

Effect of sex and frequency of litter change on growth performance, haematology and carcass yield of rabbits raised on deep litter system

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Abstract

This study was carried out to determine the effects of sex and frequency of litter change on growth performance, carcass yield and haematology of rabbits reared under deep litter. Twenty four 8 weeks old grower rabbits comprising of twelve each of males and females were randomly allocated to 24, 48 and 72 hours litter change in a 2 x 3 factorial arrangement. Data were collected on growth performance, carcass yield and haematology and analysed using ANOVA. Result showed that sex of rabbit had no significant (P>0.05) effects on weight gain, feed intake, feed conversion efficiency and cost of litter change. Also, frequency of litter change had no significant (P>0.05) effect on performance. Cost on litter change increased (P<0.05) from N200 with rabbits under 72 hours frequency to N600 with rabbits under 24 hours. Furthermore, sex had no significant effect (P>0.05) on carcass yield while frequency of litter change had significant (P<0.05) influence on heart and liver of rabbit. Sex had no significant (P>0.05) effect on the haematology except (P<0.05) monocyte. White Blood Cell and basophil were insignificant (P>0.05) with increased frequency of litter change. The study concluded that male or female rabbits could be reared under 24, 48 and 72 hours frequency litter change without any detrimental effects on growth and carcass yield. However, 72 hours litter change interval helped to reduce prevent stress conditions in rabbit and could be economically beneficial in rabbit production under deep litter housing type.

Key words: sex, litter, performance, carcass and haematology

Introduction

Protein intake in the diet of the average Nigerian both in terms of quality and quantity is widely acknowledged to be inadequate (Peace *et al*., 2002). For example 35g out of the required minimum of 65-72g of reference protein in the diet of the average Nigerian should be obtained from animal products. However, only 8.4g out of the 53.8g of protein consumed per head per day in Nigeria comes from animal sources (Alliso-Oguru, 1992). In 1986, the average animal protein intake per capita per day was about 7.6g, while only 13.26g per day was estimated as the available animal protein for every Nigerian in the year 2000 (Okuneye, 2002).

The available information over the last three decades indicated that animal protein per capita in Nigeria is less than the minimum recommended by the FAO (UNDP, 2006). The remedy to the perceived protein deficiency situation in the country calls for increased supply of animal protein products such as beef, pork, mutton, chevon, milk, poultry, and lago meat.

Hitherto, livestock policy of government over the years laid more emphasis on increased production of the conventional livestock products such as beef, pork, mutton and chevon as well as poultry products with little or no attention on other farm animals such as rabbit.

The efforts so far have not translated to production of reasonable and affordable quantity of animal products to meet the minimum protein requirements of the teeming population, job creation and food security. Hence, there is the need to consider all available options including the promotion of non-conventional micro-livestock such as rabbit for sustainable livestock development and production efficiency (Agricultural Livestock Transformation Action Plan, 2012).

Rabbits have been documented to be are very prolific with short gestation period of 30 – 32 days, producing at least 4-5 litter per year that consists with litter sizes of 6-8 kittens on the average (Biobaku 1998). In addition, they could subsist on forages and kitchen wastes to meet satisfy their basic nutritional requirements coupled with good environment and housing system.

In a study conducted by Berepubo *et al*. (1996) on cage system of rearing it was observed that the Rabbits raised in battery cage system recorded higher feed intake but lower feed conversion compared to those on the floor system. The observation was partly due to physical response of rabbit to stress associated with cage system (Berepubo *et al*., 1996).

Considering the defect of the cage system on the general welfare as a result of aforementioned stress factor of rabbit there is need to re-direct attention to system of housing that enables the animal exhibit its natural habitat for environmental and economic values. However, deep litter has its constraints. One of the highest problem is the risk of coccidiosis that often lead to high mortality and low productivity (Kustos *et al*., 2003; Szendro *et al*., 2009) in rabbit and other livestock. Though deep litter system with wood shavings (as bedding materials) has been adjudged to be preferred in poultry (Sogunle *et al*., 2007), there is dearth of information on its use and the frequency of change on the growth performance, carcass yield and blood constituents of rabbits hence the need for and this necessitated this study.

Materials and Methods

The experiment was carried out at the Rabbit Unit of the Teaching and Research Farm Directorate (TREFAD), Federal University of Agriculture, Abeokuta. The area lies within latitude 7^0 space 8"N and 3^0 25"E. The housing was a typical movable cage raised floor type (deep litter). It has a dwarf wall and the sides were covered with wire mesh. The size was 3m x 2m x 1.7m (length x breadth x height), and has the individual internal cell dimension of 45cm x 60cm that runs the length of the cage to the left and to the right sides. Wood shavings were used as a bedding material for the rabbits. The experimental pen was divided into 12 cells that comprised six (6) cells for male and female rabbits respectively with 2 rabbits per cell. The animals according to sex were placed on varying litter change of 24. 48 and 72 hours. Each of the treatment was replicated twice.

Twenty four (8 weeks old) weaner rabbits comprising of 12 males and females were used for the study. The rabbits were sourced from a reputable rabbit farm within Abeokuta metropolis. The cages were washed, disinfected and the animals were fed with fresh concentrates and water *ad libitum* with roughages given as supplement. Left over concentrate were weighed at the end of each day to determine the amount of concentrate consumed. All necessary medication were given at when due.

Data were collected on body weight gain, feed intake, feed conversion efficiency and body temperature. Body temperature of the animal per treatment and replicate was taken daily with the aid of digital body thermometer (MT – 301) between 8 and 9 hour. The thermometer was inserted into the rectum of each rabbit and the value of the body temperature was read after the beep sound from the thermometer.

Blood sample was collected through the ear (pinna) using 5ml needle and syringe and emptied into a well labelled Ethylene DdiamineTtetra Aacetate (EDTA) bottle to determine the haematology and white blood differentials. This was done for each of the animals according to treatment and replicate at the beginning and end of the study to serve as the base and final blood profiles.

At the end of 8th week, the live weight of each rabbit was taken and later sacrificed for carcass yield determination. They were slaughtered through neck decapitation, siengeding, and then eviscerated. The eviscerated weight was taken and the hot carcass was stored in a refrigerator at about 0^0C - 4^0C for 24 hours. Thereafter the cooled carcass was weighed and expressed relative to the live weight. Also, the proportion of dressed weight, major cuts, and internal organs namely; heart, liver and kidney were determined as described by Lukefahr *et al*., (1982).

Cost of litter change was determined using the total cost of packing and transportation relative to total volume of the litter packed. Cost per frequency of change was calculated and put at N12.50K. Cost on litter change was calculated as product of cost per change and number of litter change. A total litter change was 56, 28 and 19 times for 24, 48 and 72 hours frequency respectively.

All data generated from the study were subjected to one- way analysis of variance (ANOVA) in a 2×3 factorial design using SAS (1999). Significant means at 5% was separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

Main effect of sex and frequency of litter change on the performance of rabbit is shown in Table 1. Final weight, weight gain, feed intake and feed conversion efficiency were significant (P>0.05) with sex and frequency of litter change. This finding was supported by Ortiz and Rubio (2001), who reported no influence of sex on growth parameters of rabbits.

Sex of rabbit and frequency of litter change has no significant (P>0.05) effect on mortality of rabbit reared under deep litter housing type. This result was at variance with the findings of Dal Bosco *et al.,* (2000) and (2002) who reported 13.2% mortality for rabbit under deep litter system. It could be that the frequent change of litter improved the animal health and reduced morbidity that may lead to mortality. Szendro *et al*., (2009) reported improved health of rabbit housed in pens without or with platform and this opinion gave credence to this finding.

Cost on litter change and body temperature of rabbits were not significant (P>0.05) with sex. However, frequency of litter change was significant (P<0.05) effect on cost of litter change. Rabbit under 24 hours frequency of litter change had highest total cost of litter (N600) this reduced with reduced frequency of change from N300 among rabbits under 48 hours to N200 among rabbits under 72 hours frequency of change. This result was not unprecedented as frequent change of litter and direct impact on duration, quantity of litter used and overhead cost of supply. Rabbits on the 24hours litter change had their litter changed for a total of 56times, those on the 48hours had their litter changed for 28 times while those on the 72 hours litter change had their litter changed for a total of 19 times. Thus, increased frequency only resulted in high cost of production but has no economic justification or benefit when compared with final weight, weight gains and other growth parameters of rabbits.

The interactive effect of sex and frequency of litter change on the performance of rabbits reared under deep litter housing system is shown in Table 2. All parameters measured were not significantly (P>0.05) different with interaction except (P<0.05) total cost of litter change. Cost on litter increased significantly (P<0.05) with increased frequency of change across the sex of rabbit throughout the duration of the study. This was N200, N300 and N600 for 72 hours (16 times change) 48 hours (24 times change) and 24 hours (48 times change), respectively. This could be attributed to overhead cost of sourcing packing and transporting of litter materials. However, this was not of economic benefit to rabbit farmers since it did not led to increased growth of rabbit. Rather, it increased cost of production at expense of farmer’s cost benefit.

Rabbits generally have low daily feed intake (60 – 70g) and as indicated in this study, 57.34 – 66.04g and low growth rate thus, they are not heavy eaters and do not generate heavy faecal waste compared to broilers. This could be the reason for less frequency of litter change, the resultant longer use of litter as bedding material consequently low frequent (72 hours) of litter change as shown in this study (16 times).

Table 3 shows the main effect of sex on the carcass yield of rabbit. Sex had no significant (P>0.05) effect on all carcass parameters of rabbit. This result was in agreement with the finding of Oritz and Rubio (2001) who reported no influence of sex on dressing percentage of rabbit. Also the relative weight of some organs of the rabbit such as heart, liver and kidney were not significantly (P>0.05) different with sex. This finding was similar to that of Farghaly and El-Mahdy (1999) who reported that there was no significant (P>0.05) effect of sex on different organ weight except liver weight.

Table 1: Main Effect of Sex and Frequency of Litter Change on Performance of Rabbits

	Sex			Frequency of litter change			
Parameters	Male	Female	SEM	24 hours	48 hours	72 hours	SEM
Initial Weight (g)	837.50	700.00	287.75	725.00	656.30	925.00	287.75
Final Weight (g)	1287.50	116.70	379.75	1250.00	931.30	1425.00	379.75
Weight gain (g/day)	9.18	9.52	3.73	10.21	7.14	10.71	3.73
Feed Intake (g/day)	65.22	58.24	5.96	61.14	61.96	62.09	5.96
FCE	0.14	0.17	0.01	0.18	0.12	0.16	0.01
Mortality (%)	0	0	0	0	0	0	0
Cost of Litter Change (₦)	366.7	366.7	0	600[a]	300[b]	200[c]	0
Body Temperature (^{0}C)	34.596	36.84	1.96	36.61	35.03	35.51	36.86

a-c: means on the same row with different subscript are significantly different at (P<0.05).
SEM = Standard Error of Means
FCE = Feed Conversion Efficiency

Table 2: Interaction between sex and frequency of litter change on performance of rabbits

	Male			Female			
Parameters	24 hours	48 hours	72 hours	24 hours	48 hours	72 hours	SEM
Initial Weight (g)	800.00	662.50	1050.0	650.00	650.00	800.00	287.75
Final Weight (g)	1225.0	1087.5	1550.0	1275.0	775.0	1300.0	379.87
Weight gain (g/day)	8.67	8.66	10.205	12.755	5.610	10.205	3.73
Feed Intake (g/day)	64.945	64.675	66.035	57.335	59.24	58.15	5.95
FCE	0.14	0.13	0.15	0.23	0.11	0.17	0.01
Cost of Litter Change (₦)	366.7	366.7	0	600^a	300^b	200^c	0.00
Body Temperature (^{0}C)	36.36	33.21	34.21	36.85	36.86	36.81	1.96

a-c: means on the same row with different subscript are significantly different at (P<0.05).
SEM = Standard Error of Means
FCE = Feed Conversion Efficiency

Frequency of litter change had significant (Pp<0.05) effect only on heart and liver of rabbits (Table 3). Heart relative weight ranged (P<0.05) between 0.20% and 0.32%. Rabbit under 72 hour litter change had the least heart weight (0.20%) while those under 48 hour frequency of litter change had the highest (0.32%). Liver weight also varied (P<0.05) from 2.58% to 4.33% with litter change. Rabbits under 24hours litter change had highest relative weight of liver (4.33%) while those under the 48hours frequency of litter change gave the least (2.58%). Farghaly and El-Mahdy (1999) gave credence to this observation.

Table 3: Effect of sex and frequency of litter change on the carcass yield of rabbits

Parameters	Sex		SEM	Frequency of litter Change			SEM
	Male	Female		24hours	48hours	72hours	
Live Weight (g)	1287.50	116.70	379.87	1250.00	931.30	1425.00	397.87
Dressed Weight (g)	692.70	512.90	247.78	664.50	427.70	716.20	247.78
Dressed Percentage (%)	53.51	45.92	12.56	52.87	46.56	49.70	12.56
Major Cut (%)							
Fore Limbs	18.33	15.78	19.10	19.80	15.21	16.15	19.10
Hind Limbs	20.60	19.10	3.90	20.39	20.63	18.54	3.90
Lion	12.64	9.33	3.06	11.25	10.25	11.57	3.06
Organs (%)							
Heart	0.26	0.28	0.01	0.29	0.32	0.20	0.01
Liver	3.12	3.67	0.47	4.33	2.58	3.27	0.47
Kidney	0.65	0.65	0.10	0.65	0.70	0.61	0.10

SEM = Standard Error of Means

Table 4: Interaction Effect of Sex and Litter Frequency of Change on Carcass Yield of Rabbits

Parameters	Sex		SEM	Frequency of litter Change			SEM
	Male	Female		24hours	48hours	72hours	
Live Weight (g)	225.00	1087.50	1550.00	1087.50	775.00	1300.00	379.90
Dressed Weight (g)	725.00	480.60	872.40	374.80	374.80	560.00	247.80
Dressed Percentage (%)	60.29	44.66	55.59	48.50	48.50	43.83	12.56
Major Cut (%)							
Fore Limbs	23.51^{a}	12.12^{b}	19.86^{ab}	16.10^{ab}	18.31^{ab}	12.93^{b}	3.52
Hind Limbs	22.61	19.28	19.93	18.17	21.99	17.15	3.90
Lion	14.07	13.38	10.49	8.44	7.76	11.78	3.06
Organs (%)							
Heart	0.27^{ab}	0.28^{ab}	0.23^{b}	0.31^{ab}	0.37^{a}	0.17^{b}	0.01
Liver	3.75^{ab}	2.06^{b}	3.37^{ab}	4.92^{a}	3.11^{b}	2.97^{b}	0.67
Kidney	22.61	19.28	19.93	18.17	21.99	17.15	3.90

a-ab: Means on the same row with different subscript are significantly different at (p<0.05).

SEM = Standard Error of Means

Interactive effect of sex and frequency of litter change on the carcass yield of the rabbit is shown in Table 4. Interaction between sex and frequency of litter change had significant (P<0.05) effect dressed percentage (carcass slaughter yield), fore limb, heart and liver of rabbit. The result of dressed percentage (43.83-60.29) was lesser than the finding of Zotte (2002) and Yalci *et al*., (2006) who reported ranges of 55-61% and 60-69%, respectively for rabbits. The variation in this findings could be as a result of breed.

Female rabbit recorded highest significant (P<0.05) heart (0.37%) and liver (4.92%) weight while male rabbit recorded least heart and liver weight of 0.23% and 2.06%, respectively but did not follow a particular trend with frequency of litter change. This result was in agreement with the finding of Farghaly and El-Mahdy (1999) who reported that there was insignificant effect of sex on different organ weights except liver weight. Male rabbit had been reported to have remarkable growth potential than female rabbit (Ortiz & Rubio, 2001) perhaps this was responsible for higher fore limb (23.51%) recorded for male rabbit under the 24 hours frequency of litter change. This result was similar also with the finding of Yalcin *et al*., (2006) who reported female rabbits had lower hind limb (14.77%)

However, the result of relative weight of the liver and heart of female rabbit were at variance to the findings of Yalcin *et al*. (2006) who reported lesser weight of liver (3.14%) and heart (0.34%) compared to male rabbit of New Zealand breed. The variation might be due to breed of rabbits used.

Table 5: Main Effect of Litter Change and Sex on Haematology of Rabbit

Parameters	Sex		SEM	Frequency of litter Change			SEM
	Male	Female		24hours	48hours	72hours	
Initial PCV (%)	22.50	21.67	7.68	19.50	24.75	22.00	7.68
Final PCV (%)	34.25	32.00	2.17	33.33	33.00	33.50	2.17
Initial RBC ($x10^6/mm^3$)	3.27	3.14	1.44	2.73	3.62	3.26	1.44
Final RBC ($x10^6/mm^3$)	4.99	4.99	0.63	5.073	5.09	4.79	0.63
Initial HB (g/dl)	7.50	7.22	2.56	6.50	8.25	7.33	2.56
Final HB (g/dl)	11.42	10.67	1.25	11.111	11.00	11.17	1.25
Initial WBC ($x10^6/mm^3$)	5067	7467	2256.9	4388^b	8813^a	5600^{ab}	2256.9
Final WBC ($x10^6/mm^3$)	8150	3666.67	60.0	6433.33	6400	5750	60.0
Initial Neutrophil (%)	27.33	32.67	10.35	28.25	32.0	29.75	10.35
Final Neutrophil (%)	59.25	55.67	2.65	57.67	55.0	60.50	2.65
Initial basophil (%)	0.67	0.33	0.58	0.25^{ab}	0^b	1.25^a	0.58
Final basophil (%)	1.00	0	1.07	1.33	0	0	1.07
Initial eosinophil (%)	0.33	0.17	0.53	0.25	0.25	0.25	0.53
Final eosinophil (%)	0.75	0	1.45	0	1.5	0	1.45
Initial monocyte (%)	0^a	1.67^b	0.59	1.0	0.5	0.25	0.59
Final monocyte (%)	0.25	1.33	1.68	0.333	0	2.0	1.68

a-ab: Means on the same row with different subscript are significantly different at ($p<0.05$).

SEM = Standard Error of Means

Table 5 shows the main effect of sex and frequency of litter change and sex on haematology parameters of rabbit. Sex had no significant effect ($P>0.05$) on all of the parameters measured except ($P<0.05$) initial monocyte. Male rabbit had 0% initial monocyte while female rabbit recorded 1.67%. However, variations in final monocyte were insignificant ($P>0.05$) with sex.

Main effect of frequency of litter change is also shown in Table 5. Haematology were insignificant ($P>0.05$) with frequency of litter change except ($P<0.05$) initial WBC and basophil. Initial WBC ranged between 4388 and 8813 $x10^6/mm^3$. This was at variance with the normal physiological range (5000-7510 $x10^6/mm^3$) reported by Mitruka and Rawnsley (1977) for healthy rabbits but in agreement with the ranged reported by CCAC (1980) for healthy rabbits. Initial basophil differed significantly ($P<0.05$) with frequency of litter change and this ranged between 0.25 and 1.25% but not significant ($P>0.05$) with final basophil. This suggested that frequent change of litter helped reduce microbial infections and invasion of foreign organism in the system of the experimental animal. Thus, WBC and monocytes reduced with regular litter change.

The values of haemoglobin and Packed Cell Volume (PCV) in this study ranged from 6.50 g/dl to -8.25 g/dl and 33.0 to-33.50%, respectively but were insignificant ($P>0.05$). The result was within the normal range 10 to-17.4 g/dl for haemoglobin and 33.0 to -50.0% for PCV reported by Mitruka and Rawnsley (1977). Equally, all the results of the haematological parameters were within the ranged for healthy rabbit (CCAC, 1980).

Table 6: Interaction Effect of Litter Change and Sex on Haematology of Rabbit

Parameters	Sex		SEM	Frequency of litter Change			SEM
	Male	Female		24hours	48hours	72hours	
Initial PCV (%)	18.0	19.0	30.50	21.0	30.50	13.50	7.80
Final PCV (%)	36.0	34.0	31.0	28.0	32.0	36.0	1.189
Initial RBC ($x10^6/mm^3$)	2.505	2.430	4.865	2.950	4.810	1.660	1.439
Final RBC ($x10^6/mm^3$)	5.30	5.17	4.22	4.62	5.00	5.35	0.376
Initial HB (g/dl)	6.00	6.33	10.17	7.00	10.17	4.50	2.56
Final HB (g/dl)	12.0	11.33	10.33	9.33	10.67	12.00	0.687
Initial WBC ($x10^6/mm^3$)	4800^{ab}	7100^{ab}	3300^{b}	3975^{b}	10525^{a}	7900^{ab}	2256.9
Final WBC ($x10^6/mm^3$)	7950	8400	8300	3400	4400	3200	22.85
Initial Neutrophil (%)	21.50	31.00	29.50	35.00	37.00	30.00	10.35
Final Neutrophil (%)	58.50	50.00	70.00	56.00	60.00	51.00	3.26
Initial basophil (%)	0.5^{ab}	0^{b}	1.5^{a}	0^{b}	0^{b}	1^{ab}	0.57
Final basophil (%)	0	0	0	0	0	0	0
Initial eosinophil (%)	0.5	0	0.5	0	0.5	0	0.53
Final eosinophil (%)	0	3	0	0	0	0	0
Initial monocyte (%)	0^{b}	0^{b}	0^{b}	2^{a}	0.5^{ab}	1^{ab}	0.59
Final monocyte (%)	0.5	0	0	0	0	4	0.84

a-ab: Means on the same row with different subscript are significantly different at ($p<0.05$).

Interactive effect between sex and frequency of litter change on haematology of rabbit is shown in Table 6. There was no significant ($P>0.05$) difference in the haematological parameters measured except for the initial WBC, initial basophil and initial monocytes which were significantly ($P<0.05$) different with interaction. Though the results were within the range for healthy rabbit (CCAC, 1980), the result suggested that interaction helped to reduce disease infection and the animals were generally healthy. Final haematology values of the experimental animals were all insignificant ($P>0.05$) with interaction and still within normal range for healthy rabbit therefore frequent litter change help reduced disease infection and prevent allergic/stress conditions in rabbit.

Conclusion

The study concluded that sex had no effect on growth performance and carcass yield of rabbits. Also, frequency of litter change had no effect on growth performance and carcass yield of rabbit but had influence on the relative weight of heart and liver. Frequent litter change reduced microbial infection count thus reduce WBC and basophilia and therefore prevent stress conditions in rabbits. Seventy two (72) hours frequency of litter change could be economically beneficial in rabbit production under deep litter housing type.

Reference

Agricultural Transformation Action Plan 2012. Nigeria livestock transformation agenda. Office of the Honourable Minister of Agriculture & Rural Development, Abuja. 20Pp

Allison-Oguru E.A., 1992. Econometric analysis of aggregate demand for fish in Nigeria 1980-1987, Delta Agriculturist. 1(1), 1-10

Berepubo, N.A., O.J. Owen, A. Monsi, U.1. Oji and E.C. Chukwuigwe, 1996. Evaluation of “Sudden death syndrome in rabbits colonies raised under different rearing systems in Rivers State Nigeria. J. Innovations Life Sci., 2: 44–47

Biobaku, W.O. 1998. Growth response of rabbits fed graded levels of groundnut shell: effect on weight and enzyme activities. Journal of Pure and Applied Science. 1(1): 44-50

Canadian Council on Animal Care (CCAC) 1980. Guide to the care and use of experimental animals. 1: 82-90.

Dal Bosco A., Castellini C., Berenardini M. 2000. Production performance and carcass and meat characteristics of cage or pen raised. World Rabbit Science, 579-583

Dal Bosco, A. Castelli, A. and Mugnai, C. 2002. Rearing rabbit on wire net floor or straw litter: behaviour, growth and meat qualitative traits. Livestock Production Science 75: 149 - 156

Duncan, D.B. 1955. Multiple range and F-test biometrics 11: 1-42

Farghaly, H. M. and El-Mahdy, M.R.M. 1999. Genetic and non- genetic factors affecting live, carcass and non-carcass traits of New Zealand White rabbits in Egypt. Indian Journal of Animal Science, 69(8): 596-603.

Kustos K., Tóbiás G., Kovács D., Eiben Cs., Szendrı Zs. 2003. Effect of stocking density, the material of botton and feeding on performance of growing rabbits (in Hungarian). In Proc.: 15th Hungarian Conference on Rabbit Production, 2003 May, Kaposvár, Hungary, 123-128.

Lukefahr, S.D., Hohenboken, W.D., Cheeke, P.R. and Patton, N.M. 1982. Carcass and meat characteristics of Flemish giant and New Zealand white purebred and terminal cross rabbits. J. Anim. Sci., 54(6), 1169-1174

Mitruka, B.M. and Rawnsley, H.M . 1977. Clinical, biochemical and heamatological reference values in normal experimental animals. Masson publication Inc., New York, PP: 21-84.

Ortiz Hernndez, J. A.; Rubio Lozano, M.S. 2001. Effect of breed and sex on rabbit carcass yield and meat quality. World Rabbit, Science 9: 51- 60.

Peace U. Mobolaji-Bukola, E.A. Allison-Oguru, N.A. Berepubo & B.M. Oruwari (2002) Bio- economic evaluation of the performance of rabbits raised under two different housing systems. Tropicultura, 2002, 20, 4, 176-180

Statistical Analysis System (SAS). 1999. Statistical Analysis System. SAS Institute Inc. Cary, NC 27513, USA.

Sogunle, O.M., A.O Fanimo, K. O. Bello., B.A Ogunjimi and T.O Bawala 2007. Effect of litter depth on the performance of three strains of broiler chicken in sustainability of livestock industry in an oil economy. (E.A. Aglang, L.N.Agwunobi and O.O. Olawoyin) Proceedings of the 32nd annual conference of the Nigeria society of animal production. Pp 305-306.

Szendrő, Zs., Matics, Zs,. Nagy, I., Odermatt, M., Gerencsér, Zs., Szendrő, É., Radnai, I., Dalle Zotte, A. 2009. Examination of growing rabbits housed in pens without or with platform.16th Intern. Symp. Housing and Diseases of Rabbits, Fur providing Animals and Pet Animals, Celle, (in press)

UNDP, 2006. Socio-Economic Impact of Avian Influenza in Nigeria. UNDP Nigeria. July 2006.

Yalcin, S.; Onbasir, E.E. and Onbalsar, I. 2006. Effect of sex on carcass and meat characteristics of New Zealand White rabbit aged 11 weeks. Australian Journal of Animal Science, 19(8): 1212-1216

Zotte, A.D. 2002. Perception of rabbit meat quality and major factors influencing the rabbit carcass and meat quality: Review. Livestock Production Science, 75: 11 – 32.