorporated at the inclusion level of 10% for economical egg production. Rao *et al.*, (2016) reported rice DDGS can be safely incorporated 7.5 % in layer. Ranjan *et al.*, (2017) reported that 75% replacement of soybean meal with rice DDGS have higher egg production and superior egg quality traits in duck.

Thus, it may be concluded that use of distillers dried grain with soluble (DDGS) in poultry diet may be done for economic poultry production replacing costly protein ingredient soybean meal. Level of DDGS in poultry diet depends upon species and age of poultry birds, type of cereal involved in its production, method of drying after fermentation etc. In general, DDGS can be incorporated at the inclusion level of 7.5 to 10% for economic poultry production.

References

AAFCO 2005. Association of American Feed Control Officials. website www.aafco.org.

Adebiyi, A. O. and Olukosi, O. A. 2015. Metabolizable energy content of wheat distillers dried grains with soluble supplemented with or without a mixture of carbohydrases and protease for broilers and turkeys. Poult. Sci. 94:1270–1276.

Alizadeh, M., Lecompte, J.C.R., Echeverry, H., Crow, G. H. and Slominski, B. A. 2016. Effect of yeast derived products and distillers dried grains with soluble (DDGS) on antibody-mediated immune response and gene expression of pattern recognition receptors and cytokines in broiler chickens immunized with T-cell dependent antigens. Poult. Sci. 95:823–833.

Applegate, T. J., Troche, C., Jiang, Z. and Johnson, T. 2009. The nutritional value of high-protein corn distillers dried grains for broiler chickens and its effect on nutrient excretion. Poult. Sci. 88: 354–359.

Babcock, B.A., Hays, D.J. and Lawrence, J.D. 2008. Using distillers grains in the U.S. and international livestock and poultry industry. Midwest agribusiness trade research and information centre. First edn, Iowa, USA.

Barekataina, M.R., Antipatisb, C., Choct, M. and Ijia, P.A. 2013. Interaction between protease and xylanase in broiler chicken diets containing sorghum distillers' dried grains with soluble. Ani. Feed Sc. and Tech.182 (1–4): 71–81.

Batal, A. and Dale, N. 2006. True metabolizable energy and amino acid digestibility of distillers dried grains with soluble. J. of Appl. Poult Res. 15:89-93.

Batal, A.B. and Dale, N.M. 2004. True metabolizable energy and amino acid digestibility of distillers dried grains with solubles. Joint Annual Meeting abstracts: 317-318.

Choi, H.S., Lee H.L., Shin M.H., Jo, C., Lee, S.K. and Lee B.D. 2008. Nutritive and economic values of corn distiller's dried grains with solubles in broiler diets. Asian-Aust. J. Anim. Sci. 21(3):414-419.

Choi, J., Rahman, M. M. and Lee, S.M. 2014. Rice distillers dried grain is a promising ingredient as a partial replacement of plant origin sources in the diet for juvenile red seabream (*Pagrus major*). Asian-Austral. J. Anim. Sci. 27(12): 1736–1743.

Corzo, A., Schilling, M. W., Loar R. E., Jackson V., Kin, S. and Radhakrishnan, V.2009. The effects of feeding distillers dried grains with solubles on broiler meat quality. Poult. Sci. 88 (2): 432-439.

Cromwell, G. L., Herkelman K. L. and Stahly, T. S. 1993. Physical, chemical, and nutritional characteristics of distillers dried grains with solubles for chicks and pigs. J. Anim. Sci., 71 (3): 679-686.

Dinani O.P., Tyagi Pramod K., Mandal A.B., Tyagi Praveen K. and Tiwari S. P.2018a. Effect of feeding rice based distillers dried grains with solubles without or with different enzymes on carcass characteristics in broiler chickens. *Inter. J. Bio. Str Man.* 2018, 9(4):468-474.

Dinani O.P., Tyagi Pramod K., Mandal A.B., Tyagi Praveen K. and Dutta Narayan, 2018d. Evaluation of feeding value of rice based distillers dried grains with solubles (ddgs) for broiler chickens. Indian J. Anim. Res., DOI: 10.18805/ijar.B-3607.

Dinani, O.P., Tyagi, P.K., Mandal, A.B., Tyagi, P.K., Bhanja, S.K., and Popat, D.S. 2018c.Effect of feeding rice based distillers dried grains with solubles (rDDGS) on gut health, immunity and intestinal histomorphometry in broilers, *Int. J. Pure App. Biosci.* 6(2): 99-106.

Dinani, O.P., Tyagi, P.K., Mandal, A.B., Tyagi, P.K., Tyagi, J.S. and Popat, D.S. 2018b. Effect of feeding rice based distillers dried grains with solubles (rDDGS) on haematological, serum biochemical and carcass traits in broilers. *Int. J. Pure App. Biosci.* 6(2): 1085-1090 (2018).

Fastinger, N.D., Latshaw, J.D. and Mahan, D.C. 2006. Amino acid availability and true metabolizable energy content of corn distillers dried grains with soluble in adult cecectomized roosters. Poult. Sci. 85:1212-1216.

Gacche, S.M., Kanduri A.B., Patil P.V. and Gaikwad N.Z. 2016. Effect of distillers dried grains with solubles on the performance of broilers. Ind. Vet. J. 93 (04): 54 – 57.

Ghazalah, A.A., Abd-Elsamee, M.O. and Al-Arami, A.A. 2011. Use of distillers dried grains with solubles (DDGS) as replacement for yellow corn in laying hen diets. Egypt. Poult. Sci. 31: 191-202.

Guney, A. C., Shim, M. Y., Batal, A. B., Dale, N. M. and Pesti, G. M. 2013. Effect of feeding low oil distillers dried grains with soluble on the performance of broilers. Poult. Sci. 92: 2070–2076.

Gupta S. 2016. Feeding value of rice based dry distiller grains with soluble in white leghorn layers. Ph.D. thesis submitted to IVRIDU, Izatnagar, U.P.

Hack, M.A., El-Hindawy, M.M., Attia, A.I. and Khalid, M. 2015. Effects of feeding dried distillers grains with solubles with or without enzyme or vitamin E supplementation on productive performance of hisex brown laying hens. Zagazig Jour. of Agri. Res., 42(1):71-79.

Hahn, Dana L. 2010. The effects of phytase and an enzyme combination in moderate and low nutrient dense diets in laying hens. Thesis and dissertations in animal science, Paper 23.

Hassan, S.M. and Aqil, A.A. 2015. Effect of adding different levels of DDGS on productive performance of broiler chicks. Inter. J. Poult. sci. 14 (1):13-18.

He, S., Wu, Z., Liu, Y., Wu, N., Tao, Y., Xu, L., Zhou, Z., Yao, B. and Ringo, E. 2013. Effects of dietary 60 g kg^{-1} dried distiller's grains in least-cost practical diets on production and gut allochthonous bacterial composition of cage cultured fish: composition among fish species with different natural food habits. Aqua. Nutr. 19:765-772.

Hong, E.C., Chung, W.T., Kang, G.H., Park, H.D., Suh, O.S., NA, J.C., Kim, W., Nho, W.G. and Hwangbo, J. 2008. Evaluation of true metabolizable energy and the effect of corn distillers dried grains with solubles in the diets on broiler performance and nutrient availability. Kor. Jour. of Poul. Sci. 35(4): 381-389.

Hongyu, S., Lee, Eun J., Samaraweera H, Persia M. E. and Ahn D. U. 2014. Effects of increasing concentrations of corn dried distiller's grains with solubles on the egg production and internal quality of eggs. Animal Industry Report: AS 660, ASL R2899.

ICAR- CARI 2015. ICAR-Central Avian Research Institute Annual report.pp:6.

Jacob, M.E., Fox, J.T., Drouillard, J.S., Renter, D.G. and Nagaraja, T.G. 2008. Effects of dried distiller's grain on faecal prevalence and growth of *Escherichia coli* O157 in batch culture fermentations from cattle. Appl. Envir. Micro. 74: 38-43.

Kim, E.J., Purswell, J.L. and Bantom, S.L.2016. Effects of increasing inclusion rates of low fat DDGS in finishing broiler diets. Inter. J. of Poul. Sci. 15(5):182-187.

Lan, Y., Opapeju F.O. and Nyachoti C.M. 2008. True ileal protein and amino acid digestibilities in wheat dried distillers' grains with solubles fed to finishing pigs. Anim. Feed Sci. Technol. 140:155-163.

Loar, R.E., Moritz J. S., Donaldson J.R., and Corzo A. 2010. Effects of feeding distillers dried grains with soluble to broilers from 0 to 28 days post hatch on broiler performance, feed manufacturing efficiency and selected intestinal characteristics. Poul. Sci. 89:2242-2250.

Lumpkins, B.S., Batal, A.B., and Dale, N.M. 2004. Evaluation of distillers dried grains with soluble as a feed ingredient for broilers. Poult. Sci.83:1891-1896.

Luu, H. M., Binh, T.C. and Dung, N.N.X. 2000. Composition and nutritive value of rice distillers' by product for small-holder pig production, Workshop-seminar "Making better use of local feed resources" SAREC-UAF.

Masa'deh, M.K., Purdum, S.E. and Hanford, K.J. 2011. Dried distillers grains with solubles in laying hen diets. Poult. Sci. 90: 1960-1966.

Masa'deh, M.K., Purdum, S.E. and Hanford, K.J. 2012. Distillers dried grains with solubles in pullet diets. J. of Appl. Poult. Res. 21: 531–539.

Min, Y. N., Li L. L., Liu S. K., Zhang J., Gao Y. P. and Liu F. Z. 2015. Effects of dietary distillers dried grains with solubles (DDGS) on growth performance, oxidative stress, and immune function in broiler chickens. J. Appl. Poult. Res. 24:23–29.

Min, Y.N., Li H.L., Li L., Niu Z.Y., Wang J.J., Liu S.K., Zhang J. and Liu F.Z. 2013. Effects of DDGS concentrations on intestinal morphology of broiler chicken. J. Ani. Vet. Adv. 12(1):6-9.

Noll, S.L. and Brannon, J. 2005. Influence of dietary protein level and inclusion level of DDGS on performance of market tom turkeys. Minnesota turkey growers association, Gobbles. 62: 6-8.

NRC 1994. National research council. Nutrient requirements of domestic animals. Nutrient requirements of poultry. 9th Rev. Edn., Natl. Acad. Sci., Washington, DC.

Olofintoye, O.R. and Bolu, S.A. 2013. Effects of corn distillers dried grains on the performance and egg quality of laying hen. Ani. Res. Inter. 10: 1665-1672.

Pahm, A.A., Pedersen C., Hoehler D. and Stein H.H. 2008. Factors affecting the variability in ileal amino acid digestibility in corn distillers dried grains with solubles fed to growing pigs. *J. Anim. Sci.* 86:2180-2189.

Parsons, C.M., Martinez C., Singh V., Radhadkrishman S. and Noll S. 2006. Nutritional value of conventional and modified DDGS for poultry. Proc. Multi-State Poult. Nutr. Feeding Conf., Indianapolis IN.

Patil B.B., Dhage S.A. and Pachpute S.T. 2015. *In vitro* evaluation of different distiller's grains with solubles. Ind. J. Anim. Nutr. 32 (2): 181-186.

Potter, L.M. 1966. Studies with distillers feeds in turkey rations. In: Proceedings distillers feed research council conference, pp: 47-51.

Radfar, M.A., Rogiewicz, M. B., and Slominski, B. A. 2013. Enzyme pretreated yeast and yeast derived products as potential prebiotics in broiler chickens nutrition. Poult. Sci. 92 (E-suppl.1), pp: 8–12 (Abstrs).

Ranjan, A., Samanta, Gautam and Samanta, Gourab 2017. Rice based distiller dried grains and solubles in duck egg production and its quality. Ind. J. Poul. Sci. 52(3):255-258.

Rao, R. S. V., Raju, M. V. L. N., Prakash, B., Reddy, E. P. K. and Anusha R. 2016. Effect of dietary supplementation of distillery dried grain soluble from rice on performance of commercial broilers and white leghorn layers. The Proceedings of XXV World's Poultry Congress. pp: 52.

Roberson, K.D. 2003. Use of distillers grains with soluble in growing-finishing diets of turkey hens. Inter. J. of Poult. Sci. 2:389-393.

Roberson, K.D., Kalbfleisch, J.L., Pan W. and Charbeneau R.A. 2005. Effect of corn distiller's dried grains with solubles at various levels on performance of laying hens and egg yolk color. Inter. J. Poult. Sci. 4: 44-51.

Shalash, S. M. M., EI-Wafa S. A., Hassan, R. A., Ramadan, N. A., Mohamed, M.S. and EI-Gabry, H.E. 2010. Evaluation of distillers dried grains with solubles as feed ingredient in laying hen diets. Inter. J. Poult. Sci. 9(6): 537-545.

Shalash, S.M.M., Ali M.N., El-Gabry S. and Shabaan M. 2009. Novel method for improving the utilization of corn dried distillers grains with solubles in broiler diets. Inter. J. Poult. Sci. 8: 545-552.

Shim, M. Y., Pesti, G. M., Bakalli, R. I., Tillman, P. B., and Payne, R. L. 2011. Evaluation of corn distillers dried grains with soluble as an alternative ingredient for broilers. Poult. Sci. 90:369–376.

Swiątkiewicz S., Arczewska-włosek A., Krawczyk J., Puchała M. and Józefiak D. 2013. Effects of selected feed additives on the performance of laying hens given a diet rich in maize dried distiller's grains with solubles (DDGS). Brit. Poult. Sci., 54 (4): 478–485.

Swiatkiewicz, S. and Koreleski, J. 2008. The use of distillers dried grains with soluble (DDGS) in poultry nutrition. World's Poult. Sci. J. 64: 257-265.

Taysayavong, L. and Preston, T.R. 2010. Effect of rice distillers' by product on growth performance and digestibility in Moo Laat and Mong Cai pigs fed rice bran and water spinach. Liv. Res, for Rur. Develop. 22 (9):1-10.

Trupia, S., Winkler-Moser, J. K., Guney, A. C., Beckstead, R. and Chen, C.Y. O. 2016. Nutritional quality of eggs from hens fed distillers dried grains with soluble. Poult. Sci. 95: 2592–2601

Urriola, P. E., Hoehler, C., Pedersen, H. H., Stein, J. L. and Shurson G. C. 2007. Amino acid digestibility by growing pigs of distillers dried grain with solubles produced from corn, sorghum, or a corn-sorghum blend. J. Anim. Sci. 85(Suppl. 2):71 (Abstr.)

Waldroup, P.W., Wang Z., Coto C., Cerrate S. and Yan F. 2007. Development of a standardized nutrient matrix for corn distillers dried grains with solubles. Inter. J. of Poult. Sci. 6: 478–783.

Wamsley K. G. S., Loar R. E., Karges K. and Moritz J. S. 2013. The use of practical diets and regression analyses to determine the utilization of lysine and phosphorus in corn distillers dried grains and solubles using Cobb 500 male broilers. J. Appl. Poult. Res. 22: 279–297

Wang X., Peebles E. D., Morgan T. W., Harkess R. L. and Zhai W. 2015. Protein source and nutrient density in the diets of male broilers from 8 to 21 d of age: Effects on small intestine morphology. Poult. Sci. 94 (1): 61-67.

Wang, Z., Cerrate, S., Coto, C., Yan, F. and Waldroup, P.W. 2007. Utilization of distillers dried grains with solubles (DDGS) in broiler diets using a standardized nutrient matrix. Inter. J. of Poult. Sci. 6: 470-477.

Wen Jiang, Licong, Z. and Anshan, S. 2013. The effect of vitamin E on laying performance and egg quality in laying hens fed corn dried distillers grains with soluble. Poult. Sci. 92: 2956–2964.

Xue, P., Dong, C.B., Zang, J.J., Zhu, Z.P. and Gong, L.M. 2012.Energy and standardized ileal amino acid digestibilities of Chinese distillers dried grains, produced from different region and grains fed to growing pigs. Asian-Aust. J.Anim.Sci. 25(1):104-113.

Youssef, A.W., El-Azeem, N.A.A., El-Daly, E.F. and Monairy, M.M. 2013. The impact of feeding graded levels of distillers dried grains with solubles (DDGS) on broiler performance, hematological and histological parameters. Asian J. Poult. Sci. 7 (2): 41-54.

Zhang, Y., Shan A., Jiang, W., Bi, C. and Li, Z. 2013. The effect of vitamin E on growth performance and meat quality in broilers given diets containing distillers' dried grain with solubles (DDGS*).* Brit. Poult. Sci. 54(1): 138-143.

How to cite this article:

Om Prakash Dinani, Pramod K. Tyagi, A.B. Mandal, Praveen K. Tyagi, Sneh Lata Gupta and Junaid, N. 2018. Feeding Value of Distillers Dried Grain with Soluble for Poultry. *Int.J.Curr.Microbiol.App.Sci.* 7(11): 1389-1400. doi: https://doi.org/10.20546/ijcmas.2018.711.161