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PROXIMATE ANALYSIS AND METABOLIZABLE ENERGY OF POULTRY FEEDS

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ABSTRACT

The study was conducted to find the proximate analysis and metabolizable energy values of feed samples sold in Ho Municipal. It also assay to establish variations in the feed samples. Moisture content, crude protein, ash, fat, carbohydrates and energy values of the feed samples were studied. Levene's test and ANOVA were used to ascertain the variability among the feed samples at $P \leq 0.05$. Results obtained were compared with Ghana Standard Authority (GSA) and National Research Council (NRC) recommended values for poultry feeds. The results shown some discrepancies in the means of the feed samples at $p \leq 0.05$. Minimum fat contents were found inlayer mash feed and grower mash feed respectively at 2.02 % and the maximum was found in broiler starter feed at 4.60 %. The mean moisture contents of all the feed sampled fell below GSA baseline of 12%. The crude protein content values for grower mash and layer mash feeds were highly in deviation from the mean, and were respectively at 3.32% and 3.33%.There were significant differences among the mean feed composition at $p \leq 0.05$. Some of the feed compositions were inconsistence with recommended baseline stated by GSA. Quality and standards are vital to ensure farmers security to feeds and growth of birds, for this reason frequent monitoring and feed analysis by authorities are key to ensure feed standardization.

Keywords: ration, crude protein, moisture content, chicken, Ho municipal, Ghana standard authority.

INTRODUCTION

Poultry farming is one of the most important divisions of agriculture throughout the world. Basically it is a source of economical, palatable and healthy food protein (Mahesar *et al.,* 2010). The rapid population growth, increasing level of income, standard of living and taste for poultry products (meat and eggs) requires effective management of birds (FAO, 2002). Poultry refers to domestic fowls in general, but mainly to chickens, ducks, turkeys, guinea fowls, geese, pigeon, ostriches, peafowls and swans (Kekeocha, *et al*., 1986). Fowls or chickens outnumber any kind of poultry (FAO, 2018. Poultry farming in Ghana provides employment, income and food. Poultry manure obtained from these birds is an important economic component for maintaining soil fertility for crop production (Tolessa *et al.* 2015).

The development of the poultry birds depends on the quality of feed, water, breeds, environmental conditions (temperature, relative humidity, wind, etc.), medication (disease control), equipment (feeding trough and water trough, etc.) and the farming practices of the farmer (Nazri, 2003). Among these factors poultry feeds which are food for these animals is most critical, contributing to 60-80% of the economic cost input in the commercial poultry industries (Elmasoeur and Russ, 2013; Kleyn, 1992). Poultry feeds are prepared to contain all the vitamins, minerals, energy, protein, and other nutrients essential for proper growth in order to meet the nutritional requirements of birds (Kleyn, 1992). Nazri (2003) opines that in poultry production, the most important component is the feed. Any deficiency in nutrient of the poultry ration will affect the growth of birds. Poultry feeds are supposed to contain certain nutrients such as protein, carbohydrate, fat, minerals and vitamins in their right percentages for starter, grower and finisher rations for various stages of growth (Leeson and summers, 2001). Ration is the quantity of feed given to birds in a given period of time. According to Kleyn (1992), ingredients in poultry feeds have different functions and are needed in certain amount at different stages in bird's development. Starter rations are high in protein (expensive feed ingredient). However, grower and finisher rations can be lower in protein since older birds require lesser amount of protein (Poultry Hub, 2018). For maximum growth and good health, poultry need a steady supply of energy, protein, minerals, and vitamins and, most importantly water (Rose, 1997). Jacquie, (2018) in Basic Poultry Nutrition bulletin enumerated vital roles nutrients plays in the growth and production of poultry. That, proteins are required by chickens in a form of amino-acids for building body tissues such as muscles, skin, feathers, nerves and egg white. Add-on of fats reduces dustiness of feed, increases feed palatability and stored up of energy (Baiao and Lara, 2005), furthermore, cereals products form the major constituents of the feed in a form of carbohydrates and it is the main sources of energy for birds (Kuashalendra, *et al.,* 2016). Additionally, minerals in poultry diet improve bone formation, hardness in egg shell, blood clotting, enzymes activation and muscle contraction. The inclusion of vitamins ensures normal body functions, growth and reproduction. Lack of vitamins is a recipe to a number of diseases in chicken (Jacquie, 2018). The optimum nutrient intake for poultry raised commercially will depend on the commercial goals of the poultry enterprise (Poultry-Hub, 2018). Nutrient requirements are related to both body weight and the stage of maturity, as chick stage feed consumption is less.

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However, later stages feed intake will increase gradually because bird requires feed for maintenance and production purposes and further to overcome the stress of egg and meat production (Applegate and Angel, 2014). Nakim (2013) stated that growth of meat type birds is rapid as compared to egg type birds. In purview, feed intake will be more and fast in meat producing poultry. Similarly, layer birds feed consumption will increase as chicks become growers and grower becomes layers. Hence, in formulating of animal feed care must be taken based on the age and type of production (egg laying or broilers).

Assessment of poultry feed sold to farmers is of prime importance to the feed manufacturers, poultry farmers and authorities mandated to ensure standardization of feeds and to guaranteed that, feed commercially prepared and sold to farmers is of quality and contain all the necessary nutrients require for growth and production of poultry. Though, other factors may affect growth and production of the birds, studies indicate that feed plays a major role in the cost of production which contributes to60-80% and any insufficiency in nutrients of the feed will retard growth of birds (North and Bell, 1990 and FASDEP, 2000).

Studies in other areas of poultry production have been conducted by other researchers, scanty information in literature of proximate analysis and metabolizable energy of poultry feeds in recent times has been conducted in the country. There is also the need to ascertain the quality of the feeds sold which will inform practitioners in the poultry feed industry to keep to standards. The study therefore sought to undertake proximate analysis and determine metabolizable energy of chicken feeds, and further to establish whether there are differences among samples of the feeds.

MATERIALS AND METHODS

Sampling of poultry feed

Feed samples of about 1-2 kg were acquired from local commercial feed depot within Ho municipal. These feeds designated as being appropriate chick starter feed, broiler starter feed, grower mash feed and layer mash feed were respectively coded as CSF, BSF, GMF and LMF. The feeds were well packaged in air tight polythene bags and place under ambient temperature ready for analysis. They were alphabetically labelled for analysis. For each feed groups (CSF, BSF, GMF and LMF) ten samples were taken from different bags containing the feeds. The variation in the number of sampled feeds of 3, 3, 4 and 5 respectively for CSF, BSF, GMF and LMF was due to the number of available feed depot.

ANALYTICAL METHODS

For the proximate analysis of poultry feeds, Association of Official Analytical Chemists recommended methods (AOAC, 1990), 18th Edition was used to measure the levels of crude protein, ash, moisture content and fat. All analysis was done in triplicate and the mean calculated and reported.

Determination of moisture content

Feed samples each weighing 10g were taken and placed in a petri-dish and dried in previously heated laboratory oven at 105 ^{0}C to a constant weight. Moisture content (wet basis) was calculated using Equation 1.

$$\%\ MC_{wb} = \frac{(M_0 - M_1)}{M_0} \times 100 \quad \text{--------- } 1$$

where, M_0= mass of sample before drying; M_1= mass of sample after drying

Determination of crude protein content

The micro Kjeldahl method was used for the nitrogen (N) determination. Crude protein was calculated by multiplying nitrogen (N) with a protein factor 6.25. Protein =%Nitrogen ×6.25.

Determination of total ash content

Feed samples weighing 5g each were ground and put into porcelain crucible in triplicates and decarbonized in a Bunsen burner for 4 hours at 550 ^{O}C. The dry matter of the feed was used as the ash component of the feed.

Determination of fat content

20 g finely ground feed samples were placed in a cellulose thimble paper and fat extraction was carried out using hexane in a 250 mLSoxhlet extractor for 6 hours. The fat content was calculated using Equation 2 as:

$$\text{Percent Fats} = \frac{W_f + U - \left(W_{ef} X 100\right)}{W_s} \quad \text{------- } 2$$

where, W_f = weight of flask; U = fat extract; W_{ef} = weight of empty flask W_s = Weight of sample taken

Determination of carbohydrate content

Total carbohydrate was calculated using Equation 3 (Akubor *et al.,* 2000).

Carbohydrates = 100 - (protein + crudefat + moisture + ash) -------- 3.

Determination of metabolizable energy (me) value

The energy values of the feeds were calculated in kilo calories per hundred grams (kcal/100g), by multiplying the factors of fat, protein and carbohydrate respectively by 9, 4 and 4%, as reported by (Eknayakeand Nair, 1999).

$$\text{ME} = \sum\left(9f + 4p + 4c\right)$$

All the experimental analysis was in triplicates and the mean value was calculated and reported.

Statistical analysis

Microsoft Excel (2013) was used to carry out the analysis. Levene's test of homogeneity of variance was performed to establish differences among the feed samples at p ≤ 0.05. Analysis of variance (ANOVA) was carried out using one-way test to find out the means and standard deviations for the feed samples. The means of the results were compared with Ghana Standard Authority (2007) and

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National Research Council (1994) benchmarks of poultry feeds for discussions.

RESULTS

Table-1 shows Levene's test of homogeneity of variance for all the sampled feeds. There was evidence from the Levene's test that the group variances of the feed samples are not equivalent at $p \leq 0.05$ with exception of chick starter feed for crude protein and energy. Therefore, analysis of variance was used to establish the extent of deviation among the feed samples. Table-2 (a, b, c, d and e) depict the results of analysis of variance for the various nutrient compositions (Moisture, Protein, Fat, Ash, Carbohydrate and Energy) with their respective feed samples. The minimum moisture content (MC) was seen in the GMF (7.84%) and maximum was recorded in CSF (11.80%). The highest deviation of MC from the mean was seen in the GMF (1.09). LMF registered the lowest percentage of protein content of 10.08% and the greatest was registered in the BSF (22.60%). The protein content of GMF and LMF deviated from the mean value at 3.31 and 3.32 respectively. The mean fat components of the feed were at 2.47%, 3.66%, 2.71% and 2.75% for CSF, BSF, GMF and LMF, respectively. The lowest fat contents were recorded in GMF and LMF at 2.02% each. The mean precent ash was 6.72%, 8.66%, 17.08 % and 14.85 % respectively for CSF, BSF, GMF and LMF. The minimum and the maximum ash contents were recorded in CSF (5.46%) and GMF (22.06 %). Carbohydrate content of the feeds had mean estimates of 61.81%, 56.30%, 53.73% and 56.84% respectively for CSF, BSF, GMF and LMF. The maximum carbohydrate content was registered by CSF at 64.44%. The calculated mean metabolizable energy (ME) of the feeds was 343.53, 341.99, 306.37 and 316.72 kcal/100g respectively for CSF, BSF, GMF and LMF. Chick Starter Feed (CSF) had the highest mean ME and GMF recorded the lowest mean ME.

Table-1. Levene's test of homogeneity of variance of the feed samples.

FEED	NUTRIENT	TEST OF HOMOGENEITY OF VARIANCE	P-VALUE OF ONE WAY ANOVA TEST
Chick Starter Feed (CSF)	Moisture	0.701	0.013
	Crude Protein	0.642	0.048
	Fat	0.360	0.011
	Ash	0.098	0.023
	Carbohydrate	0.176	0.019
	Energy	0.566	0.069
Broiler Starter feed (BSF)	Moisture	0.439	0.000
	Crude Protein	0.378	0.023
	Fat	0.319	0.000
	Ash	0.913	0.007
	Carbohydrate	0.199	0.020
	Energy	0.533	0.000
Grower Mash Feed (GMF)	Moisture	0.151	0.000
	Crude Protein	0.177	0.000
	Fat	0.330	0.000
	Ash	0.921	0.000
	Carbohydrate	0.471	0.000
	Energy	0.659	0.000
Layer Mash Feed (LMF)	Moisture	0.418	0.000
	Crude Protein	0.054	0.000
	Fat	0.532	0.000
	Ash	0.214	0.000
	Carbohydrate	0.994	0.000
	Energy	0.930	0.000

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Table-2a. Moisture Content for Feed Samples.

Sample	N	Minimum	Maximum	Mean	Std. Deviation
CSF	30	9.08	11.80	10.4853	.61016
BSF	30	9.24	11.70	10.4093	.68490
GMF	40	7.84	11.60	9.7150	1.09930
LMF	50	8.20	10.83	9.4102	.69075

Table-2b. Protein Content for Feed Samples.

Sample	N	Minimum	Maximum	Mean	Std. Deviation
CSF	30	16.56	19.68	18.5067	.81131
BSF	30	19.46	22.60	20.9757	.90675
GMF	40	12.03	22.14	16.7630	3.31199
LMF	50	10.08	20.24	16.1582	3.32476

Table-2c. Fat Content for Feed Samples.

Sample	N	Minimum	Maximum	Mean	Std. Deviation
CSF	30	2.03	2.90	2.4737	.23806
BSF	30	3.05	4.60	3.6570	.51140
GMF	40	2.02	3.28	2.7095	.39933
LMF	50	2.02	3.58	2.7484	.46757

Table-2d. Ash Content for Feed Samples.

Sample	N	Minimum	Maximum	Mean	Std. Deviation
CSF	30	5.46	7.80	6.7237	.53926
BSF	30	7.64	9.55	8.6623	.55296
GMF	40	12.08	22.06	17.0790	2.89570
LMF	50	9.80	19.09	14.8450	2.81966

Table-2e. Carbohydrate Content for Feed Samples

Sample	N	Minimum	Maximum	Mean	Std. Deviation
CSF	30	59.66	64.44	61.8107	1.21215
BSF	30	54.34	58.84	56.2957	1.06939
GMF	40	49.82	56.82	53.7335	1.69473
LMF	50	52.35	62.75	56.8382	2.55877

Table-2f. Metabolizableenergy for Feed Samples (kcal/100g).

Samples	N	Minimum	Maximum	Mean	Std. Deviation
CSF	30	339.01	349.22	343.5323	2.68432
BSF	30	331.45	353.38	341.9983	6.12453
GMF	40	285.74	325.20	306.3715	11.61475
LMF	50	301.32	334.92	316.7212	10.44082

DISCUSSIONS

The moisture content (MC) of feed determines the amount of water in the feed samples. It is an indicator of quality and a key to safe storage (Saiful, *et al.,* 2015; Bala, 1997). High moisture content of feed with high temperatures and poor aeration during storage pre-disposes feeds to mycotoxins and spoilage (NRI, 1995), which can pose health problems to birds when fed. From the results (Table-2a) it was found that the maximum and minimum MC were respectively at 11.8% and 7.84 %. All the feed samples fell below the MC of 12% as bench mark by Ghana Standard Authority (GSA, 2007), however the results obtained agrees with Prabakaran and Dhanapal (2009) who found a MC of 11.70% as high in poultry feed samples. There were significant variations among the means of the moisture contents of the feed samples at $p \leq 0.05$.

Crude Protein (CP) in chicken feed is required in a form of amino-acid synthesizing. Protein is required for carcass growth, egg production and feather development (Mbajiorgu *et al.,* (2011). It is the major constituent and cost component of the feed (Kuashalendra, *et al.,* 2016; Elmasoeur and Russ, 2013). CP in the feed provides essential amino-acids. Increased crude protein in diet of birds results in improvement in egg size and weight (Kuashalendra, *et al.,* 2016). The minimum requirement of CP by GSA, (2007) for layer starter, layer grower, layer, broiler starter and broiler finisher were respectively cited as 18.0%, 17%, 17%, 22% and 20%. The mean lowest CP (Table-2b) was found in LMF (16.15%) which was slightly below the recommended minimum of 17% and the mean highest was found in BSF (20.97%) which was also lower than 22% as expected by GSA (2007). A feed sample of lower CP content will affect development of carcass and eggs production (NRC, 1994). There were significant variations in the means of CP of the feeds samples at $p \leq 0.05$. A minimum CP of 10.08% and 12.03% were recorded respectively for LMF and GMF. The figures obtained deviates from the recommended CP by GSA (2007). Elmasoeur and Russ (2013) reported that due to high cost of protein materials for formulation of feed, some feed manufacturers resort to lower cheap protein materials for formulation and this may be as a result of low protein content in some feeds.

Fat in poultry diet improves the adsorption of fat soluble vitamins and increases palatability of feed (Velmurugu, 2012; Baiao and Lara, 2005). With the exception of BSF having recorded a higher fat content greater than the minimum of 3% as expected by GSA (2007), the rest of the feed samples fell below the recommended fat content as shown in Table-2c. Increase in fat in broiler diet decrease feed intake and improves feed efficiency (Jeffri, *et al.,* (2010) as in Mohammadreza, *et al*. (2013). Fat component of poultry feed helps to increase overall energy concentration and in turn improve productivity and feed efficiency (NRC, 1994). The study revealed that the CSF and LMF had the minimum mean fat content of 2.02% each and the BSF had the maximum mean fat content of 4.60%.Theresultsobtained perverts from GSA (2007) baseline of 3% maximum respectively for the all stages of growth for layers and 3% minimum for broilers. There were significant differences among the fat content of the feed samples at $p \leq 0.05$

The ash component of the feed describes the inorganic content of the feed and is mainly minerals. These are critical nutrients required in specific amounts in the poultry diets for stronger bone, blood clotting, enzymes activation and muscle contraction and egg shell formations (Jacquie, 2018). A low ash content of the feed pre-disposes birds to diseases and poor egg shell formation. Significant deviations of 2.30 and 2.82 were seen in feed samples of GMF and LMF respectively as shown in Table-2d. Though most researchers focus on mineral compositions of ash, this study has unravelled the extent of variability of ash that exits in the feed sampled. A maximum value of 22.06% ash was found in GMF and the minimum obtained in CSF was 5.46%. The study recorded a significant difference among the mean ash component of the feed at $p \leq 0.05$.

Carbohydrates are essential dietary source of energy for poultry which is obtained from cereal sources of feed ingredients (maize, rice, wheat, etc.). These are easily digested by the birds. The mean carbohydrates content of the feeds as shown (Table-2e) were found to be 61.81%, 56.30, 53.73% and 56.84% for CSF, BSF, GMF and LMF, respectively. The study uncovered high amount of carbohydrates in the CSF than the other feed samples. Researchers such as Mbajiorgu, *et al.,* (2011) and Ferket and Gernat, (2006) indicated that, CSF must have lower rapid digestible carbohydrates for energy and high protein for body growth; however the results obtained were contrary to literature. There was variability among the mean carbohydrate content of the feed samples at $p \leq 0.05$
The metabolizable energy (ME) is the convectional measure of the available energy content of feed nutrients and requirements of poultry. Table-2f shows that Chick Starter Feed (CSF) had the highest mean ME of 343.53 kcal/100g while GMF recorded the lowest mean ME of 306.37 kcal /100g. The ME of the feed samples were in range recommended by NRC (1994), that the average ME for broilers in all stages of growth be 3200 kcal/kg and that for layers be 2900kcal/kg. However, the mean ME of GMF and LMF deviated respectively at 11.61and 10.44 kcal/100g. This variation may be due to inadequate mixing of the feed since the ME value was obtained from a factor of the fat, protein and carbohydrate content in the feed. The implication is that, birds fed with ration containing less fat, protein and carbohydrate will not have much energy for growth and this feed sample may contribute to stunted growth and low production in birds. The LMF (319.72 kcal/100g) were above the recommended value of 2900kcal/kg for layers as stipulated by NRC (1994).

CONCLUSION AND RECOMMENDATION

A remarkable fluctuation was found in the proximate analysis and metabolizable energy of the feed samples. There were significant variations among the various means of the feed samples at $p \leq 0.05$. Some of the feed samples deviates from mean recommended values by GSA and the NRC. For successful poultry farming, the quality of the feed is a determinant factor for growth and production (meat and egg) and every attempt must be put in place to ensure that feed prepared and sold by commercial feed manufacturers contain all the essential nutrients at the right amount for the sustenance of the poultry industry. The selection of feed ingredients for formulation of poultry feed should not be compromised; the development of birds largely depends on the nutritive value obtained in the feed ingredients used. To ensure quality and standardization of feeds, frequent monitoring and enforcement of standards in the preparation of feed is cardinal, this will ensure that nutritional feeds are formulated to meet production needs of poultry birds.

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REFERENCES

Akubor P. I., Isolokwu P. C., Ugbane O. and Onimawo I. A. 2000. Proximate composition and functional properties of African breadfruit kernel and flour blends. Food Research International. 33: 707-712.

Association of official Analytical Chemists (AOAC). 1990. Methods of Analysis of the Association of Official Analytical Chemists, 18th Ed., Association of Official Analytical Chemists, Washington, DC.

Applegate J. T. and Angel R. C. 2014. Nutrients requirements of poultry publication: History and need for update, Journal of Applied Poultry Research. 23(3): 2014.

Baiao N. C. and Lara L. J. C. 2005. Oil and Fat in Broiler Nutrition, Brazilian Journal of Poultry Science. 7(3): 129-141.

Bala B. K. 1997. Drying and storage of cereal grains. Science Publishers Inc., USA. pp. 7-10.

Eknayake S.E. R. and Nair B. M. 1999. Proximate composition, mineral and amino acid content of mature Canavaliagladiata seeds. Food Chemistry. 66: 115-119.

Elmasoeur A. and Russ N. 2013. Ghana Poultry Report Annual. Global Agricultural information Network prepared by USDA Staff in Gain report No. (1304).

Ferket P. and Gernat A. G. 2006. Factors that affect feed intake of meet birds. A review. International journal of poultry science. 5(10): 905-911.

Food and Agricultural Organization (FAO). 1986. Production Year Book, FAO, Rome. 40: 226.

Food and Agricultural Organization (FAO). 2002. World agriculture towards 2015/2030. Rome, Italy.

Food and Agricultural Organization, 2012. Poultry feed availability and nutrition in developing countries: Poultry development review. www.fao.org/docrep/019/i3531e/i3531e06

Food and Agricultural Organization (FAO). 2018. Gateway to poultry production and products. www.fao.org/poultry-production-products/en/

FASDEP. 2002. Ghana First Agricultural Policy as Captured in Food and Agricultural Sector Development Policy. Ghana/ draft-2 pff.

Ghana Standard Authority (GSA). 2007. Requirements for poultry feed. (2nd Edition) 106-1.

Jacquie J. 2018. Basic poultry nutrition, articles.extension.org/basic-poultry-nutrition. pp. 109-112.

Jeffri D., Firman H. and Kamyab A. 2010. Comparison of soybean oil with an animal/vegetable blend at four energy levels in broiler rations from hatch to market. Int. Poult Sci. 1027-1030.

Kaushalendra K., Shahla P., Chandramoni S. K., Pankaj K. S., Manoj K. and Amitava D. 2016. Effect of feeding different dietary levels of energy and protein on growth performance and immune status of Vanaraja chicken in the tropic. Veterinary World. 9(8): 893-899.

Kekeocha C. C. 1986. Poultry Production Hand book. Published by Pfizer Corporation Nairobi.pp, 66-73.

Kleyn R. 1992. Broiler feeding for better returns. Pout. Bullet. 283-286.

Landes M., Persand S. and Dyck J. 2004. India's Poultry Sector: Development and Prospects. Market and Trade Economics Division, Economic/Research Service, US. Department of Agriculture. Agriculture and Trade Report WRS-04-03.

Leeson S. and Summers J. D. 2001. Scott's nutrition of the chicken, (4th edition). Nottingham, UK, Nottingham University Press.

Mahesar S. A., Sherazi S. T. H., Abdul N., Bhanger M.I. and Sirajuddin A. R. 2010. Simultaneous assessment of zinc, cadmium, lead and copper in poultry feeds by differential pulse anodic striping voltammetry. Food and Chemical Toxicology, doi: 10.1016/j.fct.2010.05.071.

Mbajiorgu C. A., Ng'ambi J. W. and Norris D. D. 2011. Voluntary feed intake and nutrient composition in chickens. Asian Journal of Animal and Veterinary Advances. 6(1): 20-28.

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Mohammadreza P. i., Alireza S., Ali Ahmad A. Q., Vito L. and Vincenzo T. 2013. Influence of Dietary Fat Source on Growth Performance Responses and Carcass Traits of Broiler Chicks. Asian-Australasian Journal of Animal Sciences. 26(5): 705-710.

National Research Council (NRC). 1994. Nutrient requirements of poultry, 9th revised edition. National Academy Press, Washington, D.C.

National Resources Institutes (NRI). 2000. Manual for grain quality and processing, Course 3 of grain storage management, University of Greenwich, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK.

National Resources Institutes (NRI). 1995. Manure for grain storage management, University of Greenwich, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK.

Nazri M.M. 2003. Development of poultry industry. Economic review, Available online at: Nazri, M .M. Development of poultry industry. Economic Review, March 2003 Issue.

Nikam M. G. 2013. Factors affecting feed consumption in chicken. Department of Poultry Science .C.V. ScR'nagar Hyderabad (RVD/12-16).

North M. O. and Bell, D. D. 1990.Commercial Chicken Production Manual. (4th Ed). Avi. Publishing Company, Inc. West, Connecticut.

Poultry Hub. 2018. Feed Intake. Assess online: http://www.poultryhub.org/nutrition/nutrient-requirements/feed-intake/

Prabakran J. J. and Dhanapal S. 2009. Analysis of proximate composition and aflatoxins of some poultry feeds. Asian Journal of Biotechnology. 1(3): 104-110.

Rose S. P. 1997. Principles of poultry science. Wallingford, UK, CAB International.

Saiful I., Shakawat H. and Moinul H. 2015. Effect of corn moisture in the quality of poultry feed. Journal of Poultry Science and Technology. 3(2): 24-31, Jakrey Publication Ltd.

Scanes C. G., Brant, G. and Ensminger M. E. 2004. Poultry science. Upper Saddle River, New Jersey, USA, Pearson Prentice Hall.

Tolessa D., William W. H. and James R. A. 2015. Effect of pelletized poultry manure on crop production and vadosezone water quality. www.reseachgate.net/publication.

Velmurugu R. 2012. Poultry feed availability and nutrition in developing countries. Food and agriculture organization of the United Nations Poultry Development review. Massey University, Palmerton North, New Zealand. al707e00pdf.