EFFECT OF FEEDING DIFFERENT LEVELS OF RICE DISTILLERS DRIED GRAINS WITH SOLUBLES (RDDGS) ON PERFORMANCE OF BROILERS

THESIS

Submitted

In partial fulfillment of the requirements for the Degree of

MASTER OF VETERINARY SCIENCE

IN

POULTRY SCIENCE

BY
DINGORE APEKSHA DATTATRAYA
Enrolment No: V/06/0176

BOMBAY VETERINARY COLLEGE, MUMBAI

MAHARASHTRA ANIMAL AND FISHERY SCIENCES UNIVERSITY, NAGPUR – 440 001
(INDIA)

2015

DECLARATION OF THE STUDENT

I hereby declare that the experimental research work and interpretation of the thesis entitled **"EFFECT OF DIFFERENT LEVELS OF RICE DISTILLERS DRIED GRAINS WITH SOLUBLES (RDDGS) ON PERFORMANCE OF BROILERS"** or part thereof has not been submitted for any of the other degree or diploma of any university, nor the data have been derived from any thesis or publications of any university or scientific organization. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

Date:

Place: Mumbai

Signature
(**DINGORE APEKSHA DATTATRAYA**)
Enrolment No. V/06/0176
Reg. No. 1429

Dr. (Ms). D. N. Desai
Chairperson,
Advisory Committee
Assistant Professor of Poultry Science,
Bombay Veterinary College.

DECLARATION OF ADVISORY COMMITTEE

Miss DINGORE APEKSHA DATTATRAYA has satisfactorily prosecuted her course of research work for a period of not less than one semester (for M. V. Sc.) and that the thesis entitled **"EFFECT OF FEEDING DIFFERENT LEVELS OF RICE DISTILLERS DRIED GRAINS WITH SOLUBLES (RDDGS) ON PERFORMANCE OF BROILERS"** submitted by her is the result of research work is sufficient to warrant its presentation to the examination in subject of **Poultry Science** for the award of **Master of Veterinary Science** degree by the Maharashtra Animal and Fishery Sciences University, Nagpur .

We also certify that the thesis or part thereof has not been previously submitted by her for a degree of any other university.

Place : Mumbai
Date :

Dr. (Ms) D. N. Desai
Advisor / Guide
Assistant Professor
Poultry Science
Bombay Veterinary College.

ADVISORY COMMITTEE
Name and Signature of Advisory Committee Members

Sr. No.	Name	Designation	Signature
I.	Dr. A. S. Ranade	Professor, Poultry Science	
II.	Dr. P. E. Avari	Assistant Professor, Poultry Science	
III.	Dr. G. M. Gadegaonkar	Assistant Professor, Animal Nutrition	
IV.	Dr. S. A. Patwardhan	Assistant Professor, Livestock Production and Management	

CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF FEEDING DIFFERENT LEVELS OF RICE DISTILLERS DRIED GRAINS WITH SOLUBLES (RDDGS) ON PERFORMANCE OF BROILERS''** submitted by **Miss. DINGORE APEKSHA DATTATRAYA** to the Maharashtra Animal Sciences University, Nagpur, in partial fulfillment of the requirement for the degree of **Master of Veterinary Science** has been approved by the Student's Advisory Committee after examination in collaboration with the External Examiner.

Name & Signature of External Examiner	**Dr. A. S. Ranade Head of the Department**	**Dr. (Ms) D. N. Desai Guide/Advisor**

ADVISORY COMMITTEE

Sr. No.	Name	Designation	Signature
I.	Dr. A. S. Ranade	Professor, Poultry Science	
II.	Dr. P. E. Avari	Assistant Professor, Poultry Science	
III.	Dr. G. M. Gadegaonkar	Assistant Professor, Animal Nutrition	
IV.	Dr. S. A. Patwardhan	Assistant Professor, Livestock Production and Management	

Associate Dean .
Bombay Veterinary College.

Acknowledgements

"Gratitude is the emotions and expressions that are governed by humility and appreciation of help of others." *-Fadi Malouf*

This thesis has evolved as a result of efforts of great number of people and all of them deserve special mention in this section of the thesis. I am very much pleased to take this apportunity to extend my gratitude towards them

In the foremost, I would like to express my deep sense of gratitude to my research guide Dr. (Ms) D. N. Desai, Assistant Professor of Poultry Science Department for her continuous support throughout my post graduation study and research, for her patience, motivation, enthusiasm, and immense knowledge. Her guidance helped me during the entire course of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my post graduation study.

Words are not enough to express my heartfelt gratitude towards my honourable teacher Dr. A. S. Ranade, Professor, Poultry Science Department, BVC, as a member of my advisory committee for his invaluable help, suggestion, guidance, executing and pursuance during my entire post graduation programme. I shall forever remain an admirer of his work, deep knowledge and approach to the subject. I feel blessed and fortunate to work under the guidance of such an encouraging and unique personality.

I gratefully ackenowledge Dr. P. E. Avari, Assistant Professor, Poultry Science Department for his valuable guidance, timely suggestions, constructive criticism, pain shaking efforts and constant inspiration. I sincerely admire his way of counselling the students, understanding their situations and executing the appropriate solutions. I will always remain grateful for his valuable advice and support.

I am inbended to Dr. G. M. Gadegaonkar, Assistant Professor, Animal Nutrition, for his constructive suggestion, constant inspiration and advice throughout my entire research work and post graduation studies.

I sincerely express my thanks to Dr. (Mrs) S. A. Patwardhan, Assistant Professor, Department of Livestock Production and Management, for constant support and encouragement. Her valuable suggestions made a difference in my life.

It has been great privilege for me to spend some years in the department of poultry science and its members will always remain dear to me. I extend my thanks to the staff of Poultry Science, Gogate. U. A for his assistance during the entire postgraduate studies. Thanks is also reserved for the charming personalities of Poultry Science Department, Sanjay mama, Gawade mama and Subhash mama for their assistance during entire postgraduate studies. Their suggestions and support were really helpful me. It was real pleasure working with them.

I am also thankful to Mr. Divya Gulati of M/S Aqua Nature Technology for supply of Rice Distillers Grains with Solubles (RDDGS) required for the studies. Thanks are also due to M/s. Premium Chick Feeds Pvt. Ltd., At-Poynad, Taluka-Alibag, District-Raigad for supply of day-old chicks for this study. I thank M/s. Alka GreenFarms Pvt. Ltd., At- Bhadane, Taluka – Murbad, District – Thane for supply of feed ingredients for this project. I thank M/s. Hi-Tek Associates, Pune for conducting analysis of feed samples and feed material for this project.

I express my sincere gratitude and appreciation to my department colleagues Amit Kate and Nilesh Datir for their indispensable help during progress of my work and entire post graduate studies. I also extend my thanks to my senior Dr. Bhushan Gangurde and my junior Bhagyashree Rathod for their timely assistance and guidance during this research trial.

I convey my heartfelt gratitude to Ashwini (Mado) and Rupesh who have been my true and great supporters and have unconditionally loved me during my good and bad times. I am fortunate to have buddies like you in my life.

In my hostel life I am blessed with cheerful friends. Foremost I would like to thanks my rummies Ali and Vantei for understanding and supporting me. Thanks is also reserve to Varsha, Priyanka, Bhagya, Vaibhya, Deepti, Ashok and Nilam. I would also like to thanks my friends Disha, Lalitha, Lavanya and Ankita for encouraging me. Special thanks are reserve for my childhood Bhatsa friends Prati, Bunty, Tej, Dyana, Sam, Viddyu and Bharat for their indirect support.

I fell short of words to express my deepest feelings towards my beloved parents, Mamma and Pappa for their unconditional love, support and care. Without their inspiration and blessing this work would not taken the final shape. I shall be failing if I do not express my gratitude towards my sisters Madhuri and Swapnali and brother in lows Vijay and Anil also my brother Vishwanath and sister in law Sarita. I would also like to thanks beloved uncle Bharat for his love and technical support. Thanks is also reserved for my dog, Shera for his unconditional love.

I am really thanksful to all those whom I could not mention but helped me, directly or indirectly during my study at this institute. Last but not the least, I would like to express my heartfelt gratitude towards my birds.

Finally, it was the blessing from almighty which gave strength and courage to complete this task successfully. I thank him for blessing me with such wonderful people and beautiful life.

Date –

Place - Mumbai

Dingore Apeksha Dattatraya

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Poultry is one of the fastest growing segments of the agriculture sector with annual growth of 8 to 10 percent per annum. Presently India ranks third in egg production and fourth in poultry meat production in the world. This is due to initiation of intensive poultry production systems through the implementation of modern technology by the way of improved managemental practices, genetic improvement and enhanced feed production technology. The paradigm shift in poultry production in India is a result of increasing demand for poultry meat by ever increasing population attached with high nutritive value, relatively cheaper price and absence of any religious taboos regarding consumption as in case of other meat product. A prime objective of poultry producer always seems to be to improve feed efficiency and productivity by reducing the cost of production per bird. Major emphasis has been laid on research work on feed requirement of birds as it is a major input constituting 70-75% of total cost of production.

The increase in high cost of conventional animal feed ingredients in most of the developing countries has necessitated scientists to search for alternative sources of feed ingredients. The demands for alternative ingredients is higher in developing countries and thus have a profound effect on the demand for feed and raw materials. Corn and soybean meal are major ingredients of poultry feed. The cost of virtually all feed ingredients like corn, soybean meal, Di-calcium phosphate, fat and even vitamins has gone beyond expectation (Dale, 2009). Due to the ever increasing demand and less supply of raw feed ingredients, cost of feed production has increased. Alternatives for protein and energy sources in poultry diets will be an important means to meet future requirements and minimize the cost of feed production. There are two ways for decreasing the cost of production; one by decreasing feed cost, which seems to be impossible due to rising costs of feed ingredients and another is to explore new feed ingredient, which is cheaper, locally available and comparable with respect to its nutrient contents as compared to traditionally used feed ingredients.

Use of unconventional feed ingredients is one of the alternative to reduce the cost of production by replacing the conventional feed ingredients. But the choice of these alternative ingredients depends on many factors and the important ones are availability, absence of toxic principle, nutrient availability, quality composition, cost of product and economical feasibility. It is well accepted that the fastest growth rate with superior feed efficiency is possible by the conventional feeding standards and ingredients. However, the unconventional feed sources play a key role in reducing cost of feed by replacing the proportion conventional feed ingredients.

Different types of cereals are used for the production of biofuel. Due to large production of biofuel, millions of tons of fermentation residues are available to the feed industry for its use in animal and poultry feed. Distillers Dried Grains with Solubles (DDGS) is a product available from distilleries where maize, jowar, wheat, rice and other cereals are used. Tremendous amount of work has be carried out on the suitability of DDGS obtained from of maize, jowar, wheat and other cereals except Rice Distillers Dried Grains with Solubles (RDDGS).

RDDGS is the byproduct of the processing of rice alcohol industry which is produced from the distillation of fermented rice. In processing, rice is cooked at 131^0C and 2.6 kg/ m^2 pressure and yeast is added to the cooked rice for fermentation (Huang *et al*., 1999). Then the alcohol is distilled from fermentation liquor and then leftover is known as Rice Distillers Dried Grains with Solubles (RDDGS). It contains a valuable source of supplemental protein to the tune of 47% compared to 35% in soybean meal (National Research Council, 1989; Chiou *et al.,* 1996) and metabolisable energy around 3500 kcal/ kg. It is also more nutritious than the cereals in grain from which it is made up of, as it contains other nutrients recovered from fermented grains. It is also high in protein compared to rice and more in energy and less in fiber than its byproduct like rice bran or rice polishing. The final product also contain yeast residue. It does not contains any antinutritional factor, as might be the case with trypsin inhibitors in soybean. The cost of RDDGS is always less than that of the soy DOC. The nutrient content and feeding value of RDDGS is expected to be different from most commercially

available DDGS sources since the ingredients for rice liquor production include primarily rice grains.

There is very little information available on feeding and nutritional value of this important by-product. Therefore, the aim of this study is to evaluate these product and its effect on broilers. With this view, the trial has been designed on broilers with following objectives.

1. To study the effect of using different levels of Rice Distillers Dried Grains with Solubles (RDDGS) on the performance of broilers. .

2. To study the economics of broiler production by using different levels of Rice Distillers Grains with Solubles (RDDGS) in the feed.

2. REVIEW OF LITERATURE

Poultry industry has recorded highest growth as far as other livestock industry is concerned. Feed is a major input in poultry production constituting 70-75% of the total cost of production. Over the period of time, there is acute shortage of the conventional feed ingredients. Hence, there is need to identify some unconventional feed ingredients that can replace the conventional ingredients in poultry feed. Now a days, due to a large production of biofuel, millions of tons of fermentation residues are available to the animal feed industry, which is known as Distillers Dried Grains with Solubles (DDGS). DDGS is the product available from distillaries where maize or other cereals like jowar, wheat or rice is used.

Lot of work has already been done on corn DDGS and other cereals DDGS except rice DDGS. So the present trial was aimed to study the effect of different levels of Rice Distillers Dried Grains with Solubles (RDDGS) on performance of broilers. Thus, while reviewing the literature more emphasis is given on the use of Brewers Dried Grains (BDG) and Distillers Dried Grains with Solubles (DDGS) of maize, jowar, wheat and rice in poultry and pig diets and its effect on performance and economics of production.

Manh *et al*. (2002a) conducted a study to evaluate the effects of replacement of fish meal with rice distiller's waste (hem) on performance and carcass quality of growing pigs. Thirty growing Yorkshire pigs of 20 ± 1 kg live weight, individually housed, were allocated according to a completely randomized design into five different diets containing "Hem" (Rice distillers' waste) at levels of 0, 25, 50, 75 or 100% of the protein provided by fish meal, in a basal diet of rice bran and broken rice. In a parallel experiment, thirty finishing pigs (59 ± 2 kg) were used in a similar design to measure effects of "Hem" on performance and carcass quality. There were no differences among the diets in any of the performance parameters in both the growing and finishing stages. Carcass quality traits were also the same on all diets. It was concluded that in diets for growing-finishing pigs, based on broken rice and rice bran, "Hem" can be the sole protein supplement supporting performance levels comparable with the use of fish meal.

Manh *et al.* (2002b) conducted a study to evaluate four levels of fresh brewery waste in diets based on rice bran, broken rice and fish meal. The brewery waste replaced 0 (control), 30, 60 or 100% of the fish meal protein. Feed DM intakes and growth rates were reduced as the dietary levels of brewery waste were increased, with the effect being more marked in the finishing phase. Contrasting results were obtained for feed DM conversion, with apparently better conversion on the diets with brewery waste in the growing phase, but poorer conversion on these diets in the finishing phase. A 30% replacement level appeared to give the best economic return. An on-farm trial was conducted with four households with four pigs in each with initial weights of 40 to 46 kg. The control diet used in the on-station trial was evaluated in one household, while in the other three households the 30% replacement rate with brewery waste was applied. Performance of the pigs was very good in all the households, with no apparent difference between the control diet and the diet with 30% replacement of fish meal protein by the brewery waste. It is concluded that in diets for fattening pigs, based on broken rice, rice bran and fish meal, brewery waste can replace 30% of the fish meal on a protein basis, without affecting performance.

Roberson (2003) conducted two experiments with large white female turkeys to evaluate the effect of Dried Distillers Grains with Soluble (DDGS) derived from ethanol production on growth and performance from 8 to 15 week of age. Experiment-1 consisted of inclusion levels of 0, 9, 18, or 27% DDGS to corn-soybean meal based diet and the treatment diets were formulated with metabolizable energy value of 2870 kcal/kg for DDGS and on digestible amino acid basis. The grower diet was fed from 56 to 77 day of the age and the finisher diet was fed from 77 to 105 day of age. Body weight was linearly decreased at 105 d as % DDGS increased in the diet. Feed conversion was increased at $P \leq 0.100$ from 77 to 105 d of age as DDGS inclusion level increased. In Experiment-2, dietary treatments consisted of 0, 7 or 10% DDGS in the grower period. Half of the birds fed 10% DDGS in the grower period were fed 7% DDGS in finisher period. The mash diets were formulated with metabolizable energy value of 2805 kcal/kg for DDGS and on a total amino acid basis. There were no significant effects on body weight or

feed conversion in Experiment-2. Results indicated that ethanol derived DDGS can be effectively included at 10% in growing/finishing diets for turkey hens if proper formulation matrix values for all nutrients are used.

Abe *et al*. (2004) conducted a study to evaluate the use of hydrolyzed distillers dried grains (HDG) for feeding value by inclusion into a basal diet at 0, 5, 10, 15 and 20%. The corn-soybean meal based turkey starter diet was formulated to provide similar levels of ME, digestible lysine (lys) and methionine (met), calcium and phosphorus. Male poults (large white) were fed a commercial diet until three days of age. At three days of age, they were weighed and assigned into cages such that there was an equivalent cage body weight. Poults were fed the experimental diets to 18 days of age (ten replicate cages/ seven poults/ cage). At the end of the trial, two poults per pen were randomly selected, euthanized and internal organs (spleen, heart, gastrointestinal tract and bursa) were weighed. There was significant linear decrease ($P \leq 0.01$) at 11 day of age in average daily gain (ADG) and feed intake as HDG level was increased and a cubic effect ($P \leq 0.02$) in ADG during 11 to 18 days. In conclusion, up to 10% HDG can be included in turkey starter diets although higher levels may be possible after two weeks of age.

Lumpkins *et al*. (2004) conducted two experiments to evaluate the use of distillers dried grains with soluble (DDGS) from modern ethanol plants in broiler diets. Experiment-1 was a 2×2 factorial experiment with diets containing two levels of DDGS (0 and 15%) and 2 diet densities (high and low). The high and low-density diets were formulated to contain 22% CP and 3000 kcal / kg ME, respectively. Eight pens of six chicks were fed an experimental diet from 0 to 18 days of age. Weight gain and feed efficiency (gain: feed ratio) of the chicks receiving the high-density diets were ($P \leq 0.05$) better than those of chicks fed the low density diets. However, within the two densities there was no difference in performance of chicks fed diets with 0 or 15% DDGS. In Experiment-2, six replications of 50 chicks were fed one of four dietary treatments for 42 days. The diets were formulated to be iso-caloric and iso-nitrogenous and contained 0, 6, 12, or 18% DDGS. There was no significant difference in performance or carcass yield throughout the 42 days experiment except for a depression in the body weight gain and feed

conversion when chicks were fed diets with 18% DDGS in the starter period. These studies indicated that DDGS from modern ethanol plants is an acceptable feed ingredient for broiler diets and can be safely used at 6% in starter period and 12 to 15% in the grower and finisher diet.

Nguyen *et al*. (2004) replaced part of the commercial concentrate component of the diet by locally available wheat brewing by-product in an attempt to lower feed costs of small-holder broiler production in the area of Hue city, central Vietnam. There were three experimental diets containing either 5, 10, or 15% brewing by-product. The three diets were fed on five small holder farms to groups of 20 broilers each. The results showed that beer by-products enhanced growth and improved feed efficiency. Slaughter carcass traits and the weights of breast and drumstick were enhanced by the feeding of beer by-product. The inclusion of 10% beer by-products in diet increased the antibody titer against Newcastle disease when the birds were aged nine weeks, but not when they were aged either four or twelve weeks. It is concluded that substitution of brewers' wheat for part of the concentrate component can render broiler diets less expensive and more efficient.

Noll (2004) summarized results from three trials where diets containing up to 12% DDGS were fed to market toms during the grower and finisher period and found no difference in body weight gain and feed conversion compared to the control corn-soybean meal-meat meal diets.

Fasuyi (2005) conducted a study to include to maize-sorghum brewers dried grains (MSBDG) in broiler starter diet. Four broiler starter diets were formulated such that MSBDG were fed at 0, 10, 20, and 30% inclusion levels at expense of maize. A batch of 240 starter-chicks was randomly assigned in triplicate to these dietary treatments. Each diet was fed 60 birds/ treatments from day-old for 35 days. The final weight, average weight and nitrogen retention of chicks fed MSBDG at 10% and 20% dietary levels were similar to those fed the control diet; both being significantly ($P \leq 0.05$) higher than those fed diet-4 (30% dietary inclusion). The weight gain, average feed consumption as well as feed efficiency declined in diet-4 (at 30% inclusion level). At the end of the trial, the chicks were sacrificed for carcass characteristics, relative

organ and muscle measurements. The relative weights of the heart and belly fat was significantly (P ≤ 0.05) influenced by dietary treatments. It was concluded that MSBDG can act as an energy substitute for maize at inclusion levels of about 20% in broiler starter diets without any adverse effect on performance, carcass characteristics and muscle development in broiler.

Swain *et al.* (2005) conducted a study to determine the effect of feeding brewery dried grain with or without Kemyzyme-HF supplementation on performance of broilers. Performance, carcass traits and organ weights were evaluated in 150 commercial broilers from day-old to six weeks. Two basal diets were formulated containing maize, groundnut cake, fish meal and wheat bran with 22.8% CP and 2800 kcal/kg ME at starter phase (0-3 weeks) and 19.9% CP and 2900 kcal/kg ME diet at finisher phase (4-6 weeks). The five groups of broiler chicks were fed with five diets where first diet was control and the other four diets contained 5 and 10% brewery dried grains (BDG) with (0.75 g/kg feed) or without Kemzyme-HF (a cellulose-complex with β-glucanase). Body weight and feed efficiency of the broilers fed with 5% BDG and Kemzyme-HF were comparable to that of the control group. Carcass traits were not significantly different among the treatments except in drumstick weight, which was significantly (P ≤ 0.05) higher in the chicks fed with 5 and 10% BDG with or without Kemozyme-HF. Organ weights also had similar response like the carcass traits, except for the heart which was significantly (P ≤ 0.05) higher in chicks fed with 5 and 10% BDG with Kemozyme-HF. Incorporation of 5% BDG with Kemozyme-HF at 0.75 g/kg feed was suggested for economic production.

Martinez-Amezcua *et al*. (2006) conducted three experiments to evaluate the effectiveness of Opti Phos phytase and citric acid for releasing the P that is not bioavailable in distillers dried grains with solubles (DDGS). The effect of Opti Phos phytase on AMEn and amino acid digestibility was also determined. New Hampshire × Columbian chicks were fed experimental diets from 8 to 21 days of age. For Experiment-1, a basal P-deficient diet contained 40% DDGS plus supplemental amino acids and DDGS was the only source of P. The basal diet was then supplemented with 1,000 or 10,000 phytase units (FTU)/kg of Opti Phos phytase or with 0.2% of P from KH_2PO_4.

In Experiment-2, a slope-ratio chick growth and tibia ash assay used a P deficient soybean meal basal diet, and it was found that the bioavailability of P in DDGS was 67%. For Experiment-3, a P-deficient basal diet with 30% DDGS plus supplemental amino acids was supplemented with 0.05 or 0.1% P from KH_2PO_4, with 3% citric acid, or with 1,000 or 10,000 FTU/kg of Opti Phos phytase. In Experiment 1, both 1,000 and 10,000 FTU/kg of phytase increased tibia ash but had no effect on AMEn. Both 10,000 phytase units (FTU)/kg of phytase and supplemental P increased digestibility of amino acids. In Experiment-3, supplemental phytase and citric acid increased tibia ash (mg/tibia), and it was estimated that phytase and citric acid could release from 0.04 to 0.07% P from DDGS. In terms of bioavailability coefficients, the bioavailability of the P in DDGS was increased from 62 to 72%. These concluded that phytase and citric acid increase the bioavailability of P in DDGS, but phytase at 1,000 FTU/kg had no consistent effect on AMEn and amino acid digestibility.

Wang *et al.* (2007a) studied the use of moderate to high levels of DDGS in broiler diets and evaluated the effects of rapid and multiple changes in level of DDGS during the growth period. Diets were formulated to contain 0, 15, or 30% DDGS with diets formulated on the basis of digestible amino acids to meet levels typical of the U.S. broiler industry. Other groups were fed 0 and 15% or 0 and 30% DDGS on alternate week basis, with one group starting with diets containing no DDGS and other groups starting with diets containing 15 or 30% DDGS. Birds fed diets containing 15% did not differ significantly in live performance or carcass characteristics from birds fed diets with no DDGS, whether fed on a continuous basis or alternated weekly between 0 and 15% DDGS. Birds that were continuously fed diets with 30% DDGS had significantly reduced body weight and feed intake at 35 and 42 days compared to birds fed the control diet with no DDGS and had reduced breast meat yield. When birds were fed diets with 0 or 30% DDGS alternating on a weekly basis live performance was approximately midway between that of birds fed diets with 0 or 30% continuously and similar to that of birds fed 15% DDGS on a constant basis, but breast meat yield tended to be reduced. It was concluded that effective use of diets with 15% DDGS when formulated on a digestible

amino acid basis and showed that abrupt removal of this level of DDGS did not adversely affect performance of broilers.

Wang *et al.* (2007b) evaluated the use of or increasing levels of DDGS in diets for broilers. Diets were formulated for starter (0 to 14 days), grower (14 to 35 days) and finisher (35 to 42 days) periods to contain 0, 15, or 30% DDGS. Varying levels of DDGS were fed during study; with some birds receiving a constant level while others received increasing amounts as the bird aged. The DDGS levels used in the study were as follows (starter-grower-finisher, %): 1) 0-0-0; 2) 0-15-15; 3) 0-15-30; 4) 0-30-30; 5) 15-15-15; 6) 15-15-30; 7) 15-30-30 and 8) 30-30-30. Each of the dietary treatments was fed to four replicate pens of 25 birds each. Body weights and feed consumption were determined at 14, 35 and 42 days of age. The results indicated that increasing levels of DDGS had a trend to reduce the weight: volume ratio and visually decreased pellet quality. Diets containing 15% DDGS could be fed throughout the entire feeding period of 1 to 42 days of age with no adverse effects on live performance or carcass composition. Inclusion of 30% DDGS in the diet during starter or grower periods reduced body weight, elevated FCR and typically had reduced breast meat yield, compared to birds fed diets with 15% DDGS or birds fed the control diet with no DDGS.

Choi *et al.* (2008) investigated the effects of the addition of corn Distiller's Dried Drains with Solubles (DDGS) to broiler diets on growth performance and meat characteristics. A total of 3,200 day-old, unsexed Cobb-500 broiler chicks were randomly allotted to 16 pens (replicates), with 200 chicks per pen. There were four diet treatments (0, 5, 10, and 15% DDGS), and four replicates per treatment. From 8 to 21 days of age, the birds were fed broiler starter diets containing similar energy (TMEn 3,100 kcal/kg) and protein (21.6%) contents. From 22 to 35 days of age, they were fed grower diets containing similar nutrients (3,150 kcal/kg, 19.5% crude protein). No significant difference was found in growth performances among the four treatments. As the DDGS level increased, the concentration of unsaturated fatty acids in meat increased ($P < 0.05$). The color scores of breast and thigh muscles were not significantly influenced by DDGS, however, the yellowness of shank increased significantly by the addition of DDGS. The hardness of breast and thigh meats was not affected by the addition of DDGS. It was

shown that the use of DDGS in broiler diets up to 15% could decrease the feed cost by replacing part of corn and soybean meal, without any negative effect on growth performance and meat qualities.

Min *et al.* (2008) conducted a study to evaluate the use of distillers dried grains with solubles (DDGS) combined with glycerin in broiler diets. In a 3 × 2 factorial arrangement, 600 one-day-old commercial strain Cobb 500 broilers were randomly assigned to experimental diets with 0, 15 and 30% DDGS of known composition; within each level of DDGS the diets contained 0 or 5% glycerin, respectively, from 0-42 days of age. Diets were formulated to meet digestible amino acid requirements and were fed in pelleted form. Each dietary treatment was replicated four times. Body weight gain and feed consumption were measured and carcass characteristics were evaluated at 42 days of age. Inclusion of 30% DDGS had no adverse effect on body weight of chicks; however birds fed diets with 30% DDGS had greater feed intake and poorer feed conversion than birds fed the control diet at most age periods. This was highly correlated to the reduced pellet quality of diets containing the high levels of DDGS. Birds fed diets with 30% DDGS also had significantly reduced dressing percentage compared to birds fed the control diet with no DDGS. However, there was no adverse effect on breast meat yield related to the higher levels of DDGS inclusion. Addition of 5% glycerin from biodiesel production to the diets had no significant effect on body weight, feed intake or feed conversion. There was no significant effect of the addition of glycerin on dressing percentage or yield of various carcass parts. With one minor exception, there was no significant interaction between addition of glycerin and level of DDGS in the diet, even though pellet quality declined when glycerin was added to the diets. Overall, the results of this study demonstrates that 15% DDGS of known nutritional quality can be utilized in diets for growing broilers with no adverse effects provided diets are formulated on a digestible amino acid basis and meet the nutritional requirements of the broiler. Higher levels may be tolerated but there may be a loss in feed conversion unless pellet quality can be improved. A loss in dressing percentage at higher levels of DDGS has been consistently noted in this and previous studies. Incorporation of 5% glycerin from biodiesel production as a source of energy appears satisfactory.

Patil (2008) studied the effects of using distillery dried grains with solubles (DDGS) in the diets with certain feed additives on performance of broilers. The trial conducted on 250 day-old 'vencobb' broiler chicks for period of five weeks. The day old chicks were randomely divided into five equal groups. The group A was control. Group B received 10% DDGS. Group C received 10% DDGS with an enzyme (maxigrain) @0.5 kg/ ton. The birds from group D received diet containing a 10% DDGS with acidifier (Kemgest-Dry). The birds from group E received diet containing a 10% DDGS with enzyme (@ 0.5 kg/ ton) and acidifier (@1kg/ ton). The performance of birds from different groups was compared with respect to growth and performance. Thus it concluded that use of DDGS along with enzyme and acidifier, either singly or in combination is beneficial for recording better growth with respect to live weight, gain in weight, better feed conversion ratio and higher net profits at the end of fifth week.

Wang *et al.* (2008a) evaluated high levels of of distillers Dried Grains with Solubles (DDGS) in broiler diets throughout 49 days a growing period. Diets were formulated based on digestible amino acid content to contain 0, 10, 20, 30, 40, or 50% DDGS. Body weight and feed consumption were determined at 14, 35, 42, and 49 days of age. Result indicated that level of DDGS had little effect on body weight at any age until 20% inclusion. After which body weight declined significantly. Increasing DDGS levels significantly increased calorie conversion ratio. Dressing percentage decreased linearly with increasing DDGS levels from 0-50%. There was a significant reduction in breast meat or leg quarter yield as a percentage of live weight with increasing DDGS inclusion, while birds fed higher levels of DDGS had higher wings as percentage of live weight. It concluded that up to 30% DDGS could be used in broiler diets.

Wang *et al.* (2008b) conducted a study evaluate various levels of corn distillers dried grains with soluble (DDGS) were fed in broilers. The diets formulated were either iso-caloric using metabolizable energy levels similar to current U. S. industry levels or containing optimum density commensurate with

1% supplemental poultry oil. In each diet type 0, 15 and 30% DDGS were incorporated. There was little difference in pellet quality between diets with 0 or 15% DDGS but quality deteriorated severely in diets with 30% DDGS. Over the 42 days study, birds fed with 30% DDGS had significantly lower body weight and poorer feed conversation ratio as compare to control with no DDGS. Birds fed with 15% DDGS did not differ significantly with body weight and FCR than control diet.

Min *et al.* (2009a) conducted a trial to assess the effects of various dietary enzymes on energy digestibility of diets high in Distillers Dried Grains with Soluble (DDGS) for broilers. A 2 × 4 factorial arrangement of treatments was used in which a corn soybean meal control diet and a diet with 30% DDGS were supplemented with two different commercial enzyme products. In addition to the unsupplemented control, each enzyme was fed at the level suggested by the manufacturer, twice the recommended level, and four times the recommended level. Allzyme SSF (Alltech, Nicholasville, KY) was used in the first experiment, and Rovabio Excel (Adisseo, Alpharetta, GA) was used in the second experiment. Male commercial strain chicks that were 15 (trial 1) or 20 (trial 2) days old were randomly assigned to the experimental diets, with each treatment replicated thrice. After a five days period of acclimation to the diets, excreta samples were collected. The energy contents of the diet and excreta were determined and digestibility of dietary energy was calculated. In both trials, there was a significant ($P \leq 0.05$) difference in gross energy digestibility between the corn-soybean meal control diets and diets with 30% DDGS. However, no significant improvement in gross energy digestibility was obtained by adding any level of the two enzymes. Moreover, no significant interactions were found between the basal diets and various enzyme levels. It concluded that enzymes used in these studies had no apparent beneficial effect on energy digestibility of corn-soybean meal diets or diets with a high level of DDGS.

Min *et al.* (2009b) study was conducted to evaluate the use of DDGS in combination with canola meal (CM) in broiler diets. In a 6 × 6 factorial arrangement, 1,080 one-day-old male broilers were randomly assigned to diets with 0, 5, 10, 15, 20, and 25% DDGS of known composition; within each

level of DDGS, diets contained 0, 5, 10, 15, 20, or 25% CM from 0 to 18 days of age. Each treatment was replicated six times. Diets were formulated to meet digestible amino acid requirements and were fed as a 3.17-mm pellet. Body weight and feed consumption were measured at 18 days of age. In addition, feed bulk density and percentage of fines were evaluated. The DDGS and CM levels as well as their interaction significantly affected feed intake and BW ($P < 0.05$). Moreover, feed intake and BW declined dramatically with the increasing inclusion of CM. However, no significant difference was noted in FCR due to dietary DDGS and canola levels. Percentage of fines and diet bulk density were influenced significantly by dietary DDGS and CM levels as well as by their interaction. The percentage of fines increased with increasing combinations of DDGS and CM. However, the effect of dietary DDGS and canola concentrations on feed bulk density did not show a clear trend. By regression analysis, percentage of fines had a significant impact on feed intake and BW gain but failed to show any clear-cut relationship between bulk density and performance factors. Therefore, when DDGS and CM are used in combination, the total level of the two ingredients in the formulation should be considered.

Shalash *et al.* (2009a) performed three experiments to evaluate nutritive value of Distillers Dried Grains with Solubles (DDGS) in starter broiler diets using different levels (0, 6, 9 or 12%) Experiment-1 was designed to determine the digestibility coefficients of nutrients for DDGS using 16 cockrels, 40 weeks old compared to a mixture of yellow corn and DDGS 1:1 or 100% DDGS. Experiment-2 was designed to evaluate the nutritive value of DDGS protein using Total Protein Efficiency (TPE) technique. A total number of 80 unsexed one-day old Arbor Acers broiler chicks were distributed between two treatments of 40 chicks each in four replicates (10 chicks each) and commercial diet (22% CP and 3000 Kcal/kg ME) for two weeks. On the 14^{th} day, the chicks were fed experimental diet (18% CP) in which cereals (yellow corn and fine wheat bran) provided 65% of dietary CP, while the test material (DDGS) will provided the 12%, from 14 up to 28 days of age. Significant reduction took place in body weight gain, feed intake, protein intake and T. P. E value for chicks fed diets containing DDGS compared with those fed diets containing soyabean meal as a source of protein. Experiment-3 was designed

to evaluate DDGS at different levels: 0, 6, 9 and 12% in starter diets. A total number of 240 unsexed one-week old Arbor Acers broiler chicks were distributed into four treatments of 60 chicks each in six replicates (10 chicks each). Diets were formulated to contain 22% CP and 3070Kcal/kg ME at starter period. Performance and Relative Economic Efficiency (REE) of chicks fed diets with 6% DDGS approximately equaled those fed control diet. However, Reduction in body weight and body weight gain took place in both 9 and 12% DDGS supplemental diets, being significant in the 12% diet. A notificeable reduction in REE values took place between treatments. The 6% DDGS level equaled almost the control REE performance. The 9 and 12% DDGS treatments showed lower REE than both control and the 6% level. Inclusion of DDGS in the broiler diets had no effect on mortality rate.

Shalash *et al*. (2009b) evaluated the possibility of improving the utilization of dried distiller's grains with Solubles (DDGS) in broiler diets. A total number of 150 day-old chicks were randomly assigned for five groups received, diet containing 12% corn Dried Distillers Grains with Solubles (DDGS) without or with enzyme preparation (E), Radish Root Extract (RRE, as a source of peroxidase enzyme), or E plus RRE, in addition to control diet. The addition of RRE improved numerically Body weight (BW) at 28 days and significantly decreases plasma antioxidants capacity by 56.11% compared to control birds. Enzyme preparation failed to improve performance of broiler fed DDGS diet. It was concluded that using RRE as a source of peroxidase enzyme is a suitable feed additive for improving the utilization of DDGS.

Denstadli *et al.* (2010) conducted a study to evaluate the effect of a gradual substitution of wheat and soy with brewers dried grains (BDG) on pellet quality, performance and organ weights in broiler chickens. Five diets were formulated in which 0, 10, 20, 30, or 40% BDG replaced wheat and soy, with a concomitant gradual reduction in the calculated AME level. Each of the five experimental diets was fed to 12-day-old broiler chickens (Ross 308) kept in six pens, with 12 birds/pen. Feed intake was not affected by BDG inclusion and compensatory feed intake did not occur, perhaps having been neutralized by a significant ($P < 0.001$) reduction in the pellet durability index. The pellet durability index was 85% in the control diet (0% BDG) and decreased

significantly ($P < 0.001$) to 68% in the diet with 40% BDG. Increased levels of BDG reduced BW gain significantly ($P < 0.001$) and led to a significant ($P < 0.001$) increase in the feed: gain ratio. The feed: gain ratio was significantly ($P < 0.05$) higher in birds fed 30 and 40% BDG compared with birds fed 0, 10 and 20% BDG. The apparent ileal digestibility values of protein and energy were significantly reduced by BDG inclusion ($P < 0.01$ and $P < 0.001$, respectively), whereas starch digestibility increased significantly ($P < 0.001$). The relative gizzard weight increased significantly ($P < 0.001$), whereas the relative cecal weights were not affected by BDG inclusion. It concluded that, 10 to 20% inclusion of BDG supports acceptable growth and feed utilization, and favors the development of a well-functioning gizzard.

Hussaini *et al.* (2010) conducted an experiment to evaluate the influence of different levels of Brewers Spent Grain (BSG) and enzyme supplementation (ES) in the diet on productive performance and digesta viscosity of broilers from 7-42 days of age. Six treatments were arranged factorially with three levels of BSG (none, 7.5, 15%) unsupplemented with 0.05% enzyme. It concluded that reduction in weight gain, feed intake and increase in feed conversion ratio in broilers by feeding 15% BSG during the starter period in comparison to control group ($P < 0.05$). ES improved body weight, feed intake and daily weight gain in starter period. BSG may be used upto 7.5 and 15% of the diets of broilers at starter and grower period, respectively

Jung and Batal (2010) conducted two experiments to evaluate the feeding value of high-protein corn distillers' dried grains (HP-cDDG), from a plant using a front-end fractionation process, on broiler performance in batteries (0 to 20 days of age in Exp-1) and floor pens (0 to 33 days of age in Exp-2). In Exp-1, 1day-old male broiler chicks were placed in batteries in an environmentally controlled room. Six experimental diets were formulated to contain 0, 3, 6, 9, 12, or 16% HP-cDDG and to be isocaloric and isonitrogeneous. The mash diets were fed to eight replicates of six chicks per replicate from 0 to 20 days of age. Overall (0 to 20 days of age) the inclusion of 6% HP–cDDG or greater in the diets negatively impacted body weight (BW) gain and feed conversion ratio as compared with the control or the 3% HP-

cDDG diet. The negative effect was likely due to a marginal lysine deficiency in the diets as the level of HP-cDDG increased. In Exp-2, 1d-old male broiler chicks were housed in floor pens in an environmentally controlled room. Six experimental diets were formulated to contain 0, 3, 6, 9, 12, or 16% HP-cDDG and to be isocaloric. The crumble (0 to 15 days of age) and pellet diets (16 to 33 days of age) were fed to eight replications per treatment containing 40 chicks per replication. There was no effect of up to 16% HP–cDDG inclusion on broiler performance during the starter period (0 to 15 days of age). However, any inclusion of HP-cDDG in the diets during the grower period (16 to 33 days of age) significantly decreased body weight gain as compared with the control diet. Also, the inclusion of 9% HP-cDDG or greater to the diets negatively impacted feed conversion ratio. In conclusion, HP-cDDG could be an acceptable feed ingredient for broilers, but special attention must be paid to the amino acid levels (especially lysine) in order to prevent deficiencies.

Kluth and Rodehutscord (2010) conducted a study to determine the effect of the duration of pre-feeding on prececal amino acid (AA) digestibility of wheat distillers dried grains with solubles (DDGS) in broilers. The experimental diets with DDGS at levels of 0, 10 and 20% were offered ad-libitum for 7, 5 and 3 days starting on 14, 16 and 18 days of age. Titanium dioxide was used as an indigestible marker. Six pens of ten birds were allocated to each treatment. Digesta was sampled on a pen basis from the distal two-thirds of the intestine section between Meckel's diverticulum and 2 cm anterior to the ileo-cecal-colonic junction. Ingested and digested amounts of AA were determined for each pen. Digestibility of AA in the diets was not significantly affected by the duration of pre-feeding but was significantly reduced by inclusion of DDGS. Digestibility of AA in DDGS was determined by using a linear regression approach. The digestibility of AA in DDGS ranged from 76% (Arg, five days of feeding) to 33% (Asp, three days of feeding). There was no significant effect of pre-feeding time on AA digestibility of DDGS. Lysine digestibility of DDGS was 72%. The mean digestibility of the AA Arg, Cys, Ile, Leu, Lys, Met, Phe, Thr, and Val of DDGS across the three pre-feeding times was 66%. This study gave evidence that three days of pre-feeding a diet is sufficient in studying prececal AA digestibility in broilers when low- digestible feeds are used.

Loar II *et al.* (2010) evaluated the effect of two levels (0 vs. 8%) of distillers dried grains with solubles (DDGS) in a starter broiler diet (0 to 14 days; 45 replicates/treatment) after these same birds were subsequently fed a grower diet (14 to 28 days) with either 0, 7.5, 15, 22.5, or 30% DDGS (nine replicates/treatment). Ross × Ross 308 male broilers were used in this experiment, and evaluation criteria consisted of feed mill parameters, broiler growth, relative liver weight, ileal viscosity and cecal content count of *Clostridium perfringens* and *Escherichia coli* analyzed by both selective media and real-time PCR. Increased inclusion of DDGS resulted in a nonlinear response for production rate ($P < 0.05$), conditioner energy usage ($P < 0.01$) and pellet mill energy usage ($P < 0.05$). Increasing DDGS resulted in a linear decrease in pellet quality ($P < 0.001$) and an increase ($P < 0.001$) in total fines. Inclusion of DDGS decreased ($P < 0.001$) energy usage at the pellet mill and decreased ($P < 0.05$) bulk density of the diets. The DDGS levels fed during the starter phase (0 vs. 8%) had no effect on the broilers at 14 or at 28 days of age. Increasing DDGS inclusion levels during the grower phase resulted in a linear decrease ($P < 0.001$) in body weight gain and liver relative weight ($P < 0.001$). A DDGS starter × grower interaction ($P < 0.05$) was observed for feed consumption, in which birds that consumed no DDGS during the starter phase exhibited a decrease in feed consumption with the higher inclusion levels of DDGS during the grower phase, whereas birds that received 8% DDGS during the starter phase were unaffected by DDGS inclusion level in the grower phase. Feed conversion, mortality, ileal viscosity, and cecal *C. perfringens* and *E. coli* concentrations were unaffected by DDGS level in the grower diet. The feed intake response suggests a beneficial effect of exposing broiler chicks to DDGS if inclusion levels of 22.5% or higher is to be fed after 14 days of age. However, the data suggest that the young broiler can be negatively affected with inclusion levels of 15% DDGS or higher up to 28 days of age.

Oryschak *et al.* (2010a) evaluated feeding value of extruded and non-extruded wheat and corn distillers dried grains with solubles (DDGS) for broilers with two experiments. In experiment-1, male broilers (n = 360) housed in battery cages were fed assay diets that included either 15 or 30% wheat or

corn DDGS (extruded or not) in relation to a basal diet from d 21st to 28th days. Birds were killed on 28th and ileal digesta was collected to establish the apparent ileal digestibility (AID) coefficients of energy and nutrients for test ingredients using the difference method based on five cages of eight birds per diet. In experiment-2, a 42 days study compared the growth performance of broilers fed phase diets including 0, 5, or 10% wheat or corn DDGS, based on four pens of 55 birds per diet × sex combination. Diets within phase were formulated to have a similar content of AME, CP, and digestible lysine. Breast meat weight and yield were determined on 37th day by sampling five birds per pen. In experiment-1, at 15% inclusion, AID coefficients of most amino acids were higher for corn DDGS than for wheat DDGS ($P < 0.05$). At 30% inclusion, however, there were fewer differences in AID between corn and wheat DDGS. Twin-screw extrusion increased the AID of AA in both corn and wheat DDGS by 10 to 34% ($P < 0.05$). In experiment-2, there was no adverse effect of including corn or wheat DDGS at up to 10% of the diet on pen average daily weight gain, feed disappearance, feed efficiency, breast meat weight, or yield. In conclusion, extrusion increased the feeding value of DDGS. The AID coefficients for amino acids were similar between corn and wheat DDGS. It confirmed that either corn or wheat DDGS can be included upto 10% of wheat-based broiler diets without affecting growth performance or breast meat yield.

Oryschak *et al.* (2010b) conducted a study evaluate the nutritive value of triticale distillers dried grains with solubles (DDGS) for broilers with two experiments. In experiment 1, 400 male broilers housed in battery cages were fed diets including 15 or 30% triticale DDGS (extruded or not) or a basal diet, supplemented with or without a multi- enzyme complex from 21st to 28th days. Birds were killed and ileal digesta was collected on 28th day to establish the apparent ileal nutrient digestibility (AID) coefficients for both assay diets and DDGS as test ingredients based on five cages per diet. In experiment-2, a 42 days performance study compared growth phase-specific diets formulated to similar levels of AME, CP and digestible lysine with graded levels (0, 5, or 10%) of triticale DDGS inclusion based on a minimum of four pens per diet × sex combination. Breast muscle weight and percentage yield were determined on 37th day by sampling five birds per pen. In experiment-1, there was a

significant (P < 0.05) DDGS level of inclusion × enzyme interaction for CP, lysine, methionine, tryptophan, isoleucine, histidine and phenylalanine; such that the AID increased with enzyme supplementation based on 15% but not 30% DDGS inclusion. At 15% DDGS inclusion, enzyme supplementation increased the AID of these nutrients in DDGS between 6 and 19 percentage units. Extrusion of triticale DDGS increased (P < 0.05) the AID of GE, CP, methionine, tryptophan, branched-chain amino acids and phenylalanine between 3 and 8 percentage units. In experiment 2, feeding up to 10% triticale DDGS had no adverse effect on feed intake, weight gain or feed efficiency of broilers compared with controls over the 42 days study. Feeding up to 10% triticale DDGS did not affect breast weight or yield on 37th day. In conclusion, feed enzyme complex supplementation and extrusion both increased the nutritive value of triticale DDGS for broilers. Triticale DDGS can be fed upto 10% of practical broiler diets without adverse effect on performance and breast muscle yield.

Schilling *et al.* (2010) conducted a trial to evaluate the effects of feeding various levels of distillers dried grains with solubles (DDGS; 0, 6, 12, 18, and 24%) on broiler breast and thigh meat quality. Breast meat from broilers that were fed DDGS had a higher (P < 0.05) pH than those from the control diet. In addition, the 18 and 24% DDGS treatments yielded breast meat with higher (P < 0.05) pH values than the 6% DDGS treatment. No differences existed (P > 0.05) among breast meat from the different treatments with respect to cooking loss, instrumental color and consumer acceptability, but breast meat from the control (0% DDGS) treatment had slightly lower (P < 0.05) shear force than breast meat from the 18 and 24% DDGS treatments. In addition, no differences (P > 0.05) existed among proximate composition of breast and thigh meat from the control and DDGS treatments. As DDGS concentration increased, there was a linear increase (P < 0.05) in linoleic and. polyunsaturated *fatty* acids, which indicates a greater potential for lipid oxidation. The TBA reactive substances values were greater (P < 0.05) for the 18 and 24% DDGS treatments at fifth day when compared with the control and 6% DDGS treatments, which indicates increased oxidation. It was concluded that all treatments yielded high quality breast meat and that thigh meat quality

was similar among treatments containing 0 to 12% DDGS, but higher inclusion levels led to thigh meat that was more susceptible to oxidation.

Min *et al.* (2011) conducted an experiment to evaluate the effect of a commercial carbohydrase preparation (Rovabio® Max AP) on protein and energy utilization of diets with 0 or 30% DDGS. One hundred and ninety two, 18-day-old male broiler chicks of a commercial strain (Cobb 500) were randomly distributed among six treatments which included two basal diets containing 0 or 30% of DDGS; each supplemented with or without an enzyme preparation fed at the level recommended by the manufacturer (1X), two (2X) and four times (4X) the recommended level. The results showed that weight gain, feed intake, feed conversion ratio and mortality rate were not significantly affected by level of DDGS or enzyme inclusion in the diet or their interactions. Excreta nitrogen (N) and gross energy (GE) were significantly increased by inclusion of 30% of DDGS in the basal diet. While AME and AMEn values were not affected by the addition of high level of DDGS in the diet, GE digestibility and NR were significantly affected. Supplementation of either basal diet with different levels of enzyme had no significant effects on excreta N content or AME, GE digestibility, or NR values. Moreover, the interaction between different levels of DDGS and enzyme levels on performance or nutrient utilization parameters were not significant. It concluded that the addition of the enzyme preparation used in this trial was not effective in improving nutrient utilization of corn-soybean meal diets with or without DDGS.

Abdel-Raheem *et al.* (2011) conducted a study to determine the effect of different levels of Distillers' Dried Grains with Solubles (DDGS) from wheat and corn on prececal Amino Acids (AA) digestibilities, growth performance and some slaughter characteristics of broilers. A total number of 240 one-day-chicks (Ross 308) were randomly allotted to three treatments (80 birds/group) with four replicate pens per treatment and 20 birds per pen. Chicks were fed the experimental diets with DDGS at levels of 0, 6 and 12% for five weeks. Average daily gain, feed intake and feed conversion ratio was recorded. The results indicated that, body weight decreased in broilers fed 12% DDGS than the control group at the end of the experiment. No significant differences with respect to feed intake and feed conversion at the first (1-22

days) and second (22-35 days) growing periods. A significant reduction in the warm and cold carcass weight and the warm and cold dressing % at 12% inclusion level of DDGS. Tryptophan digestibility was lower ($P < 0.05$) with the addition of 12% levels of DDGS at d 21days. At day 35th there is a significant decrease in the digestibility of total amino acids, some individual AA like threonine (9.1%) and arginine (6.38%) at 12% inclusion of DDGS in comparison with the control group. It was concluded that 12% level of DDGS from wheat and corn reduce growth performance, carcass traits, some AA and DM digestibilities in broilers under present experimental conditions.

Loar Π *et al.* (2011) evaluated the effects of varying levels of DDGS in a with 8% increments. Increasing inclusion rate of DDGS led to decreased body weight gain (BWG), whereas mortality seemed to be linearly increased. However, there was an increase seen in feed conversion (FCR) in conjunction with the increase in DDGS in the diet. It concluded that an inclusion level of 8% DDGS or less is recommended for starter diets for broiler chicks.

Shim *et al.* (2011) conducted a trial to evaluate the effects of graded levels of corn distillers dried grains with solubles (DDGS) as a partial replacement for sources of protein, energy and other nutrients for broilers when the digestible amino acid balance was maintained. 0, 8, 16, and 24% DDGS were incorporated into isonutritive diets at the expense of corn, soybean meal and DL-Met. Poultry oil, l-Lys, and l-Thr additions increased with increasing levels of DDGS. Diets were each fed to 36 Cobb-500 straight-run broilers in six floor pens in two experiments. In experiment-1, broilers fed ≥ 8% DDGS showed increased Body weight (BW) gain compared with those fed the control diet during the 0 to 18 days starter period ($P = 0.0164$) but were almost identical in body weight (BW) at 42 days ($P = 0.9395$). The only difference at 42 days was in the carcass fat composition of female broilers: percentage of fat pad decreased with increasing DDGS level ($P = 0.0133$). It was concluded that Corn DDGS reduced the pellet durability index. In experiment-2 at 42 days, broilers fed all levels of DDGS showed increased BW gain compared with those fed the control diet. It was concluded that broilers may perform well when fed properly balanced feeds containing DDGS upto 24% DDGS despite reduced pellet quality.

Lukasiewicz *et al.* (2012) undertook a Study on 540 broiler chickens of Cobb 500 line. One-day chicks were randomly allocated to three nutritional groups: K, D1 and D2, each group consisted of six replicates of 30 birds. The factor that differentiated the groups was the content of dried wheat decoction in the starter type feed mixture (5 % and 7 %). Production results (individual body weight, feed intake and mortality) of the birds were controlled in a 42 days rearing period. On the 42nd day of rearing, six male and six female chickens from each group were chosen for slaughter that had body weights similar to the average of each group according to gender. The aim of this study was to determine experimentally whether the by-product of ethanol production is suitable for replacing soybean meal in feeding broiler chickens. The application of the wheat decoction had no negative effect on production results of the chickens. The birds fed a mixture with a higher content of Dried Distillers Grains with Solubles (DDGS) were characterized by a similar body weight and better feed conversion ratio compared to the control birds. A properly-balanced (fiber, energy, amino acids) nutritional dose of the dried wheat decoction may be used as a good energy-protein component in feed mixtures for broilers. It is a rational means of DDGS management which is, simultaneously, a cheaper substitute for soybean meal.

Min *et al.* (2012) conducted a trial to evaluate the effects of distillers dried grains with solubles (DDGS) on the meat quality and antioxidant status and capacity of broiler chickens. One-day old male broiler chickens (720) were assigned to six treatments, with four replicates per treatment. Birds were fed diets formulated to contain 0, 5, 10, 15, 20 and 25% corn-based DDGS, respectively, for a period of six weeks. The addition of DDGS influenced the general meat quality by affecting the b* (yellowness) values, cooking loss and shear force ($P < 0.01$). Moreover, the fatty acid profiles of the breast and thigh were affected by DDGS levels. In particular, no significant difference was found in saturated, monounsaturated and polyunsaturated fatty acids ($P > 0.05$), but feeding DDGS significantly increased the ratio of polyunsaturated to saturated fatty acids ($P < 0.01$). In breast meat and liver tissue, total superoxide dismutase activity decreased significantly between birds fed the control diet and the DDGS diets ($P < 0.05$). In the liver, glutathione peroxidase

activity was similar to that of the control group in the diet with 15% added DDGS ($P < 0.01$). The malondialdehyde production of breast muscle was not affected ($P > 0.05$) by dietary DDGS concentrations; however, liver malondialdehyde production was influenced significantly ($P < 0.01$) by dietary DDGS levels. Overall, including DDGS at concentrations upto 15% in the broiler diet is feasible and can result in ideal meat quality.

Aghabeig *et al.* (2013) evaluated the impact of a gradual replacement of soybean meal with Brewers Dried Grains (BSG) on performance and protein digestibility in broiler chickens. Six diets were formulated in which 0, 5, 10, 15, 20 and 25% BSG replaced soybean meal. A total of 144 Ross-308 broiler chickens divided into 24 pens and each experimental diet was fed to 11day-old broiler chickens kept in four pens. Feed utilization was affected by BSG inclusion only at finisher phase ($P < 0.05$). Feed intake value in control (0% BSG) and 5% BSG groups was greater than that in other groups. Body weight gaining group fed diet with 25% BSG was less than others at grower phase, and feed efficiency was low for this group ($P < 0.001$). Feed: gain ratio was not affected by BSG inclusion at the finisher phase (24 to 42 days). The ileal digestibility values of protein were significantly increased by some levels of BSG inclusion ($P < 0.01$). It concluded that 20% inclusion of BSG at 11 to 24 days and 5% inclusion of BSG at 25 to 42 days supports acceptable performance in the broiler chickens.

El-abd (2013) conducted an experiment of 42 days was conducted with a flock of 180 unsexed one-day old Japanese quail chicks, distributed at random into three groups each in three replicates. Treatments were T1 as control, T2 containing 50% DDGS and T3 containing 100% DDGS. All chicks had free access to feed and water ad libitum during the experiment. Average daily gain, feed intake and feed conversion efficiency were determined. The results indicated that, chicks fed 50% and 100% DDGS had higher body weight gain at 42 days, performance index, higher feed intake and better feed conversion ratio compared to the control diet. Feeding diet containing 50% and 100% DDGS had the highest total plasma protein, globulin concentrations, moreover lower in GOT and GPT than the control diet. No significant effect of DDGS levels on the averages values of carcass

characteristics. In conclusion, use of DDGS at 100% recorded the best results compared to the other treatments. The results obtained cleared that DDGS can be successfully fed at level 100% as replacement for yellow corn in Japanese quail diets.

Foltyn *et al*. (2013) conducted a study to evaluate the graded levels of corn distillers dried grains with soluble (DDGS) as partial replacement for soybean meal in diets for broilers. In the first experiment 900 males of ROSS 308 were used and they fed diets with 0, 60, 120 and 180 g/kg DDGS in grower diets (Control group, D6, D12 and D18) from 9^{th} to 35^{th} day of age. In the second experiment 800 broilers both sex of Cobb 500 were used and they fed diets with 0 and 200 g/kg DDGS in grower diets (Control group and D20) from 9^{th} to 35^{th} day of age. Until age 30^{th} day there were not significant differences among the groups in live weight in the first experiment. But at 35^{th} day of age the live weight of chickens fed 60 and 120 g/ kg DDGS (2498.5 g and 2496.3 g) was significantly higher ($P < 0.05$) than in Control group (2425.9 g, without DDGS). In the second experiment, from 23^{rd} to 35^{th} day of age significantly higher ($P < 0.05$) live weight had group fed diet without DDGS in comparison with chickens fed 200 g/kg DDGS. The differences between groups at 35^{th} day of age was 75.7 g. Feed conversion ratio was similar in all groups in both experiments. There was not observed significant effect of DDGS on weight and proportion of abdominal fat. Feeding DDGS had significant effect ($P < 0.05$) on decrease the lightness (L*) of breast meat in the first experiment, which was not confirmed in the second experiment.

Ivanova *et al.* (2013) investigated the effect of feeding compound feed with various proportions of wheat dry distiller's grain on the productive and slaughter traits in broiler chickens. The study was conducted with 120 male Ross 308 broiler chickens divided into four groups with 30 birds each. Each group was further subdivided into three subgroups of ten chickens. Chickens were reared in battery cages with water and feed ad libitum. The live body weight of day-old chickens in all groups was equal. The duration of the experiment was 42 days and live body weight was checked at 10, 28 and 42 days of age, whereas feed utilization during each period of the life based on feed intake and weight gain of subgroups. Except for the control, the starter,

grower and finisher of experimental groups (II–IV) were supplemented with wheat dry distiller's grain (DDG) as followed: Group I – 0%, group II – 10%, group III – 15% and group IV – 20% DDG. By the end of the 42 day period, five chickens from each group with a body weight close to group mean were slaughtered and slaughter analysis was performed. The inclusion of 10% and 15% wheat DDG in compound feeds for broiler chickens fattened up to 42 days of age did not have a significant effect on their growth as compared to control group. The inclusion of 20% wheat DDG to compound feed reduced substantially ($P < 0.05$) live body weight of chickens by 6.1% vs controls. During the starter period, a trend to poor feed utilization was observed in groups which received 15 and 20 % DDG with compound feed – by 9.7 and 7.6% vs controls, but during the grower and finisher periods, as well as throughout the entire 42 days experimental period, this parameter did not show any significant differences between the control and experimental groups as well as among the three experimental groups. Compound feeds with 15% and 20% wheat DDG fed to broiler chickens resulted in statistically significant reduction of the thigh weights and slaughter yield vs controls at the end of the trial. The inclusion of 20% DDG in the ration also resulted in statistically significantly lower breast weight than in controls. The inclusion of DDG in compound feed for broiler chickens did not influence significantly the chemical composition of meat. Based on conclusions made, the inclusion of no more than 15% DDG in compound feeds for broiler chickens throughout the 42 days fattening period was recommended.

Min *et al. (*2013) evaluated the effects of dietary DDGS levels on small intestinal morphology of broilers. A total 720 Cobb 48 males were used in this experiment. Birds were fed a diets formulated contain 0, 5, 10, 15, 20 and 25% DDGS, respectively for a period of six weeks. About 10-15% DDGS inclusion level showed better Villus Height (VH), Crypt Depth (CD) and ratio of villus height to crypt depth (VCR) for broiler intestinal morphology. Therefore, dietary added with DDGS can improve intestinal morphology, up till 15% DDGS concentrations were considered to be suitable for broiler starter and grower.

Youssef *et al.* (2013) conducted a study to evaluate the Distillers Dried Grains with Soluble (DDGS) as feed ingredients for broilers. It is a valuable source of energy, protein, water soluble vitamins and minerals in poultry diet. The present study was carried out during summer to study the impact of feeding graded levels of DDGS on broiler performance, hematological and histological parameters. A total number of 160 day-old, unsexed Cobb broiler chicks were randomly divided into four groups. Birds of each group were subdivided into four replicate of ten birds each. The different experimental diets (starter, grower and finisher contain DDGS at levels of (0, 5, 10 and 15%). Diets were iso-caloric and iso-nitrogenous. Feed intake, body weight gain, feed conversion ratio, carcass characteristics were recorded. The result showed that DDGS significantly ($P \leq 0.05$) affected productive performance, carcass characteristics and Ht%. DDGS inclusion in the diet significantly ($P \leq 0.05$) decreased glucose concentration, H/L ratio and pH value and improved the histology of small intestine, liver and pancreas. This study concluded that the graded levels of DDGS upto 15% showed no adverse effects when used in broiler starter, grower and finisher diets on growth performance and carcass characteristics. The hematological and histological parameters were improved suggesting that DDGS can be used upto 15% in broiler diets.

Thus, while reviewing the literature, it was found that DDGS of maize, jowar and wheat can act as acceptable feed ingredient in broiler diets upto 15%. Therefore, an experiment was designed by using Rice Distillers Dried Grains with Solubles (RDDGS) at different levels in broiler diets to evaluate its effect on performance of broilers.

3. MATERIAL AND METHODS

Feed is the major input in the poultry production constituting about 70-75% of total cost of production. Maize and Soy DOC are the two sources of energy and protein respectively in the feed of poultry. But there is a gap between demand and supply of these ingredients which leads to increase in the cost of these ingredients. Hence, there is a need of finding some alternative source for energy as well as protein to decrease the cost of production. Nowdays, due to increase in the production of ethanol, millions of tons of fermented residue is available, which is commonly known as DDGS (Distillers Dried Grains with solubles). It is a product available from distilleries where maize or other cereals like jowar, wheat or rice is used. Tremendous amount of work has been done in a short period of time to determine the suitability of this residue obtained from using various cereals. However, very little work has been carried out on use of DDGS available upon fermentation of rice. Hence, in order to study the effects of RDDGS this experiment is designed.

The experiment was conducted at the Department of Poultry Science, Bombay Veterinary College, Goregaon, Mumbai - 400 063, on 400 day-old broiler chicks of 'Cobb 400' strain purchased from M/s. Premium Chick Feeds Pvt. Ltd., At- Poynad, Taluka- Alibag, District- Raigad. The trial was conducted for a period of six weeks. The objectives of the study were:

1. To study the effect of different levels of Rice Distillers Dried Grains with Solubles (RDDGS) on the performance of broilers.
2. To study the economics of broiler production by using different levels of RDDGS in the feed.

Experimental Design:

The day-old broiler chicks, immediately after arrival, were randomly divided into four equal groups of 100 birds each. Each group was further subdivided into four replicates of 25 birds each. All the birds were reared on deep litter system under ideal and identical managemental and environmental

conditions. The birds received pre-starter, starter and finisher feed. The groups were subjected to one of the following treatments:

Group A- Control diet using Corn – Soybean DOC diet.

Group B- Diet containing Rice Distillers Dried Grains with Solubles (RDDGS)* at 5% in total diet replacing Soybean DOC and oil.

Group C- Diet containing Rice Distillers Dried Grains with Solubles (RDDGS)* at 10% in total diet replacing Soybean DOC and oil.

Group D- Diet containing Rice Distillers Dried Grains with Solubles (RDDGS)* at 15% in total diet replacing Soybean DOC and oil.

* It was presumed that RDDGS contained 47 % CP and 3500 Kcal/kg of ME.

Feed:

The required quantities of feed ingredients used in the present experiment were procured from M/s. Alka Green farms Pvt. Ltd., At- Bhadane, Taluka - Murbad, District - Thane. The prestarter, starter and finisher diets for all the groups were formulated as shown in Tables 1, 2 and 3 respectively. The pre-starter mash was offered for first week, starter mash was offered up to end of third week and finisher mash was offered thereafter upto sixth week. All the diets were isocaloric and isonitrogenous.

Proximate Analysis of Experimental Mashes:

The proximate analysis of the experimental mashes was carried out at M/s Hi-Tek Associates, Wakdewadi, Pune – Mumbai Road, Pune - 411005 as per A. O. A. C. (1995) methods of analysis. The percent proximate composition of pre-starter, starter and finisher mashes is presented in Tables 4, 5, and 6 respectively.The percent proximate composition of RDDGS used in the experiment is presented in Table 7.

Housing and Management:

The birds were reared on deep litter system of housing. All the groups were provided with similar environmental and managemental conditions throughout the experimental period. An identical and adequate

Table: 1 Formulation for prestarter diets.

Ingredients	Group A	Group B	Group C	Group D
Maize	53.60	54.61	55.61	54.01
Deoiled Rice Bran	0	0	0	1.86
Oil	1.92	1.00	0.08	0
Soy DOC	40.40	35.19	30.00	24.74
Rice Distillers Grains with Soluble	0	5.00	10.00	15.00
Trace Mineral Mixture	0.10	0.10	0.10	0.10
Dicalcium Phosphate	1.80	1.85	1.90	1.90
Limestone Powder	1.40	1.40	1.40	1.40
Salt	0.30	0.30	0.30	0.30
Vitamin Premix	0.01	0.01	0.01	0.01
Choline Chloride	0.05	0.05	0.05	0.05
Anticoccidial	0.05	0.05	0.05	0.05
DL-Methionine	0.21	0.20	0.18	0.17
L-Lysine	0.11	0.19	0.27	0.36
Toxin Binder	0.05	0.05	0.05	0.05
Total	**100.00**	**100.00**	**100.00**	**100.00**

Table: 2 Formulation for starter diets.

Ingredients	**Group A**	**Group B**	**Group C**	**Group D**
Maize	54.70	55.71	56.71	57.71
Deoiled Rice Bran	0	0	0	0
Oil	3.30	2.38	1.46	0.54
Soy DOC	38.00	32.80	27.60	22.40
Rice Distillers Grains with Soluble	0	5.00	10.00	15.00
Trace Mineral Mixture	0.10	0.10	0.10	0.10
Dicalcium Phosphate	1.85	1.85	1.90	1.95
Limestone Powder	1.35	1.38	1.38	1.38
Salt	0.30	0.30	0.30	0.30
Vitamin Premix	0.01	0.01	0.01	0.01
Choline Chloride	0.05	0.05	0.05	0.05
Anticoccidial	0.05	0.05	0.05	0.05
DL-Methionine	0.17	0.16	0.15	0.14
L-Lysine	0.07	0.16	0.24	0.32
Toxin Binder	0.05	0.05	0.05	0.05
Total	**100.00**	**100.00**	**100.00**	**100.00**

Table: 3 Formulation for finisher diets.

Ingredients	**Group A**	**Group B**	**Group C**	**Group D**
Maize	59.25	60.37	61.36	62.32
Deoiled Rice Bran	0	0	0	0
Oil	4.20	3.24	2.33	1.42
Soy DOC	32.60	27.38	22.17	17.00
Rice Distillers Grains with Soluble	0	5.00	10.00	15.00
Trace Mineral Mixture	0.10	0.10	0.10	0.10
Dicalcium Phosphate	1.87	1.90	1.95	2.00
Limestone Powder	1.38	1.38	1.38	1.38
Salt	0.30	0.30	0.30	0.30
Vitamin Premix	0.01	0.01	0.01	0.01
Choline Chloride	0.05	0.05	0.05	0.05
Anticoccidial	0.05	0.05	0.05	0.05
DL-Methionine	0.14	0.13	0.12	0.11
L-Lysine	0	0.04	0.13	0.21
Toxin Binder	0.05	0.05	0.05	0.05
Total	**100.00**	**100.00**	**100.00**	**100.00**

Table : 4 Proximate composition (% DMB) of pre-starter mashes.

Nutrients	Group A	Group B	Group C	Group D
Moisture	12.94	12.41	12.88	12.55
Crude protein %	25.99	27.16	26.64	25.88
Ether extract %	4.84	4.34	3.48	3.68
Crude fiber %	3.89	3.32	4.24	3.56
Total ash %	6.88	6.74	6.38	6.66
Nitrogen free extract %	58.40	58.44	59.26	60.22

Table : 5 Proximate composition (% DMB) of starter mashes.

Nutrients	Group A	Group B	Group C	Group D
Moisture	10.09	10.40	10.14	10.34
Crude protein %	23.88	23.31	25.18	24.58
Ether extract %	5.04	6.55	5.30	4.82
Crude fiber %	3.31	3.58	3.86	3.70
Total ash %	7.65	7.09	6.67	6.55
Nitrogen free extract %	60.12	59.47	58.99	60.35

Table : 6 Proximate composition (% DMB) of finisher mashes.

Nutrients	Group A	Group B	Group C	Group D
Moisture	10.40	10.21	10.78	9.85
Crude protein %	21.37	21.97	21.46	21.24
Ether extract %	9.04	7.53	7.06	6.03
Crude fiber %	3.42	3.59	3.40	3.36
Total ash %	6.87	6.23	6.96	6.51
Nitrogen free extract	59.30	60.68	61.12	62.86

Table : 7 Proximate composition (% DMB) of Rice Distillers Dried Grains with Solubles (RDDGS).

Nutrients	RDDGS
Moisture	11.80
Crude protein %	49.75
Ether extract %	2.40
Crude fiber %	5.43
Total ash %	4.29
Nitrogen free extract %	38.13

feeding and watering space was provided to all the birds throughout the experimental period. The brooding was carried out for first three weeks by using electric bulbs.

The group feeding practice was followed throughout the experimental period. Weighed quantity of feed was offered to each group. The group-wise refusal was weighed next morning to arrive at actual daily feed consumption of each group. The birds were given free access to fresh, clean and wholesome drinking water throughout the experimental period.

Medication and Vaccination:

Immediately after arrival, chicks were provided with antistress elements through drinking water. The immunization against Ranikhet Disease (B1 strain) and Infectious Bursal Disease (IBD) (Intermediate strain) was carried out on 7^{th} and 14^{th} day, respectively, followed by booster doses on 21^{st} day (B1) and 28^{th} day (IBD) through drinking water.

Parameters Studied During Experiment:

During the experiment following parameters were studied

1. Weekly average live weights
2. Weekly average gain in weights
3. Daily gain in weights
4. Weekly average feed consumption
5. Weekly average feed conversion ratio (FCR)
6. Weekly mortality
7. Economics of production

The live weights of day-old chicks were recorded on arrival and thereafter at weekly intervals. From these data, average weekly live weights and average weekly gain in weights were calculated for each group. The daily live weights of two birds were recorded daily from each replicate from all groups and the daily gain was calculated. The records maintained for daily feed consumption were used to calculate average weekly feed consumption. The week wise and overall feed conversion ratios of various groups were calculated. The daily record of mortality, if any, during the experimental period was also maintained.

Economics of Production:

The economics of broiler production was calculated at the end of sixth week considering feed cost as the only variable. The feed cost per kilogram was calculated by considering prevailing prices of the feed ingredients. The sale price was considered as ₹ 70 per kg live weight.

Statistical Analysis:

All the data obtained were subjected to statistical analysis as per Snedecor and Cochran (1998), by using randomized block design.

4. RESULT AND DISCUSSION

The present experiment was conducted to study the effect of feeding different levels of Rice Distillers Dried Grains with Solubles (RDDGS) on performance of broilers. The trial was conducted on four hundred Cobb-400 broiler birds for the period of six weeks. The day-old broiler chicks, immediately after arrival, were randomly divided into four equal groups of 100 birds each viz., A to D. Each group was further subdivided into four replicates of 25 birds each. Group A received control diet, groups B, C and D received diet containing Rice Distillers Dried Grains with Solubles (RDDGS) replacing Soybean deoiled cake (DOC) and oil at 5, 10 and 15% levels, respectively. All the diets were isocaloric and isonitrogenous. The performance of all the groups was compared with respect to the parameters studied in the experiment.

Live weights:

The data pertaining to average weekly live weights of the birds from day-old to six weeks of age from different groups are presented in Table 8. The same is depicted graphically in Figure 1. It is observed from the table that average initial live weights of the birds at day-old stage for groups A to D were 43.03, 42.85, 43.15 and 42.30 g, respectively. The corresponding average live weights at the end of six weeks were 2493.86, 2259.54, 2077.91 and 1990.41 g. From the data, it is revealed that the birds from group A receiving control diet recorded the highest live weights at the end of sixth week, followed by the birds from groups B, C and D. The birds from the group D receiving the diet containing Rice Distillers Dried Grains with Solubles (RDDGS) at 15% level replacing Soybean DOC and oil recorded the lowest live weights among all treatments including control.

The data pertaining to average weekly live weights from different replicates within the groups were compared. It was noted that the differences within the replicates were statistically non-significant. Hence, the data from replicates were pooled and then subjected to statistical analysis. The statistical analysis of data pertaining to average weekly live weights is

Table: 8 Average weekly live weights (g) of birds

Weeks	Groups			
	A	**B**	**C**	**D**
	Control	**Rice DDGS @ 5%**	**Rice DDGS @ 10%**	**Rice DDGS @ 15%**
Day-old	43.03	42.85	43.15	42.30
I	149.82	147.66	150.61	143.40
II	401.38	387.80	381.16	348.93
III	799.71	766.55	725.82	671.12
IV	1356.31	1260.89	1173.76	1073.08
V	1929.29	1736.69	1609.92	1520.35
VI	2493.86	2259.54	2077.91	1990.41
Mean	**1024.77^{a}**	**943.14^{ab}**	**880.33^{bc}**	**827.08^{c}**

Note: Those means with at least one common superscript do not differ significantly**.**

CD for treatments 5% = 100.99 g

Table : 9 ANOVA for live weights

Sources	DF	SS	MSS	F
Treatments	3	151998.99	50666.33	6.26**
Weeks	6	16145570.34	2690928.39	332.75**
Error	18	145565.27	8086.96	
Total	27	16443134.60		

** - Significant at 1%.

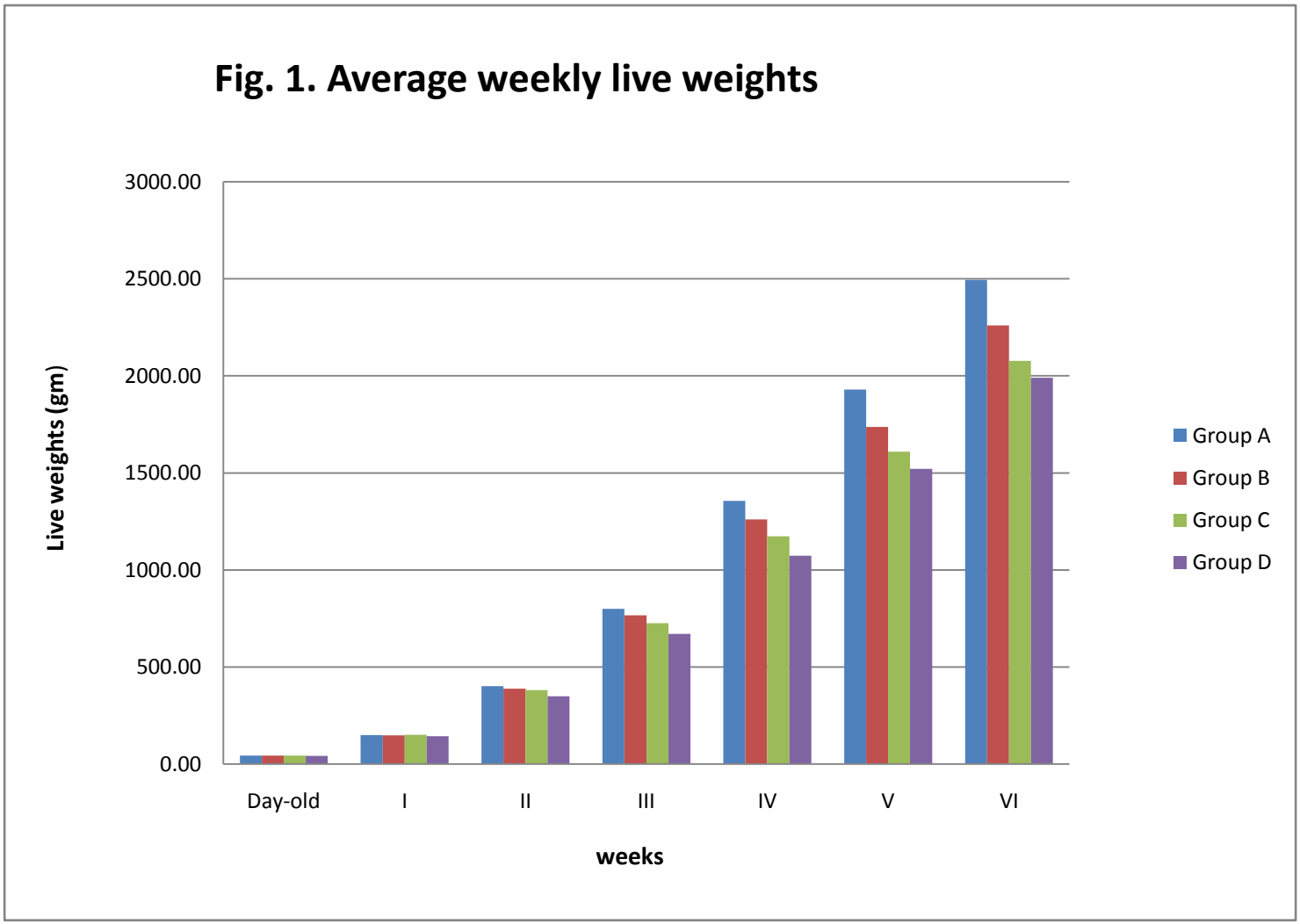


Fig. 1. Average weekly live weights
Live weights (gm)
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Day-old
I
II
III
IV
V
VI
weeks
Group A
Group B
Group C
Group D

presented in Table 9. The statistical analysis of data revealed that, various treatments had significant (P≤ 0.01) effect on average weekly live weights of birds. Further comparison of treatments means indicated that the average weekly live weights of birds from group A receiving control diet was significantly higher than all other treatment groups, except group B. The differences in average weekly live weights of birds from group B receiving RDDGS at 5% level replacing soybean DOC and oil and the control group were statistically non-significant. Among the treatment groups, the differences in average weekly live weights of birds from groups B and C were statistically non-significant. Similarly the differences in average weekly live weights of birds from groups C and D were statistically non-significant. However, the average weekly live weights of birds from groups B receiving RDDGS at 5% levels replacing soybean DOC and oil were significantly higher than the live weights of birds from group D receiving RDDGS at 15% level.

Thus, it may be concluded that in general, the diet containing Rice Distillers Dried Grains with Solubles (RDDGS) at various levels in the diet replacing Soybean DOC and oil have negative effect on average live weights of birds. Further, as the level of inclusion of RDDGS increased the live weights of birds reduced. Hence, use of RDDGS in broiler diets is not recommended as far as the response in terms of the growth of the birds.

The finding of the present study are in agreement with the finding of Shalash *et al*. (2009a) who reported that there is significant reduction in body weight with increasing levels of DDGS. However, Wang *et al*. (2008b) had reported that birds fed with 15% DDGS did not differ significantly with respect to body weights than control. This observation does not corroborate with the findings in the present study.

Gain in weights:

The data pertaining to average weekly gain in weights of the birds from different groups from first to sixth week of age are presented in Table 10. The same is depicted graphically in Figure 2. It is seen from the table that total gain in weights of broilers from groups A to D during six weeks were 2450.83,

2216.69, 2034.76 and 1948.11 g, respectively. From the data it is revealed that, the birds from the group from group A receiving control diet recorded the highest gain in weights at the end of sixth week, followed by the birds from groups B, C and D. The birds from the group D receiving the diet containing RDDGS at 15% in total diet replacing Soybean DOC and oil recorded the lowest gain in weight at the end of six weeks among all the treatments including control.

The data pertaining to average weekly gain in weights from different replicates within the groups were compared. It was noted that the differences within the replicates were statistically non significant. Hence, the data from replicates were pooled and then subjected to statistical analysis. The same is presented in Table 11. The statistical analysis of data revealed that, various treatments had significant ($P \leq 0.01$) effect on average weekly gain in weights of birds. Further comparison of the treatment means revealed that all the treatment groups receiving RDDGS at 5, 10 and 15% levels replacing Soybean DOC and oil recorded significantly lower gain in weights than control. The differences in average weekly gain in weights amongs the groups B and C receiving RDDGS at 5 and 10% levels, respectively, were statistically non-significant. Similarly, the differences in weekly gain in weights of birds among groups C and D were statistically non-significant. However, the birds from group D recorded significantly lower gain in weight as compared to birds from B receiving diet with RDDGS at 5% level.

Therefore, it may be concluded that replacing Soybean DOC and oil with RDDGS negatively affects the gain in weights of broilers.

The finding of the present study are in agreement with the finding of Lumpkins *et al.* (2004), who reported significant reduction in body weight gain with increasing levels of DDGS. However, Youssef *et al*. (2013) reported that birds fed with 15% DDGS had no adverse effects on body weight gain. This observation does not corroborate with the finding of the present study.

Table : 10 Average weekly gain in weights (g)

Weeks	Groups			
	A	B	C	D
	Control	RDDGS @ 5%	RDDGS @ 10%	RDDGS @ 15%
I	106.79	104.81	107.46	101.10
II	251.57	240.14	230.55	205.53
III	398.33	378.75	344.66	322.19
IV	556.60	494.34	447.94	401.96
V	572.98	475.80	436.17	447.28
VI	564.57	522.85	467.99	470.05
Total	**2450.83**	**2216.69**	**2034.76**	**1948.11**
Mean	**408.47^{a}**	**369.45^{b}**	**339.13^{bc}**	**324.68^{c}**

Note: Those means with at least one common superscript do not differ significantly**.**

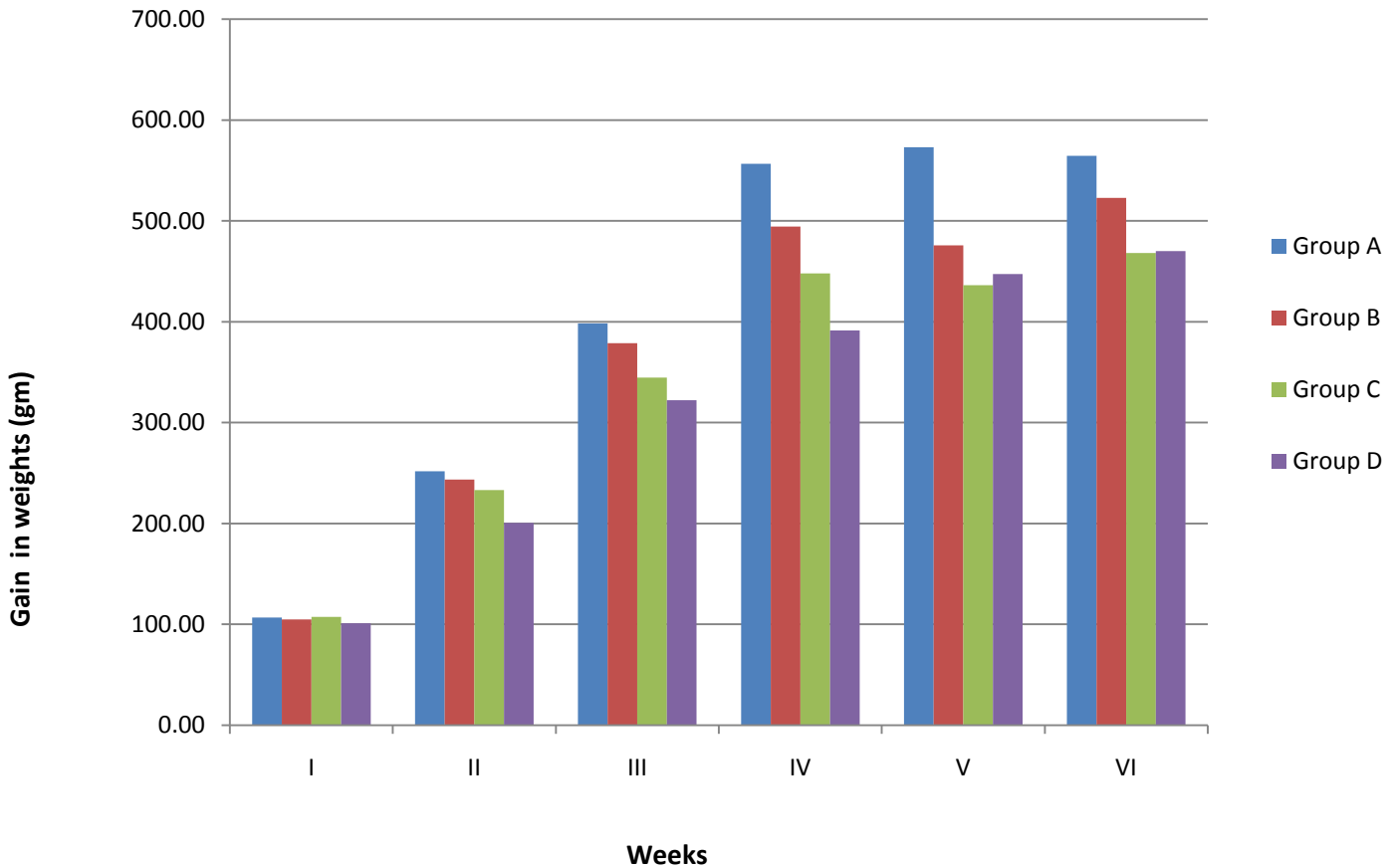
CD for treatments at 5% = 33.47 g

Table : 11 ANOVA for gain in weight

Sources	DF	SS	MSS	F
Treatments	3	24725.78	8241.93	11.14**
Weeks	5	524964.57	104992.91	141.87**
Error	15	11101.16	740.08	
Total	23	560791.51		

** - Significant at 1%.

Fig. 2. Average weekly gain in weights



Daily gain in weights:

The data pertaining to average daily gain in weights of the birds from different groups from day-old to forty two days of age are presented in Table 12. It is seen from the table that average daily gain in weights of broilers from groups A to D upto six weeks were 61.48, 51.88, 49.65 and 48.23 g, respectively. From the data it is revealed that, the birds from the group A receiving control diet recorded the highest daily gain in weight at the end of sixth week, followed by the birds from groups B, C and D. The birds from the group D receiving the diet containing Rice Distillers Dried Grains with Solubles (RDDGS) at 15% in total diet replacing Soybean DOC and oil recorded the lowest daily gain in weight among all treatments including control. This trend is similar to the average weekly live weights of birds from different groups.

Table : 12 Average daily gain in weights (g)

Weeks	Groups			
	A	**B**	**C**	**D**
	Control	**RDDGS @ 5%**	**RDDGS @ 10%**	**RDDGS @ 15%**
Mean	61.48	51.88	49.65	48.23

The present findings were in agreement with Abdel-Raheem *et al.* (2011) who reported that the there was decrease in average daily gain in broilers fed with 12% of DDGS than control diet. However, Oryschak *et al.* (2010b) reported that there was no adverse effect of including corn and wheat DDGS at up to 10% of diet on average daily weight gain.

Feed consumption:

Average weekly feed consumption of the birds from groups A to D, from day-old to six weeks of age are presented in Table 13. The same are depicted graphically in Figure 3. The total feed consumption per bird during six weeks period for groups A to D was 4536.16, 4317.10, 3913.59 and 3899.42 g, respectively. The corresponding average weekly feed consumption of birds

from groups A to D were 756.03, 719.52, 652.27 and 649.90 g. From the data it is revealed that, the birds from the group A receiving control diet recorded the highest feed consumption at the end of sixth week, followed by the birds from groups B, C and D. The birds from the group D receiving diet containing Rice Distillers Dried Grains with Solubles (RDDGS) at 15% in total diet replacing Soybean DOC and oil recorded the lowest feed consumption among all treatments including control.

The data pertaining to average weekly feed consumption from different replicates within the groups were compared. It was noted that the differences within replicates were statistically non-significant. Hence, the data from replicates were pooled and then subjected to statistical analysis. The statistical analysis of data pertaining to average weekly feed consumption is presented in Table 14. The statistical analysis of data revealed that, various treatments had significant ($P \leq 0.01$) effect on average weekly feed consumption of birds. Further comparison of treatment means indicated that the average weekly feed consumption of birds from group A receiving control diet was significantly higher than all the treatment groups. Among the treatment groups, the feed consumption of birds from group B receiving RDDGS at 5% level was significantly higher than the feed consumption of birds from groups C and D. However, the differences in feed consumption of birds from groups C and D receiving RDDGS at 10 and 15% were statistically non-significant.

Thus, it may be concluded that inclusion of Rice Distillers Dried Grains with Solubles (RDDGS) in broiler diets significantly affects the feed consumption of birds. Moreover, as the level of inclusion of RDDGS increases from 5 to 15% in diet, the feed consumption goes on reducing significantly. This reduction in feed consumption also has reflected in corresponding lower live weights and gain in weights of birds. It may be due to lower palatability and digestibility of nutrients from RDDGS. Moreover, it was also observed during the trial that due to fine texture of RDDGS, the birds were not preferring the RDDGS included in the diet at various levels. Thus, as the inclusion of RDDGS was increased, the birds consumed lesser quantity of feed due to powdery nature.

Table : 13 Average weekly feed consumption (g) of birds

Weeks	Groups			
	A	**B**	**C**	**D**
	Control	**Rice DDGS @ 5%**	**Rice DDGS @ 10%**	**Rice DDGS @ 15%**
I	131.25	128.25	124.91	131.43
II	394.07	398.10	361.45	361.25
III	622.72	627.43	570.94	557.73
IV	972.71	915.17	822.87	819.16
V	1170.18	1060.57	946.40	962.12
VI	1245.23	1187.59	1087.03	1067.74
Total	**4536.16**	**4317.10**	**3913.59**	**3899.42**
Mean	**756.03[a]**	**719.52[b]**	**652.27[c]**	**649.90[c]**

Note: Those means with a least one comman superscript do not differ significantly**.**

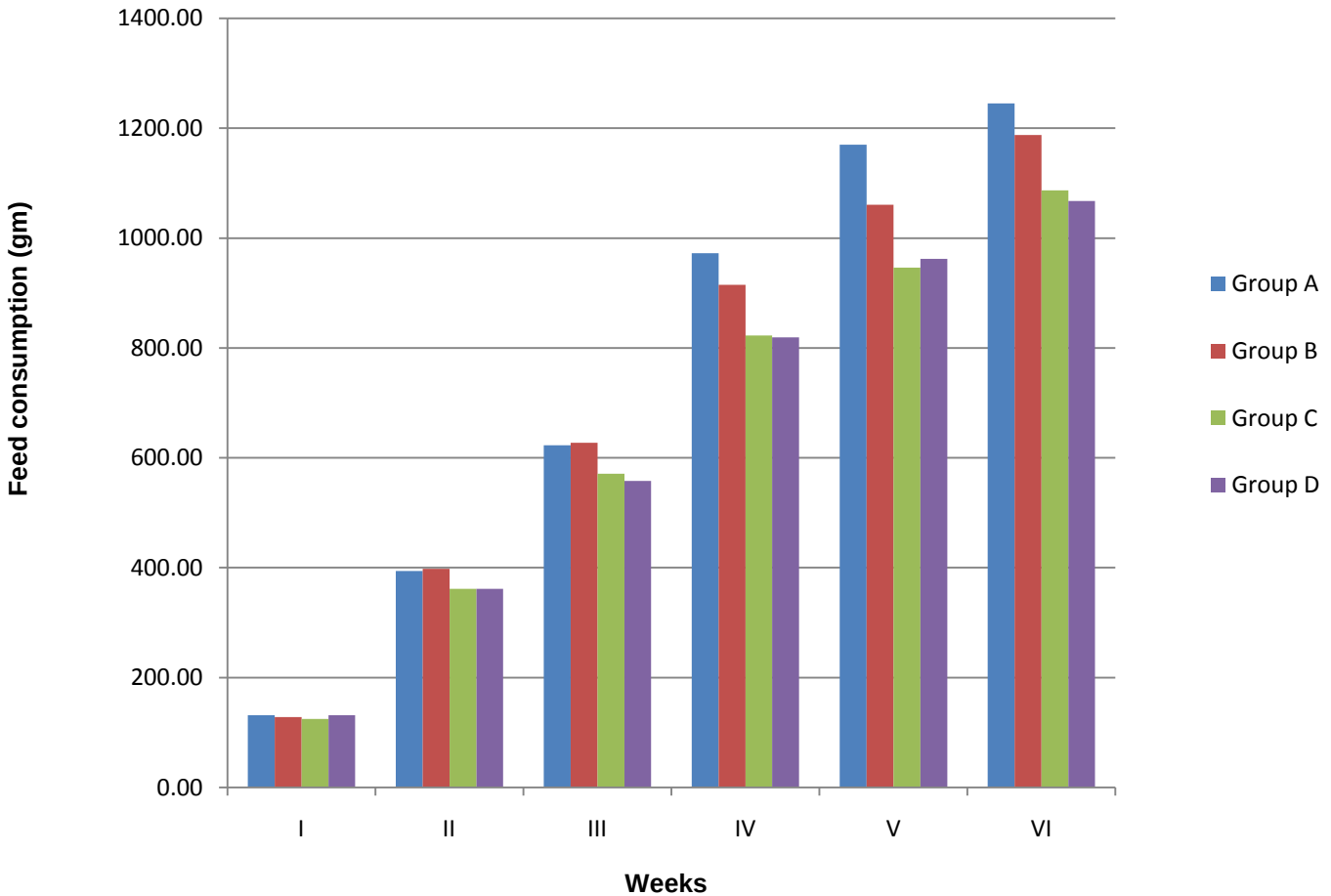
CD for treatments at 5% = 51.19 g

Table: 14 ANOVA for feed consumption

Sources	DF	SS	MSS	F
Treatments	3	49103.08	16367.69	9.45**
Weeks	5	3141302.56	628260.51	362.95**
Error	15	25964.41	1730.96	
Total	23	3216370.05		

** - Significant at 1%.

Fig. 3. Average weekly feed consumption



The finding of the present study is in agreement with the findings of Hussaini *et al.* (2010), who reported that there is reduction in feed consumption by feeding 15% Brewers Spent Grain (BSG) in comparison to control group. Aghabeig *et al.* (2013), also reported that the feed consumption in control 0% BSG and 5% BSG groups was greater than 10, 15, 20 and 25% BSG groups. However, Abdel-Raheem *et al.* (2011) reported that the birds receiving diet with inclusion of 0, 6 and 12% of DDGS had no significant difference with respect to feed consumption. This observation is not in agreement with findings of present study.

Feed conversion ratio:

Average weekly feed conversion ratios in term of feed intake per unit gain in weight for groups A to D, from day-old to six weeks of age are presented in Table 15. The same data are also depicted in Figure 4. It is noted from the table that average feed conversion ratio for birds from groups A to D were 1.73, 1.81, 1.79 and 1.87, respectively. The corresponding cumulative feed conversion ratios for birds from groups A to D were 1.85, 1.95, 1.92 and 2.00. It was observed that control group recorded better FCR than all other treatments. Among the treatment groups, the birds from group C recorded better FCR than the birds from groups B and D. The feed conversion ratio of birds from control group was marginally better than the birds from group C. The FCR for the birds from group D receiving the diet containing RDDGS at 15% in total diet replacing Soybean Doc and oil was the poorest among all the treatment groups including control.

The data pertaining to average weekly feed conversion ratio from different replicates within the groups were compared. It was noted that the differences within the replicates were statistically non-significant. Hence, the data from replicates were pooled and then subjected to statistical analysis. The statistical analysis of the data pertaining to average weekly feed conversion ratio is presented in Table 16. The statistical analysis of the data

Table : 15 Average weekly feed conversion ratio of birds

Weeks	Groups			
	A	B	C	D
	Control	Rice DDGS @ 5%	Rice DDGS @ 10%	Rice DDGS @ 15%
I	1.23	1.22	1.16	1.30
II	1.57	1.66	1.57	1.76
III	1.56	1.66	1.66	1.73
IV	1.75	1.85	1.84	2.09
V	2.04	2.23	2.17	2.15
VI	2.21	2.27	2.32	2.27
Mean	**1.73^{a}**	**1.81^{bc}**	**1.79^{ab}**	**1.88^{c}**
Cumulative FCR	**1.85**	**1.95**	**1.92**	**2.00**

Note: Those means with a least one comman superscript do not differ significantly.

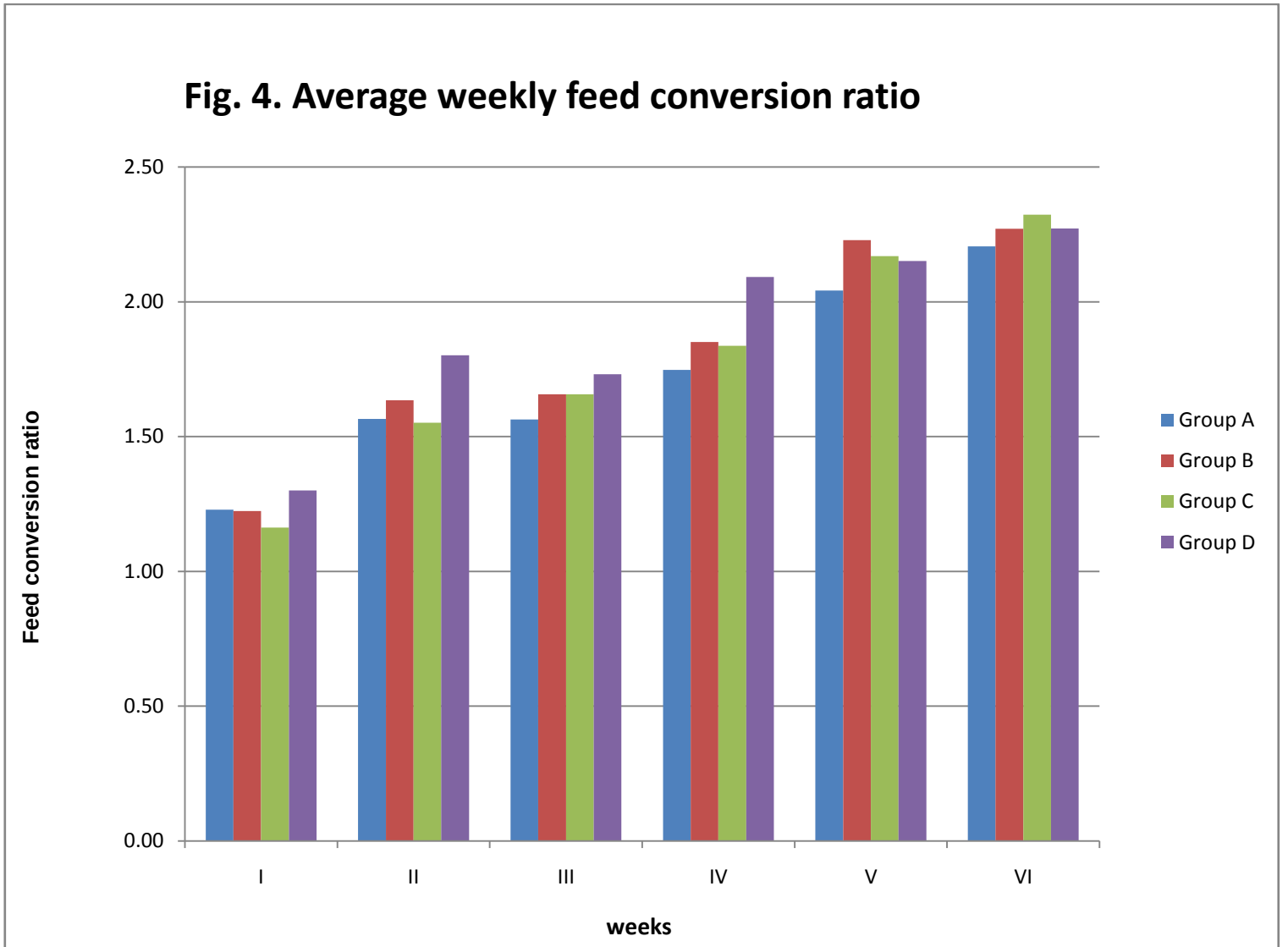
CD for treatments at 5% = 0.07

Table : 16 ANOVA for feed conversion ratio

Sources	DF	SS	MSS	F
Treatments	3	0.069	0.023	7.67**
Weeks	5	2.877	0.575	191.67**
Error	15	0.050	0.003	
Total	23	2.996		

** - Significant at 1%.

Fig. 4. Average weekly feed conversion ratio



revealed that, various treatments had significant ($P \leq 0.01$) effect on average weekly feed conversion ratios of birds. Further comparison of treatment means revealed that the birds from control group recorded significantly better feed conversion ratio than the birds from all treatment groups except group C receiving diet with 10% RDDGS replacing soybean DOC and oil. The differences in feed conversion ratio of birds from groups B and C receiving RDDGS at 5 and 10% levels, were statistically non-significant. Similarly, the birds from group D recorded non-significant differences with respect to feed conversion ratio with the birds from group B. However, the birds from group D receiving RDDGS at 15% level recorded significantly poorer feed conversion ratio than treatment group C.

The results of present study are in agreement with findings of Lumpkins *et al.* (2004), who reported that there was significant difference in feed conversion ratio when broilers were fed diets with 18% DDGS and leads to poor FCR. However, Wang *et al.* (2008b) reported that the birds fed with 15% DDGS did not show significant change in feed conversion ratio than control diet. Noll (2004) also reported that the birds fed with DDGS upto 12% did not report any significant change in feed conversion ratio as compared to control corn-soybean meat-meal diets. These observations do not corroborate with the findings of the present study.

Mortality:

The data pertaining to mortality during the entire experimental period of six weeks from groups A to D are presented in Table 17. The same data are also depicted in Figure 5. From the table, it is observed that mortality in groups A to D were 4, 4, 1 and 2 birds, respectively. The corresponding mortality percentages for groups A to D were 4, 4, 1 and 2 %. The total mortality in all the groups was well within limits of the average mortality on the farm under field conditions. Upon post-mortem, none of the dead birds showed any specific lesion suggestive of any specific disease or disease condition. Hence, it is concluded that use of Rice Distillers Dried Grains with Solubles (RDDGS) at different levels had no ill effect on the health of the broilers.

Fig. 5. Weekly mortality

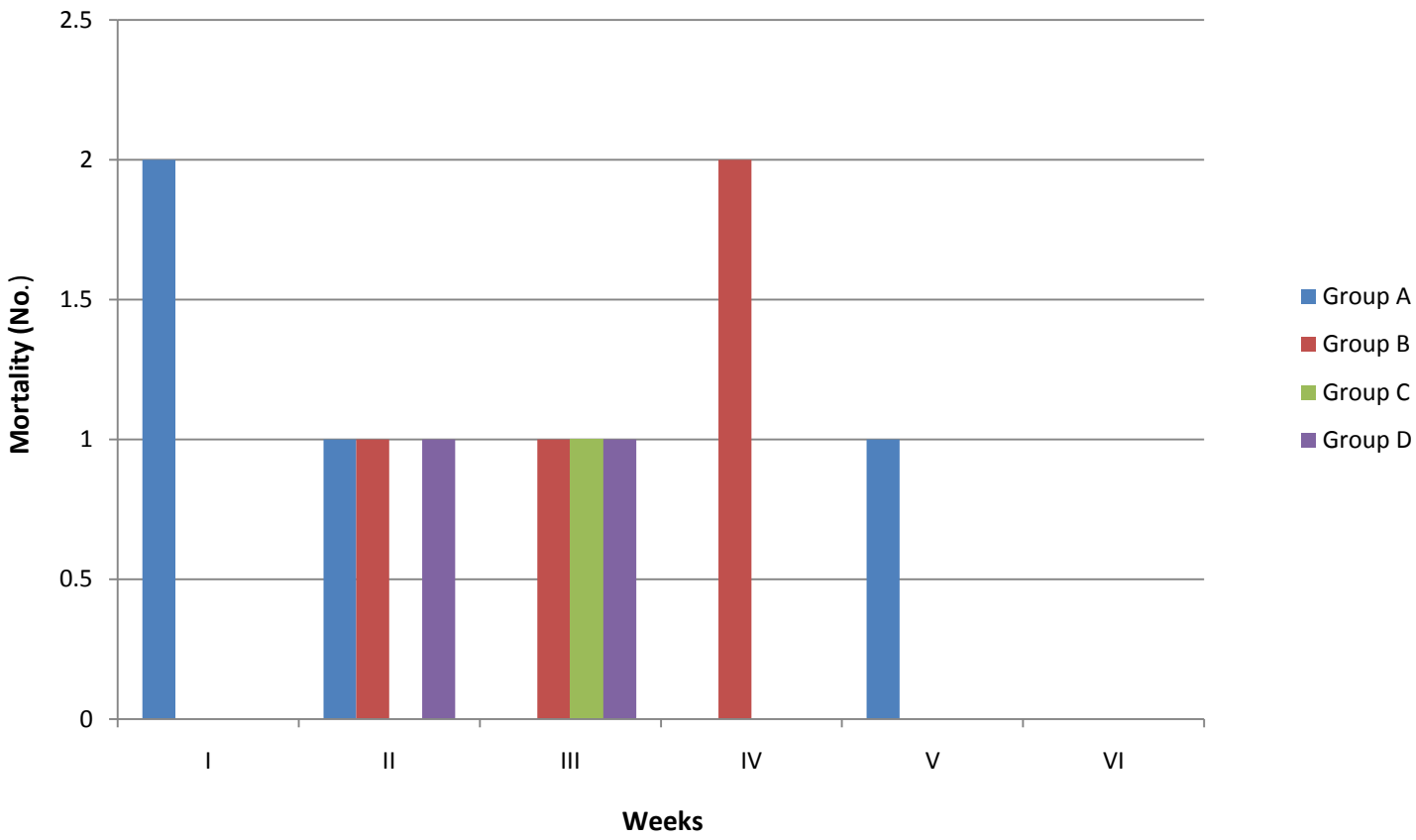


Table : 17 Weekly mortality of birds (No.)

Weeks	Groups			
	A	B	C	D
	Control	Rice DDGS @ 5%	Rice DDGS @ 10%	Rice DDGS @ 15%
I	2	0	0	0
II	1	1	0	1
III	0	1	1	1
IV	0	2	0	0
V	1	0	0	0
VI	0	0	0	0
Total	**4**	**4**	**1**	**2**
Percentage	**4**	**4**	**1**	**2**

Economics of production:

During the study, the economics of broiler production from different groups was calculated. The same is presented in Table 18. The economics of broiler production of trial was worked out considering the prevailing costs and prices of input and output in the market.

The cost of day-old chicks, feed, medication, vaccination, litter, labour and overheads were considered while calculating the cost of production. From table it is observed that net cost of production per bird was ₹ 160.47, 145.49, 127.45 and 119.94 for the birds from groups A, B, C and D, respectively. It is observed that the group D receiving diet containing Rice Distillers Dried Grains with Solubles (RDDGS) at 15% in total diet replacing Soybean DOC and oil had the lowest cost of production on per kg basis. The broilers were sold at ₹ 70 per kg on live weight basis. The net profit per bird was 14.10, 12.68, 18.00 and 19.39 for groups A to D, respectively. The corresponding net profit per kg live weight was 5.65, 5.61, 8.66 and 9.74 for groups A to D. The birds from groups D recorded the highest net profit per kg followed by the birds from groups C, A and B, respectively.

Table : 18 Economics of production at the end of sixth week

Parameters	Groups			
	A	B	C	D
Chick cost (₹)	18.00	18.00	18.00	18.00
Feed intake (g)				
1. Prestarter	150	150	150	150
2. Starter	1000	1000	1000	1000
3. Finisher	3386.16	3167.10	2763.59	2749.42
Feed price per kg (₹)				
1. Prestarter	30.66	28.78	26.87	25.33
2. Starter	30.35	28.45	26.52	24.71
3. Finisher	28.80	26.75	24.93	23.07
Feed cost per bird (₹)				
1. Prestarter	4.60	4.32	4.03	3.80
2. Starter	30.35	28.45	26.52	24.71
3. Finisher	97.52	84.72	68.90	63.43
Total feed cost per bird (₹)	132.47	117.49	99.45	91.94
Miscellaneous cost per bird (₹)	10.00	10.00	10.00	10.00
Net cost of production per bird (₹)	160.47	145.49	127.45	119.94
Body weight at the end of 6^{th} week (g)	2493.86	2259.54	2077.91	1990.41
Return on sale @ ₹70 per kg body weight	174.57	158.17	145.45	139.33
Net profit per bird (₹)	**14.10**	**12.68**	**18.00**	**19.39**
Net profit per kg (₹)	**5.65**	**5.61**	**8.66**	**9.74**

* – Miscellaneous cost includes cost of medicines, vaccines, litter, labour and other overheads

Overall performance:

The overall performance of broilers from different groups during trial is presented in Table 19.

Table : 19 Overall performance of birds during six weeks

Parameters	Groups			
	A	B	C	D
Initial weight (g)	43.03	42.85	43.15	42.30
Final weight (g)	2493.86^{a}	2259.54^{ab}	2077.91^{bc}	1990.41^{c}
Total gain in weight (g)	2450.83^{a}	2216.69^{b}	2034.76^{bc}	1948.11^{c}
Average weekly gain in weight (g)	408.47^{a}	369.45^{b}	339.13^{bc}	324.68^{c}
Total feed consumption (g)	4536.16^{a}	4317.10^{b}	3913.59^{c}	3899.42^{c}
Cumulative feed conversion ratio	1.85^{a}	1.95b	1.92^{ab}	2.00c
Mortality (%)	4	4	1	2
Net profit per bird (₹)	14.10	12.68	18.01	19.39
Net profit per kg (₹)	5.65	5.61	8.67	9.74

Note : Those means with atleast one common superscript in a row do not differ significantly.

The overall performance of the birds during six weeks indicated that use of RDDGS is not useful for obtaining comparable performance from the birds with respect to growth parameters when compared with birds from control group. Further, it was also observed that increase in the level of incorporation of RDDGS lead to reduction in productive performance. Similarly, as the level of incorporation of RDDGS increased, it caused reduction in feed consumption and deterioration of feed conversion ratio. The use of RDDGS had no ill effect on health of birds at any level of inclusion used in the trial. However, the profit margins increased upon increase in the level of

incorporation of RDDGS due to reduction in the price of the feed. Hence, it is suggested that the use of RDDGS may be done with caution as it doesn't have beneficial effect on growth performance but, has an effect in reducing feed price thereby increasing the profit margins. Further, the selling price of birds will decide the usage in the poultry industry.

5. SUMMARY AND CONCLUSIONS

The present experiment was conducted to study the effect of feeding different levels of Rice Distillers Dried Grains with Solubles (RDDGS) on performance of broilers. The trial was conducted on four hundred Cobb-400 broiler chicks for the period of six weeks. The day-old broiler chicks, immediately after arrival, were randomly divided into four equal groups of 100 birds each viz., A to D. Each group was further subdivided into four replicates of 25 birds each. Group A received control diet. Group B received diet containing RDDGS at 5% in total diet replacing Soybean DOC and oil, Group C received diet containing RDDGS at 10% in total diet replacing Soybean DOC and oil and Group D received diet containing RDDGS at 15% in total diet replacing Soybean DOC and oil. All the diets were isocaloric and isonirogenous. The performance of all the groups was compared with respect to the parameters studied in the experiment. All the groups were reared under identical managemental and environmental conditions throughout the experimental period on deep litter system of housing for a period of six weeks.

The observations were recorded for daily feed consumption, weekly live weights, daily weights of selected birds in each groups and mortality. From these observations, average weekly feed consumption, average weekly live weights, average weekly gain in weights, average daily gain in weights and average weekly feed conversion ratios were calculated. The economics of production for the broilers was also calculated at the end of trial.

The average initial live weights of birds at day-old stage for groups A to D were 43.03, 42.85, 43.15 and 42.30 g, respectively. The corresponding average live weights at the end of six weeks were 2493.86, 2259.54, 2077.91 and 1990.41 g. The live weights of birds from group A were highest followed by the birds from groups B, C and D. The birds from the group D, recorded significantly lower live weights when compared to other treatment groups as well as control except for group C. Thus it may be concluded that the use of RDDGS does not have beneficial effect on live weights of birds at the end of six weeks.

The total gain in weights of birds from groups A to D during six weeks were 2450.83, 2216.69, 2034.76 and 1948.11 g, respectively. The corresponding average weekly gain in weights of birds from different groups was 408.47, 369.45, 339.13 and 324.68 g. The birds from group A recorded highest gain in weights followed by birds from group, B, C and D at the end of six weeks. Hence, the birds from all treatment groups receiving RDDGS at 5, 10 and 15% levels recorded statistically lower gain in weight than the birds from control group. The average weekly gain in weights of the birds from group D were significantly lower than the gain in weights of birds from group B. The differences in gain in weights of birds from groups B and C were statistically non-significant. Thus, it can be concluded that as the level of RDDGS increases from 5 to 15% in the diet there is a significant reduction in the gain in weight of broilers.

The average daily gain in weights of birds from groups A to D during six weeks were 61.48, 51.88, 49.65 and 48.23 g, respectively. The birds from group A recorded highest daily gain in weight followed by birds from group, B, C and D. Weekly gain in weights and daily gain in weight reduced as the inclusion level of RDDGS increased in the diet.

The total feed consumption per bird during six weeks period for the birds from groups A to D were 4536.16, 4317.10, 3913.59 and 3899.42 g, respectively. The corresponding average weekly feed consumption of birds from groups A to D was 756.03, 719.52, 652.27 and 649.90 g, respectively. The birds from control group recorded significantly higher feed consumption than all other treatment groups. Among the treatment groups receiving RDDGS, the birds from groups C and D receiving RDDGS at 10 and 15% levels respectively, recorded significantly lower feed consumption than the birds from group B receiving RDDGS at 5% level. Thus, it may be concluded that the feed consumption of birds reduces as the level of RDDGS increases in diet. This has also reflected in recording lower body weights as the level of RDDGS increased.

The average weekly feed conversion ratios of the birds from groups A to D were 1.73, 1.81, 1.79 and 1.88, respectively. It is observed that birds from group A recorded better FCR when compared to treatment groups. Among the treatment groups, the group C recorded marginally better FCR than groups B and significantly better FCR than group D. The differences in feed conversion ratio of

birds from groups C receiving RDDGS at 15% level and the control group were statistically non-significant.

During entire periods of six weeks it is noticed that total mortality for groups A to D was 4, 4, 1 and 2%, which as per industry standards is well within the limits. Hence, no ill effects were noticed due to use of RDDGS in the diet upto 15% level on the health of the birds.

It is noticed that the net cost of production per bird for groups A to D were ₹160.47, 145.49, 127.45 and 119.94, respectively. It is observed that the treatment groups had lower cost of production as compared to control group. The cost of production per bird reduced as the inclusion level of RDDGS increased. The net profit per bird was ₹14.10, 12.68, 18.00 and 19.39 for groups A to D, respectively. The corresponding profits per kg for groups A to D were ₹5.65, 5.61, 8.66 and 9.74. It was observed that the birds from group D helped in obtaining the highest profits upon sale of birds. The profit obtained from group B was the lowest among all treatment groups including control. The profit from sale of birds from treatment group was due to reduction in feed prices.

Thus, it is concluded that use of RDDGS is not beneficial to record better or comparable production performance when compared to the birds receiving corn-soybean diets alone. However, more profits can be obtained upon use of RDDGS due to reduction in feed prices and depending on selling price of birds.

A. BIBLIOGRPHY

A. O. A. C. (1995) Association of Analytical Chemist, Official Methods of Analysis, 15th Edn. Collegiate Press, Washington, D. C. - 20044: 957.

Abdel-Raheem, S M., R. Leitgeb and C. Iben (2011) Effects of dietary inclusion level of distillers' dried grains with solubles (DDGS) from wheat and corn on amino acid digestibilities in broilers, International Journal of Poultry Science **10 (12) :** 952-958.

Abe, C., N. C. Parsons, J. Brannon and S. L. Noll (2004) High protein corn distillers dried grains as a feed ingredient, Journal of Poultry Science, **83:** 264.

Aghabeig, R., S. Moghaddaszadeh-Ahrabi and M. Afrouziyeh (2013) Effects of brewer's spent grain on performance and protein digestibility in broiler chickens, European Journal of Experimental Biology, **3(3):** 283-286.

Chiou, P. W. S., K. J. Chen, K. S. Kuo, J. C. Hsu and B. Yu (1996) Studies on the protein degradabilities of feedstuffs in Taiwan, Animal Feed Science Technology, **55 :** 215-226.

Choi, H. S., H. L. Lee, M. H. Shin, C. Jo, S. K. Lee and B. D. Lee (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.

Dale, N. M. (2009) Growing intrest in alternative feed ingredients, Feed and nutrition featured articles, The poultry site, www.thepoultrysite.com.

Denstadli, V., S. Ballance S. H. Knutsen, B. Westereng, and B. Svihus (2010) Influence of graded levels of brewers dried grains on pellet quality and performance in broiler chickens, Poultry Science, **89:** 2640–2645.

El-Abd, N. M. (2013) Evaluation of using distillers dried grains with solubles (DDGS) in Japanese quail diets. World Applied Sciences Journal, **22 (1):** 17-21.

Fasuyi, A. O. (2005) Maize-sorghum based brewery by-product as an energy substitute in broiler starter: Effect on performance, carcass characteristics, organs and muscle growth, International Journal of Poultry Science, **4 (5):** 334-338 (Abst.).

Foltyn, M., V. Rada, M. Lichovnikova and E. Drackova (2013) Effect of corn DDGS on broilers performance and meat quality, Acta Universitatis Agriculturae Et Silviculturae Mendelinae Brunensis, 59-64.

Huang, H. J., P. W. Chiou, C. Chen, J. Chiang and B. Yu (1999) Effects of rice distillers' and grain supplementation on performance of lactacting cows, Animal Feed Science and Technology **77:** 303-315.

Hussaini, S. J., H. Nassiri Moghaddam and H. Kermanshahi (2010) The influence of different levels of brewers spent grain and enzyme on performance and digesta viscosity of broiler chicks, Journal of Animal and Veterinary Advances, **9(20) :** 2608-2612.

Ivanova, I., V. Georgigieva and M. Lelev (2013) Effect of wheat distillers grain in compound feeds for broiler chickens on productive and slaughter traits, Bulgarian Journal of Agricultural Science **19:** 102-108.

Jung, B. and A. B. Batal (2010) Evaluation of high protein distillers' dried grains as a feed ingredient for broiler chickens, Canadian Journal of Animal Science, **90:** 505-512.

Kluth, H. and M. Rodehutscord (2010) Effect of the duration of prefeeding on amino acid digestibility of wheat distillers dried grains with solubles in broiler chicken, Poultry Science, **89:** 681–687.

Loar Π, R. E. and A. Corzo (2011) Effects of varying levels of distillers dried grains with solubles on growth performance of broiler chicks, Brazilian Journal of Poultry Science, 279-281.

Loar Π, R. E., J. S. Moritz, J. R. Donaldson and A. Corzo (2010) Effects of feeding distillers dried grains with solubles to broilers from 0 to 28 days posthatch on broiler performance, feed manufacturing efficiency, and selected intestinal characteristics, Poultry Science, **89:** 2242–2250.

Lukasiewicz, M., D. Pietrzak, J. Niemiec, J. Mroczek and M. Michalczuk (2012) Application of dried distillers grains with solubles (DDGS) as a replacer of soybean meal in broiler chickens feeding, Archiv Tierzucht, **55 (5):** 496-505.

Lumpkins, B., A. B. Batal and N. M. Dale (2004) Evaluation of distillers dried grains with solubles as a feed ingredient for broilers, Journal of Poultry Science, **83**: 1891-1896.

Manh, L. H., N. X. D. Nguyen and B. Ogle (2002a) Effects of replacement of fish meal with brewery waste on the performance of growing pigs submitted to SAREC project. www.mekarn.org/sarec03/manhcantho01.htm

Manh, L. H., N. X. D. Nguyen and E. Lindberg (2002b) Effects of replacement of fish meal with rice distillers' waste (hem) on performance and carcass quality of growing pigs submitted to SAREC project.
www.mekarn.org/sarec03/manhcantho03.htm

Martinez-Amezcua, C., C. M. Parsons and D. H. Baker (2006) Effect of microbial phytase and citric acid on phosphorus bioavailability, apparent metabolizable energy and amino acid digestibility in distillers dried drains with solubles in chicks, Poultry Science **85:** 470–475.

Min, Y. N., F. Yan, F. Z. Liu, C. Coto and P. W. Waldroup (2009a) Effect of various dietary enzymes on energy digestibility of diets high in distillers dried grains with solubles for broilers, Journal of Applied Poultry Research, **18:** 734–740.

Min, Y. N., A. Hancock , F. Yan , C. Lu, C. Coto, A. Karimi, J. H. Park, F. Z. Liu and P. W. Waldroup (2009b) Use of combinations of canola meal and

distillers dried grains with solubles in broiler starter diets, Journal of Applied Poultry Research, **18:** 725-733.

Min Y. N., F. Z. Liu, A. Karimi, C. Coto, C. Lu, F. Yan and P.W. Waldroup (2011) Effect of Rovabio® Max AP on performance, energy and nitrogen digestibility of diets high in distillers dried grains with solubles (DDGS) in broilers, International Journal of Poultry Science, **10 (10) :** 796-80.

Min Y. N., F. Z. Liu, Z. Wang, C. Coto, S. Cerrate, F. P. Costa, F. Yan and P. W. Waldroup (2008) Evaluation of distillers dried grains with solubles in combination with glycerine in broiler diets, International Journal of Poultry Science, **7 (7):** 646-654.

Min, Y. N., L. Li, P. W. Waldroup, Z. Y. Niu, Z. P. Wang, Y. P. Gao and F. Z. Liu (2012) Effects of dietary distillers dried grains with solubles concentration on meat quality and antioxidant status and capacity of broiler chickens, Journal of Appl. Poult. Res, **21:** 603-611.

Min, Y. N., H. L. Li, L. Li, Z. Y. Niu, J. J. Wang, S. K. Liu, J. Zhang and F. Z. Liu (2013) Effects of dietary distillers grains with solubles (DDGS) concentration on intestinal morphology of broiler chicken, Journal of Animal and Veterinary Advances, **12(1):** 6-9.

National Research Council (1989), Nutrient Requirement of Dairy Cattle, 6th edn. National academic science, Washington, D. C.

Nguyen L. Q., T. Q. Vui, H. T. Hue, D. T. Hang and A. C. Beynen (2004) Influence of replacement of concentrate by beer by-product on performance of broilers in Vietnam, International Journal of Poultry Science, **3 (11):** 724-727.

Noll, S. (2004) DDGS in poultry diets: Does it makes sense. Midwest Poultry Federation Pre-Show Nutrition Conference, River Centre, St. Paul, MN.

Oryschak, M., D. Korver, M. Zuidhof, and E. Beltranena (2010a) Nutritive value of single-screw extruded and nonextruded triticale distillers dried grains

with solubles, with and without an enzyme complex, for broilers, Poultry Science **89:** 1411-1423.

Oryschak, M., D. Korver, M. Zuidhof, X. Meng and E. Beltranena (2010b) Comparative feeding value of extruded and non-extruded wheat and corn distillers dried grains with solubles for broilers. Poultry Science, **89:** 2183–2196.

Patil, U. M. (2008) Studies on effects of using distillery dried grains with solubles (DDGS) in the diets with certain feed additives on performance of broilers. M. V. Sc. Thesis submitted to Bombay Veterinary College, Parel. Maharashtra Animal and Fishery Science University, Nagpur.

Roberson, K. D. (2003) Use of dried distillers grains with solubles in growing-finishing diets of turkey, International Journal of Poultry Science, **2 (6):** 389-393.

Schilling M. W., V. Battula, R. E. Loar II, V. Jackson, S. Kin, and A. Corzo (2010) Dietary inclusion level effects of distillers dried grains with soluble on broiler meat quality, Poultry Science, **89:** 752–760.

Shalash, S. M. M., S. Abou El-Wafa, M. A. M. Sayyad, Hoda E. El- Gabry, N. A. Ramadan and M. S. Mohamed (2009a) Nutritive value of distillers dried grains with soluble and broiler performance at starter period. International Journal of Poultry Science, **8 (8):** 783-787.

Shalash, S. M. M., M. N. Ali, M. A. M. Sayyad, Hoda E. El- Gabry and M. Shabaan (2009b) Novel method for improving utilization of corn distillers dried grains with soluble in broilers diet, International Journal of Poultry Science **8 (6) :** 545-552.

Shim, M. Y., G. M. Pesti, R. I. Bakalli, P. B. Tillman and R. L. Payne (2011) Evaluation of corn distillers dried grains with solubles as an alternative ingredient for broilers, Poultry Science, **90:** 369–376.

Snedecor, G. W. and W. G. Cochran (1998) Satatistical Methods, 8th Edn., Oxford and IBH Publishing Company, New Delhi.

Swain, B. K., S. B. Barbuddhe and R. N. S. Sunderam (2005) Effect of feeding brewery dried grain (BDG) with enzyme supplement on the performance of broilers, Indian Journal of Poultry Science, **40 (1):** 26-31.

Wang, Z ., S. Cerrate, C. Coto, F. Yan and P.W. Waldroup (2007a) 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, **6 (10):** 725-731.

Wang, Z., S. Cerrate, C. Coto, F. Yan and P. W. Waldroup (2007b) use of constant or increasing levels of distillers dried grains with solubles (DDGS) in broiler diets, International Journal of Poultry Science, **6 (7):** 501-507.

Wang, Z., S. Cerrate, C. Coto, F. Yan and P. W. Waldroup (2008a) Evaluation of high levels of distillers dried grains with solubles (DDGS) in broilers diets, International Journal of Poultry Science, **7(10) :** 990-996.

Wang, Z., S. Cerrate, C. Coto, F. Yan, F. P. Costa, Abdel-Maksoud and P. W. Waldroup (2008b) Evaluation of corn distillers dried grains with solubles in broiler diets formulated to be isocalaric at industry energy levels or formulated to optimum density with constant 1% fat, International Journal of Poultry Science, **7(7):** 630-637.

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

THESIS ABSTRACT

a)	Title of the thesis (in Capital letters)	**:**	EFFECT OF DIFFERENT LEVELS OF RICE DISTILLERS DRIED GRAINS WITH SOLUBLES (RDDGS) ON PERFORMANCE OF BROILERS
b)	Full name of student	**:**	Dingore Apeksha Dattatraya
c)	Name and address of Major Advisor	**:**	Dr. (Ms). D. N. Desai, Assistant Professor, Department of Poultry Science, Bombay Veterinary College, Parel, Mumbai- 400012
d)	Degree to be awarded	**:**	M. V. Sc.
e)	Year of award of degree	**:**	2015
f)	Major subject	**:**	Poultry Science
g)	Total number of pages in the thesis	**:**	54
h)	Number of words in the abstract	**:**	325
i)	Signature of Student	**:**	
j)	Signature, Name and address of forwarding authority	**:**	
k)	Signature of Associate Dean		

B. ABSTRACT

TITLE : EFFECT OF FEEDING DIFFERENT LEVELS OF RICE DISTILLERS DRIED GRAINS WITH SOLUBLES (RDDGS) ON PERFORMANCE OF BROILERS

The present experiment was conducted to study the effect of feeding different levels of Rice Distillers Dried Grains with Solubles (RDDGS) on performance of broilers. The trial was conducted on 400 'Cobb 400' day-old broilers chicks for a period of six weeks. The day-old broiler chicks, immediately after arrival, were randomly divided into four equal groups of 100 birds each viz., A, B, C and D. Each group was further subdivided into four replicates of 25 birds each. Group A received control diet, Groups B received diet containing RDDGS replacing Soybean deoiled cake (DOC) and oil at 5% level. Group C received diet containing RDDGS replacing Soybean deoiled cake (DOC) and oil at 10% level and D received diet containing RDDGS replacing Soybean DOC and oil at 15% level. All the diets were isocaloric and isonitrogenous. The birds from the group A recorded highest live weight and gain in weight followed by the birds from group B, C and D. The birds from group D recorded significantly lower body weights as compared to the birds from all other groups including control. It was noticed that the birds from the group A recorded highest feed consumption. However, the birds from group D recorded significantly lower feed consumption when compared to all the treatment groups including control. The birds from control group were better in feed utilization when compared to the birds from various treatment groups. The birds from the group D recorded more profit due to less cost of production. Hence, it is concluded that use of Rice Distillers Dried Grains with Solubles (RDDGS) is not beneficial to record better or comparable production performance when compared to the birds receiving corn-soybean diets alone. However, more profits can be obtained upon use of RDDGS due to reduction in feed prices, depending on selling price of birds.

प्रबंध सारांश

1.	प्रबंधाचे नांव	:	तांदळाचे उर्ध्वपातन करून मिळणा—या सुकवलेल्या धान्याचा व विद्राव्याचा वेगवेगळया प्रमाणात वापर करून त्याचा मांसल पक्षांवर होणारा परिणाम अभ्यासणे
2.	विद्यार्थ्याचे नांव	:	डिंगोरे अपेक्षा दत्तात्रय
3.	प्रबंधाचे नांव	:	डॉ. (कु). दी. न. देसाई सहाय्यक प्राध्यापक, कुक्कुटपालन विभाग, मुंबई पशुवैद्यकीय महाविद्यालय, परळ, मुंबई—400 012
4.	पदवी	:	पदव्युत्तर पदवी
5.	पदवी प्रदान करण्याचे वर्ष	:	2014
6.	मुख्य विषय	:	कुक्कुटपालनशास्त्र
7.	प्रबंधाची एकूण पाने	:	54
8.	सारांशाचे एकूण शब्द	:	399
9.	विद्यार्थ्याची सही	:	
10.	विभाग प्रमुखाचे नाव, सही आणि पत्ता	:	
11.	सहयोगी अधिष्ठाता मुंबई पशुवैद्यकीय महाविद्यालय परळ, मुंबई—400 012	:	

सारांश

शीर्षक :— तांदळाचे उर्ध्वपातन करून मिळणा—या सुकवलेल्या धान्याचा व विद्राव्याचा वेगवेगळया प्रमाणात वापर करून त्याचा मांसल पक्ष्यांवर होणारा परिणाम अभ्यासणे

तांदळाचे उर्ध्वपातन करून मिळणा—या सुकवलेल्या धान्याचा व विद्राव्याचा वेगवेगळया प्रमाणात वापर करून त्याचा मांसल पक्ष्यांवर होणारा परिणाम पाहण्यासाठी हा प्रयोग करण्यात आला. सदर प्रयोग 'कॉब 400' जातीच्या 400 मांसल पक्षांच्या पिल्लांवर सहा आठवडे करण्यात आला. एका दिवसाच्या मांसल पिल्लांचे प्रत्येकी 100 पक्षी याप्रमाणे अ,ब,क आणि ड असे गट करण्यात आले. प्रत्येक गटात प्रत्येकी 25 पक्ष्यांचे चार उपगट करण्यात आले. गट 'अ' ला मका व सोयाबीन पेंड ने बनविलेला नियंत्रित आहार देण्यात आला. गट 'ब' च्या खाद्यात सोयाबीन पेंड आणि तेलाऐवजी तांदळाचे उर्ध्वपातन करून मिळालेले सुकवलेले धान्य व विद्राव्य 5% प्रमाणात देण्यात आले. गट 'क' च्या खाद्यात सोयाबीन पेंड आणि तेलाऐवजी तांदळाचे उर्ध्वपातन करून मिळालेले सुकवलेले धान्य व विद्राव्य 10% प्रमाणात देण्यात आले आणि गट 'ड' च्या खाद्यात सोयाबीन पेंड आणि तेलाऐवजी तांदळाचे उर्ध्वपातन करून मिळालेले सुकवलेले धान्य व विद्राव्य 15% प्रमाणात देण्यात आले. हया सर्व गटांमधील खाद्यात उर्जा व नायट्रोजयुक्त अन्नघटकांचे प्रमाण समान होते. गट 'अ' च्या पक्ष्यांनी सर्वाधिक वजन आणि वजनातील वाढ नोंदवली आणि त्यामागोमाग अनुक्रमे ब, क आणि ड या गटातील पक्ष्यांनी वाढ नोंदवली. गट 'ड' च्या पक्ष्यांनी नियंत्रित गट आणि इतर चाचणी गटांच्या तुलनेत लक्षणियरित्या कमी वजन व वजनातील वाढ नोंदवली. गट 'अ' च्या पक्ष्यांनी सर्वाधिक खाद्य खाल्ले तर गट 'ड' च्या पक्ष्यांनी नियंत्रित व इतर

चाचणी गटांपेक्षा लक्षणिरीत्या सर्वात कमी खाद्य खाल्ले. गट 'अ' च्या पक्ष्यांनी इतर गटातील पक्ष्यांपेक्षा उत्तम खाद्याचे गुणोत्तर नोंदवले. उत्पादन किंमत कमी असल्यामुळे गट 'ड' च्या पक्ष्यांपासुन जास्त नफा मिळवता आला. तरी सर्वकष नोंदीवरून असे निदर्शनास येते की तांदळाचे उर्ध्वपातन करून सुकवलेले धान्य व विद्राव्य खाद्यात वापरणे हे उत्पादन क्षमतेच्या दृष्टीने मका व सोयाबीनयुक्त खाद्यापेक्षा तुलनात्मक फायद्याचे नाही. परंतु खाद्याची किंमत कमी होत असल्यामुळे तांदळाचे उर्ध्वपातन करून सुकवलेल्या धान्य आणि विद्राव्याचा वापर केल्यास पक्ष्यांच्या विक्रीच्या किंमतीनुसार अधिक नफा मिळवला जाऊ शकतो.

C. VITA

Miss Dingore Apeksha Dattatraya was born on 2nd October 1988 at Tal. Shahapur, Dist. Thane, Maharastra state. She finished her Secondary School Certificate Examination from G. V. Khade Vidyalaya, Shahapur. For further studies she was admitted in Acharya Bhise Junior College, Shahapur. Then she attended the Bombay Veterinary College at Parel, Mumbai belonging to Maharashtra Animal and Fishery Sciences University, Nagpur and completed her graduation in the Veterinary Science and Animal Husbandary (B. V. Sc and A. H.) in the year 2012.

Due to her interest in Poultry Science she gained admission in the Department of Poultry Science of Bombay Veterinary College in November 2012. Two fruitful years of post graduate study resulted in submission of the present thesis successfully. As part of her training in Department of Poultry Science she assisted various research works.