EFFECT OF INCLUSION OF SALVINIA MOLESTA ON DIGESTIBILITY, CARCASS AND LYMPHOID ORGANS OF BROILERS

PENGARUH PENCANTUMAN SALVINIA MOLESTA PADA KECERNAAN, CARCASS DAN LIMFOID ORGAN BROILER

Freddy Gena,[*)], L. D. Mahfudz[**)], Sumarsono[**)]
freddygena@yahoo.com
[*)] Student Study Program Faculty of Agriculture and Animal Sciences, Diponegoro University
**) Lecturer Faculty of Agriculture and Animal Sciences, Diponegoro University

ABSTRACT

The objective of this study was to substitute soybean meal with Salvinia molesta in broiler diets and observed the following parameters; carcass, breast muscle, abdominal fat, crude protein digestibility, spleen and bursa of fabricius. A total of 100, 15days of age Lohman strain broilers with initial mean body weight of ±773.83 g were used in this experiment. The experimental design was Completely Randomized Design (CRD) with 4 dietary treatments consisted of Salvinia molesta meal as follows; T0 = control diet, T1 = 6% Salvinia molesta added, T2 = 12% Salvinia molesta added and T3 = 18% Salvinia molesta added. The treatments were replicated five times with five chicks per experimental unit. Feed and water was offered ad libitum from day 15 to 42 and the chicks were vaccinated against Newcastle Disease and Gumboro at age 4 and 15 days old. The data was analyzed using analysis of variance (ANOVA) and F-test with the aid of statistics analytical program (SPSS, version 16) and for mean comparison Duncan Multiple Range Test (DMRT) was applied after significant treatment difference (P<0.05)among treatments. The results showed that the dietary treatments had significant (P<0.05) effect on broiler carcass percentage among the treatments, T0, T1, T2, T3 were 72.75, 72.06, 68.67, 67.27% respectively. Significantly (P<0.05) higher breast muscle percentage (39.20%) was noticed with control diet followed by T1 (34.52%), T2 (30.05%) and T3 (28.61). The marginal differences were significant (P<0.05). Abdominal fat percentage values were similar for control and T1 but significant (P<0.05) to T2 and T3. Crude protein digestibility was significantly (P<0.05) affected by the treatments and the better value was obtained by control diet (86.30%) numerically and significantly least value (77.42%) obtained was with chickens on diet T3 (18% Salvinia molesta). Based on these results the incorporation of Salvinia molesta in the broilers diet can be recommended however, 6% level produced better results than other treatments with respect to the control diet.

Keywords: *Carcass, digestibility, Lohman broiler, Salvinia molesta, soybean meal*

ABSTRAK

Tujuan dari penelitian ini adalah untuk menggantikan bungkil kedelai dengan Salvinia molesta dalam pakan broiler dan mengamati parameter berikut; karkas, otot dada, lemak perut, kecernaan protein kasar, limpa dan bursa fabricius. Penelitian ini menggunakan Sebanyak 100 ekor ayam strain ayam pedaging Lohman umur 15 hari dengan berat badan rata-rata awal ± 773,83 g. Rancangan yang digunakan adalah Rancangan Acak Lengkap (RAL) dengan 4 perlakuan pakan yang terdiri dari Salvinia molesta sebagai berikut; T0 = ransum kontrol, T1 = 6% penambahan Salvinia molesta, T2 = 12% penambahan Salvinia molesta dan T3 = 18% penambahan Salvinia molesta dan diulang lima kali dengan lima anak ayam per unit eksperimental. Pemberian Pakan perlakuan dimlai pada umur 15-42 hari, selanjutnya pemberian air minum secara ad libitum. Vaksinasi ayam dialkuakan pada umur 4 dan 15 hari jenis Newcastle Disease dan Gumboro. Data dianalisis dengan menggunakan analisis varians (ANOVA) dan F-test dengan bantuan statistik program yang analitis (SPSS, versi 16) dan apabila ada perbedan yang signifikan (P<0,05) akan dilanjutkan dengan analisis Duncan Multiple Range Test (DMRT). Hasil penelitian menunjukkan bahwa pemberian pakan dengan penambahan Salvinia molesta pengaruh yang signifikan (P<0,05) terhadap persentase karkas broiler antara perlakuan T0, T1, T2, T3 dengan nilai rataan masing-masing 72,75, 72,06, 68,67, 67,27%. Pengaruh yang Signifikan

(P<0,05) terhadap persentase otot dada dengan persentase lebih tinggi (39.20%) ter hadap perlakuan kontrol pakan diikuti oleh T1 (34,52%), T2 (30.05%) dan T3 (28.61%).
Pengaruh Lemak Perut untuk kontrol dan T1 signifikan (P >0,05) tetapi perlakuan control signifikan (P<0,05) terhadap perlakuan T2 dan T3. Kecernaan protein kasar perlakuan T3 (18% Salvinia molesta) signifikan (P<0,05) terhadap perlakuan T1, T2 maupun perlakuan control. Berdasarkan hasil penelitian penambahan Salvinia molesta dalam pakan ayam pedaging dapat direkomendasikan pada level 6% dengan menghasilkan nilai yang lebih baik dibandingkan perlakuan lainnya maupun terhadap pakan kontrol.

Kata kunci: Karkas, kecernaan, Lohman ayam pedaging, Salvinia molesta, bungkil kedelai

INTRODUCTION

Broiler industry is one of the rapidly increasing and successful domesticated animal industries in recent years and this is driven by the high demand of its products which are relatively cheap but of great quality. The success of broiler industry also however, exerts heavy demand on the feed-base resource. Due to high cost of the traditionally used protein sources, competition with human nutrition and other industrial needs the price of most poultry feed ingredients have worsen particularly protein sources (Martens *et al*., 2012). Therefore, it is of great importance to shift the focus on other protein sources which can be incorporated into the broiler feeding operations without comprising normal broiler performance. One ideal plant is *Salvinia molesta* which is an invasive aquatic weed with great potential due to its high protein content as well as phenomenon growth rate.

This plant grows vegetatively and grows best in nitrogenous and phosphorous contained waterbodies (Cary and Weerts, 1983). Under ideal growing conditions the plant can produce an annual dry weight of about 110 t dry matter/ha (Mitchell and Tur, 1975 as cited by Moozhiyil and Pallauf, 1986) which can supply the broiler industry. Previous investigators (Ma'arifah et al., 2013) used *Salvinia molesta* on cross bred native chickens and the respond from the birds was very promising while others (Zulkarnain and Syahruddin, 2008; Zaman *et al*., 2013) fermented *Salvinia molesta* prior to offering to the birds and the results are also interesting. Utilizing *Salvinia molesta* as broiler feed will result in several advantages such as; 1) reduce feed cost incurred in the feeding operation; 2) reduce the reliance on the traditionally used protein ingredients such as soybean meal; 3) conserve and preserve the aquatic environment from being destructed by the invasive aquatic weeds. However, for any diet to be recommended as adequate ingredient in broiler diet important studies has to be carried out such as digestibility and the protein accretion by the birds. Therefore, this study will involve substituting soybean meal with *Salvinia molesta* in broiler diet and investigate the crude protein digestibility, carcass, breast muscle, abdominal fat, and spleen and bursa of fabricius among the broiler chickens.

RESEARCH MATERIALS AND METHODS

Research Materials

*Salvinia molesta (*S.molesta*)* was collected at a nearby pond (Rawa Pening, Semarang) and prior to sun drying the roots like hairs were separated from the main fronds in order to reduce the fiber content of the plant. After sun drying the plants were grounded manually and kept in airtight polythene plastic bags until the day of usage. Samples of S.molesta and the rest of the ingredients used were analyzed for proximate components using methods as stated by AOAC (1990).

The unsexed Lohman broiler chicks were obtained at a commercial

hatchery and placed in a temporary brooder for the first 14 days. At day 15th the 100 chicks were selected by body weight and the average body weight was ±773.83g.

Prior to the arrival of chicks the house was cleaned well and all necessary equipments were made available such as cages, feed (commercial and experimental diets), vaccines (ND and Gumboro), drinkers, feeding holder, electric bulb (source of heat) and thermometer in the poultry house. Each cage contained a drinker, feeding holder and an electric bulb (source of heat).

Research Methods

Experimental Design

The experimental design used in this research is a Completely Randomized Design (CRD) with 4 dietary treatments and five replications of five birds per experimental unit. The treatments applied in this study are as follows;

T0 = (Control diet) without *Salvinia molesta*
T1 = Diet with 6% *Salvinia molesta*
T2 = Diet with 12% *Salvinia molesta*
T3 = Diet with 18% *Salvinia molesta*

Research Procedure

In the preliminary period (from day 1 to day 11) the DOC were fed a standard commercial starter diet *ad libitum* purposely to equalize the initial body weights then were fed the adaptation diet (basal diet) for a 3 day period. The basal diets consisted of corn-soybean meal as the main ingredients and formulated to meet the nutritional requirements of broilers (NRC, 1994), but soybean meal was reduced and substituted by S.molesta in the diets as shown in Table 2. The experimental diets were fed as mash and formulated to maintain a similar metabolic energy content of 2900 kcal/kg in both the starter and finisher diets but protein content was reduce from 20 to 19% in starter and finisher diets respectively.

At 15 days old, the chicks were weighed individually, foot tagged and allotted to one of the 4 dietary treatments in a completely randomized design (CRD). The broiler birds were vaccinated against Newcastle Disease (ND) twice, on the 4th and along with Gumboro vaccine on 15th days old.

The experimental starter diet was fed when the birds were 15 days old and lasted for 7 days while the experimental finisher diet was fed beginning at day 22 and ran over a period of 21 days. All feed and water was offered *ad libitum*. The chickens were raised in a temporary made bamboo floor pen (1 m x 1 m) with a rice straw littered floor (5 cm depth). The photoperiod was 16 h for the first 21 days then reduced to 12 h during the rest of the finisher phase.

Research Parameters and Collecting Data

At the end the end of the trial one bird/experimental unit (i.e., 5 birds/treatment) was randomly selected for the determination of crude protein digestibility, breast muscle and abdominal fat, spleen and bursa of fabricius.

Birds were fasted for 24 hours then fed a known quantity of each treatment diets and water was provided *ad libitum*. Seven hours after force feeding the birds were slaughtered through severing the jugular vein. After 4 minutes of bleeding ileal digesta was collected from the Merckel's diverticulum to the ileo-caeca junction. The ileal samples of each bird were then placed into a collecting tray and sun dried for 3 days before taken to the laboratory for analysis. The proximate composition of the ileal digesta and feed samples were used to calculate digestibility for crude protein (CP) according to methods as stated by AOAC (1990). The formula used to determine the digestibility of crude is as follows;

$$\text{Digestibility (\%)} = \frac{PCF - PCD}{PCF} \times 100$$

Description:

PF = Protein Content in Feed

PD = Protein Content in Digesta

After collecting the ileal digesta the birds were dipped in a water bath for two minutes and feathers were manually plucked by hand. After the removal of the head carcasses were manually eviscerated to determine the carcass percentage, breast muscle and abdominal fat weights. Abdominal fat was removed from parts around the viscera and gizzard and weighed to the nearest gram. Lymphoid organs (spleen and bursa of fabricius) were also obtained and weighed to the nearest gram.

Statistically Analysis

The experiment was conducted using completely Randomized Design (CRD) having 4 dietary treatments and 5 replications with 5 chicks per treatment. Data was subjected to ANOVA and Duncan Multiple Range Test (DMRT) was applied after significant (P<0.05) mean difference among the treatments (Duncan, 1955).

RESULT AND DISCUSSION

Effect of Treatment Diets on Carcass, abdominal fat and breast muscle

The results presented in Table 1 reveals that the various dietary treatments had significant (P<0.05) effect on the broiler carcass. The maximum mean carcass yield was achieved with chickens on T0 (control diet) which was similar (P>0.05) to T1 and T2 but

Significant (P<0.05) to T3 which was the lowest carcass among the treatments groups. The general trend of carcass values was in alleviating levels of in the diet caused depression of carcass yield. The cause of depressed carcass results noticed in the current trial could be attributed to the tannin content of S.molesta and the high crude fiber contents of the diets. Since treatment 3 had the highest inclusion of S.molesta level (18%) and crude fiber (12.68%) it was most likely that these factors provoked the least carcass value obtained.

The abdominal fat and breast muscle components of finisher broilers are important factors used to assess the quality of any given feed. High breast muscle accretion by broilers is regarded as superior while heavy deposit of abdominal fat indicates poor finishing product (Medugu *et al*., 2010). Therefore, it is the aim of the industry to increase breast muscle yield and reduce fat deposition with better feed efficiency without compromising the normal growth rate of the birds (Mohammed and Horniakova, 2012)

The data in Table 1 depicts that highest percentage of abdominal fat deposition of 2.26% was recorded with

Table 1. Effect of Dietary Treatments on Carcass, Abdominal Fat, Breast Muscle and Crude Protein deposition

	Dietary Treatmentt[1]			
Variables	T0	T1	T2	T3
Carcass Yield (% FLW)	72.75^{a}	72.06^{ab}	68.67^{ab}	67.27^{b}
Abdominal Fat (% FLW)	2.26^{a}	2.07^{a}	1.12^{b}	0.70^{c}
Breast (% Carcass wt.)	39.20^{a}	34.52^{b}	30.05^{c}	28.61^{c}
Crude Protein Digestibility (%)	86.30^{a}	83.59^{a}	83.77^{a}	77.42^{b}

$^{a-c}$ Means with different superscript along the same row differ significantly (P<0.05)

[1] T0 = control diet; T1 = 6% *S.molesta* in diet; T2 = 12% *S.molesta* in diet and T3=18% *S.molesta* in diet.

chickens fed the control diet (T0) while the lowest percentage value was recorded with chickens on diet T3 (0.70%) whereas diets T1 (2.07) and T2 (1.12) recorded intermediate values. Applying DMRT it was discovered that mean values from diets T0 and T1 were similar (P>0.05) but significant (P<0.05) to T2 and T3. Abdominal fat deposition was observed to have a decreasing trend in ascending levels of S.molesta.

It is postulated that chickens fed with high amounts of fiber results in lower abdominal fat content and the present study further confirms this with diet T3. This is in conformity with Saki *et al*. (2011) who observed that chickens fed diets containing high fiber attained lower abdominal fat content at 21 and 42 day of age. Also the influence of tannin on abdominal fat deposition cannot be ruled out.

Contrasting results with Zulkarnain and Syahruddin (2008) who reported better abdominal fat deposition, better performance and protein digestibility on broiler chickens was after fermenting of S.molesta but present experiment involved air dried S.molesta which resulted in suppressed BWG, carcass, breast muscle and abdominal fat deposition especially with 18% S.molesta inclusion level. These contrasting results could be attributed to form of S.molesta being used as broiler feed which could influence the presence of the antinutrient and the nutrient quality and availability of the test diets. In a study by Widodo *et al*.

Table 2. Ingredients and Calculated Content of Experimental Diets

	Starter Diet: 3-4 weeks Period				Finisher Diet: 4-7 Weeks Period			
Feed Ingredients	T0	T1	T2	T3	T0	T1	T2	T3
Corn	52.10	52.30	51.00	51.80	54.00	52.90	52.60	52.50
Salvinia	0.0	6.00	12.00	18.00	0.00	6.00	12.00	18.00
Soybean meal	21.30	17.00	14.00	10.80	19.30	16.50	12.70	9.40
Vegetable oil	1.20	1.20	1.30	1.30	1.20	1.10	1.20	1.20
Rice bran	16.80	15.90	15.10	11.80	17.70	17.60	16.40	14.60
Fish meal	5.00	5.00	5.00	5.00	4.00	3.50	3.50	3.50
Calcium carbonate	0.80	0.70	0.40	0.40	1.00	0.70	0.40	0.20
Premix	0.80	0.70	0.40	0.30	1.00	0.70	0.40	0.20
Methionine	1.00	0.60	0.40	0.30	0.90	0.60	0.40	0.20
Lysine	1.00	0.60	0.40	0.30	0.90	0.60	0.40	0.20
Total	100	100	100	100	100	100	100	100
Total Nutrient Composition								
ME (kcal/kg)	2900.71	2900.84	2900.31	2900.80	2902.62	2901.51	2901.97	2902.10
Crude Protein (%)	20.32	2 0.04	20.27	20.33	19.02	19.14	19.03	19.12
Crude Fat (%)	5.04	4.94	4.91	4.68	5.09	4.91	4.87	4.71
Crude Fiber (%)	6.22	8.36	10.57	12.10	6.31	8.68	10.75	12.68
Methionine (%)	1.26	0.97	0.87	0.85	1.14	0.94	0.84	0.73
Lysine (%)	1.55	1.42	1.47	1.61	1.42	1.39	1.44	1.49
Calcium (%)	1.24	1.77	2.10	2.73	1.36	1.65	1.98	2.41
Phosphor (%)	0.72	1.05	1.39	1.70	0.68	1.02	1.35	1.68

* ME was calculated with Balton formula as cited by Sibbald (1989)
ME = 40.81 (0.87 (CP + 2.25 CF + BETN) + K) K = 4.9

** Proximate Analysis in Nutrition and Feed Science Laboratory, Faculty of Animal Science and Agriculture, Diponegoro University

*** Table of Feedstuff Composition by Amrullah (2004)

(1996) who reported that feeding of high tannin sorghum (HTS) resulted in decrease carcass weight and increased abdominal fat while in the current experiment increasing S.molesta resulted in decreasing trend of both the carcass and abdominal fat content. This could be related to the broiler breed/strain being used, the protein to energy content of the diets, presence of antinutrient and the level of dietary crude fiber

The breast muscle percentages (Table 1) among the treatments show a similar pattern to that of abdominal fat content and that is it decreases as the levels of S.molesta increased in the diet. The sizes of breast muscles could indicate the quality and utilization efficiency of diets by the birds and according to the results it would seem that birds fed treatment diets T2 and T3 poorly utilized their feed.

This can indicate that the control diet had sufficient nutrients to support the breast muscle development of the birds than the S.molesta inclusion diets. Among the S.molesta contained diets chickens fed T3 produced the lowest (28.61%) breast muscle. These results are probably due to the protein concentration and availability in the treatment diets. Diet T2 and T3 contained more of the S.molesta which could lead to the low protein availability to synthesize breast muscle thus attained the least breast muscle percentage. According to Williams (1997, as cited by Kumar *et al*., 2005) breast muscle yield depends on methionine and cysteine concentration in the diet, and methionine according to Gous *et al*. (1982) involves in the detoxification of tannin. Therefore, as S.molesta levels increased in the diets the amount of tannin also increased and this caused imbalance in the concentration of amino acids, therefore, presumably there were not sufficient amino acids available for the birds to meet their maintenance requirements as well as for breast muscle development resulting in lower breast muscle values noticed on diet T3. As reported by Saki *et al*. (2011) the negative effects of high crude fiber diets is more pronounced in chicks however, broilers tend to adapt as they mature. Therefore, the average breast muscle percentage differences noted in the present trial could be attributed to the tannin component of the diets arising from S.molesta inclusion in the diets. The 6% S.molesta inclusion was the appropriate level since higher amounts caused further depression in the breast muscle accretion of the broiler chickens.

Effect of Treatment Diets on Crude Protein (CP) Digestibility

The data of crude protein digestibility of the chickens fed the various treatment diets are presented in Table 1. The result indicates that the levels of S.molesta in the diets had a significant effect ($P<0.05$) on the ease of protein utilization by the broiler chickens. The maximum crude protein digestibility value (86.30%) was obtained with chickens fed the control diet which was similar to treatments T1 (83.59%) and T2 (83.77%) but significant ($P<0.05$) to treatment T3 (77.42%). However, when comparing the values the general trend was depression of CP digestibility in increasing S.molesta levels in the diets.

The descending trend of protein utilization in increasing levels of S.molesta clearly indicates that S.molesta contains undesirable components which impaired the normal digestion and metabolism of protein subsequently affecting the tissue accreditation of the birds. Since carcass yield is an indication of the quality and utilization efficiency of the diets by the birds (Bamgbose and Niba, 1998 as cited by Uchegbu e*t al*., 2004) and according to the results of this study birds in dietary T3 poorly utilized their feeds hence it showed in the low percentage values of breast muscles. These results could be attributed to the antinutrient components of S.molesta as well as the high crude fiber

contents of treatment diet T3. Tannins are known to impair performance as well as nutrient digestibility and crude fiber also acts as a diluents or antinutrient and thus negatively affects performance and nutrient digestibility (Johnston *et al*., 2003). Therefore, combining these two complex components of the tested diets it was possible that digestibility of crude protein would decrease in diets with high inclusion levels of S.molesta (T2 and T3).

Effect of Treatments Diets on Spleen and Bursa Fabricius

The result on the effect of the dietary treatments on the two observed lymphoid organs are stated in Table 3. It shows that maximum percentage of spleen was gained by chickens fed diet T3 (0.39%) while the minimum percentage was recorded with control diet (0.24%) and intermediate values were recorded with diets T1 (0.26%) and T2 (0.34%). The mean comparison with DMRT revealed that this values attained were non-significant whereas for the bursa of fabricius the maximum value was obtained with chickens fed diet T2 (0.18%) and minimum value was recorded with diet T0 (0.10%). According to DMRT the marginal differences of Bursa were not significant.

The non-significant difference and similar pattern of both lymphoid organs in ascending levels of S.molesta could indicate that the health status of the birds in the present experiment were quite similar. According to Niu *et al*. (2009) bursa fabricius weight of broilers aged 42 days is at 0.13% of live weight and based on the values obtained from the present experiment treatment T0 had the lowest bursa fabricius percentage, i.e., 0.10% compared to other treatments. These results could indicate that birds given S.molesta inclusion diets had a fairly better health condition compared to that of the control. Generally, the weights of lymphoid organs (bursa and spleen) are known to decrease in response to increasing levels of stress (Ravindran *et al*., 2006), however, interestingly when comparing with the control treatment the birds reared with S.molesta slightly had higher values, therefore, it can be alleged that S.molesta in the diet helped reduced the stress level of the birds and provoked better health status. Stress can be in the form of high ambient temperature, vaccination, pathology, and non-sterile environmental conditions which can affect the development of the lymphoid organs (Alloui *et al*., 2005).

CONCLUSION

1. The optimum inclusion level of Salvinia molesta which produced better results was 6%.
2. Although the two lymphoid organs measured did not differ among treatments however, Salvinia molesta fed chickens had higher weights which may indicate better health status of chickens than chickens without Salvinia molesta
3. Since Salvinia molesta has is found abundantly in nature further experiment is required on how to better utilize this plant in order to become a sole protein source in poultry diet as well as other monogastric animals.

Table 3. Effect of Dietary Treatments on bursa and spleen

Variables	Dietary Treatmentt[1]			
	T0	T1	T2	T3
Bursa (% FLW)	0.10[a]	0.15[a]	0.18[a]	0.15[a]
Spleen (% FLW)	0.24[a]	0.26[a]	0.34[a]	0.39[a]

Means with same superscript along the same row did not differ significantly (P>0.05)
[1] T0 = control diet; T1 = 6% *S.molesta* in diet; T2 = 12% *S.molesta* in diet and T3=18% *S.molesta* in diet.

REFERENCES

AOAC, 1990. Official methods of analysis. 15 th ed. Association of official analytical Chemist, Washington, DC.

Alloui, M.N., S. Sellaoui, and S. Djaaba. 2005. Morphometrical and anatomopathological survey of the bursa of fabricius in broiler chickens. ISAH. Warsaw, Poland 2: 52-55.

Bamgbose, A. M. and A. T. Niba. 1998. Peerformance of broiler chickens fed cotton seed cake in the starter and finisher rations. In A. D. Ologhobo and E. A. Iyayi (ed.), The Nigerian livestock in the 21st century, Proceedings of 3rd annual conference of Animal Science Association of Nigeria, September 22-24, Lagos Pp. 84-87.

Cary, P. R. and P. G. J. Weerts. 1983. Growth of Salvinia molesta as affected by water temperature and nutrition. II. Effects of phosphorus level. Aquat. Bot. 17:61-70.

Duncan, D. B. 1955. Multiple range and F-Test. Biometrics, 11: 1-42.

Gous, R. M., M. A. Kuyper and C. Dennison. 19982. The relationship between tannic acid content and metabolizable energy concentration of some sorghum cultivars. South African J. Anim. Sci., 12: 39-44.

Johnston, L. J. S. Noll, A. Renteria, and J. Shurson. 2003. Feeding by-products high in concentration of fiber to nonruminants. In: Third National Symposium on Alternative Feeds for Livestock and Poultry, Kansas City, November 4, 2003.

Kumar, V., A. V. Elangovan and A. B. Mandal. 2005. Utilization of reconstituted high-tannin sorghum in the diets of broiler chickens. Asian Australian J. Anim. Sci., 18(4): 538-544.

Martens, S. D. T. T. Tiemann, J. Bindelle, M. Peters, C. E. Lascano. 2012. Alternative plant protein sources for pigs and chickens in the tropics- nutritional value and constraints: a review. J. Agri. and Rur. Trop. And Subtro., 13(2): 101-123.

Medugu, C, I., I. D. Kwari, J. Igwebuike, I. Nkama, I. D. Mohammed and B. Hamaker. 2010. Carcass and blood components of broiler chickens fed sorghum or millet as replacement for maize in the semi arid zone of Nigeria. Agri. and Bio. J. of North America, 1: 2151-7517.

Miller, E. L. 2004. Protein nutrition requirements of farmed livestock and dietary supply. Retrieved May 30, 2014, from http://www.fao.org/docrep/007/y5019e/y5019e06.htm#TopOfPage

Mitchell, D. S. and N. M. Tur. 1975. The rate of growth of Salvinia molesta (S. auriculata auct.) in laboratory and natural conditions. J. Appl. Eco., 12: 213-225.

Mohammed, H. A. and E. Horniakova, 2012. Effect of using saturated and unsaturated fats in broiler diet on carcass performance. Slovak J. Anim. Sci., 45(1):21-29.

Moozhiyil, M. and J. Pallauf. 1986. Chemical composition of the water fern, Salvinia molesta, and its potential as feed source for ruminants. Econo. Bot., 40(3): 375-383.

Niu, Z., Y. Liu, F.Z, Yan, Q. L. and W. C. Li. 2009. Effects of different levels of vitamin E on growth performance and immune responses of broilers under heat stress. Poult. Sci., 88: 2101-2107.

NRC. 1994. Nutrient Requirements for Poultry. 9th rev. ed. Natl. Acad. Press, Washington, DC.

Ravindran, V., D.V. Thomas, D.G.Thomas and P.C.H.Morel. 2006. Performance and welfare of broilers as affected by stocking density and zinc bacitracin supplementation. Anim. Sci. J., 77: 110–116.

Saki, A. A., H. R. Hemati Matin, P. Zamani and F. Mirzaaghatabar. 2011. Non starch polysaccharides and broiler responses. W. Appl. Sci. J., 15(2): 192-198.

Uchegbu, M. C., I. C. Okoli, C. E. Anyanwu, E. B. Etuk, B. O. Esonu and A. B. I. Udedibie. 2004. Performance, carcass and organ characteristics of finisher broilers fed graded levels of raw Napoleona imperials seed meal. Livestock Research for Rural Development, Vol. 16, Art. #41. Retrieved June 29, 2014, from http://www.lrrd.org/lrrd16/6/uche16041.htm

Widodo, W., Koentjoko, M. Kamal and M. M. Ardhana. 1996. The effect of levels of two varieties of sorghum in the diets on broiler performance. J. Agr. Sci., 19: 107-109.

Williams, P. E. V. 1997. Poultry production and science: future directions in nutrition. W. Poult. Sci. J., 53(1): 33-48.

Zulkarnain, H and H. E. 2008. Syahruddin Peningkatan qualitas Kiambang (Salvinia molesta) melalui pendekatan bioteknologi dengan beberapa jenis kapang sebagai pakan broiler. Fakultas Peternakan Universitas Andalas Padang. Sumatra