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EFFECT OF DIFFERENT OF RATION OF COARSE AND FINE LIMESTONE PARTICLES ON PRODUCTION AND SHELL QUALITY OF LAYERS AT PEAK

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ABSTRACT: *A study was conducted to determine the influence of different particle sizes of limestone in layer diets on egg production and eggshell quality from 18 to 28 weeks of age. Limestone consisting of small (<1.0 mm) and coarse (2.0 - 3.8 mm) particles that is used in poultry diets was obtained from a South African company. The two particle sizes were mixed to produce five treatments viz. 100 fine (F): 0 coarse (C); 75 F: 25 C, 50 F: 50 C, 25 F: 75 C and 0 F: 100 C. Diets were isocaloric and isonitrogenous. A total of 167 point of lay pullets (18 weeks) were obtained from a commercial pullet farm and were individually caged. The pullets were randomly allocated to five treatments (n = 33) to determine egg production and eggshell quality characteristics. Egg production and eggshell quality data were recorded on individual bird basis and summarized at the end of the week. Dietary treatment did not influence (P>0.05) egg production and egg shell quality (shell thickness, egg weight, egg output, egg surface area, shell percentage and SWUSA) at 24 weeks of age. These results suggested that the influence of dietary limestone particle size distributions at a later stage of the laying period on egg production and egg quality needs further investigation.*

ORIGINAL ARTICLE

Keyword: *Calcium, Egg production, Egg weight, and Eggshell quality*

INTRODUCTION

In laying hens, calcium plays an important role in bone integrity and eggshell formation. Therefore, any deficiency in the supply or problem in calcium metabolism will lead to weaker bones and eggshells. This will have a deleterious effect on hatching egg quality, as well as, the production of table eggs. According to Roland (1986), the average calcium requirements for eggshell formation within a population of hens are greatest at approximately peak production.

There are several factors involved in egg shell formation of which calcium as a major constituent of the eggshell feature prominently. In this regard, not only the source and level of calcium is important but also the particle size of the calcium source. Roland (1986, 1988), and Guinotte and Nys (1990) reported that larger particles are superior to small or medium in improving egg shell strength and weight. In contrast, Keshavarz and Nakajima (1993) and Keshavarz (1998) found no influence of large particle size on egg shell thickness and egg weight.

The solubility of calcium carbonate depends on the particle size and source of calcium origin (Guinotte and Nys, 1990). Therefore, the ultimate aim should be to supply fine and coarse limestone particles in layer diets in a ratio that will ensure that calcium is available for egg shell formation. Small particle sources such as pulverized calcium carbonate ($CaCO_3$)) passed quickly through the digestive tract and the bird may not be able to sufficiently extract enough calcium to meet its needs. On the other hand, ground limestone could be absorbed by the hen during the day when it is eating, but

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during the hours of darkness metering of calcium occurs in the digestive tract from the gizzard because of the breakdown of the shell grit or limestone chips (Woolford, 1994). Larger particle sizes of $CaCO_3$ in the form of coarse limestone or oyster shell) will be retained in the gizzard for a longer period of time (Woolford, 1994; Korver, 1999). This situation allows for a gradual release of calcium from the gizzard to the small intestine for absorption, resulting in increased time over which the hen receives dietary calcium. According to Farmer et al. (1986), the aim is to offer the bird a constant supply of calcium to improve the shell characteristics and not an excess since it lowers production.

The aim of the study was therefore to investigate the effect of particle size distribution from a specific limestone source in a layer diet on egg production and egg quality at peak production (24 weeks of age).

MATERIAL AND METHODS

One hundred and sixty seven 17 weeks old pullets were obtained from a commercial pullet farm. All the pullets received the same layer diet except for the particle size distribution of the calcium supplement in the diets during lay. The pullets were randomly allocated to five groups of 33 pullets per diet. Pullets in each group received one of the five different ratios of fine (<1.0 mm) and coarse (2.0 - 3.8 mm) limestone particles namely 100, 75, 50, 25 and 0% fine or coarse particles. The two particle sizes of limestone grit were obtained from a commercial supplier of limestone to the poultry industry and these were classified as fine, (particle size <1.0 mm) and coarse (2.0 – 3.8 mm). The two types were mixed in the following ratios 100 F: 0 C, 75 F: 25 C, 50 F: 50 C, 25 F: 75 C and 0 F: 100 C. A medium particle size mixture (1-2 mm) was obtained by mixing equal amounts of fine and coarse particles. There were thus five dietary treatments with 33 individual hens in single cages serving as replicates for each treatment.

Limestone was screened through sieves to obtain samples with appropriate diameters. An amorphous limestone (paste here) was used. The limestone source contained 90 % $CaCO_3$ and 36 % calcium.

Cages were fitted with feed troughs, water nipples and perches. The individual birds had free access to water and feed. Feed intake was recorded weekly. At arrival the pullets were subjected to a 16 hour light and an eight hour darkness regime, regulated by a timer.

Egg numbers were recorded daily and summarised on a weekly basis throughout the experimental period (*i.e.*, 18-28 weeks). Shell-less and those with defective shells were also recorded for production calculations. Individual egg weights were recorded for all the eggs produced by each hen on daily basis. Percent lay on a daily basis was calculated using the formula given by North (1984).

Five eggs of each hen were collected at week 24 to determine the shell quality. Following the measurement of egg weight, eggs were broken and shell thickness and shell weight (including membranes) determined. The shells were washed under slightly flowing water to remove adhering albumen (Kuhl and Seker, 2004; Strong, 1989) and wiped with a paper towel to remove excessive moisture. A meter sensitive to 0.001 mm was used to measure eggshell thickness. Three measurements were made on the sharp, blunt and equator of an egg and average thickness obtained for individual locations (Ehtesham and Chowdhury (2002).

The surface area (cm^2) of each egg calculated using the formula of Carter (1975), ($3.9782W^{.7056}$), where W is the egg weight in grams. Shell weight per unit surface area (SWUSA) expressed asmg/cm^2 and egg volume was calculated according to procedure described by Carter (1975) and Narushin (1997). Egg output (egg mass) was calculated by multiplying percent egg production x egg weight (North and Bell, 1990).

Statistical analysis

There effect of particle size and Data were subjected to ANOVA using the general linear model procedure (SAS Institute, 1999) to determine the effect of particle size distribution and age on response variables relating to egg production. The same procedure was followed to determine the effect of particle size distribution on response variables (shell thickness, shell weight, shell percentage, SWUSA, egg surface area, egg volume and egg contents).

RESULTS AND DISCUSION

Feed intake

Data on weekly feed intake of the hens fed diets with different particle sizes are shown in Table 1. Different particle size distributions of limestone in the diet did not significantly ($P>0.05$) influence feed intake of hens. In agreement with these results Watkins et al. (1977) observed that particle size distribution did not affect feed intake significantly. Guinotte and Nys (1990) who found significant increases in feed intake in Leghorns from 66 to 77 weeks, when hens were fed particulate limestone supplemented with coarse particles of limestone. Average daily feed intake was 119 g A highly significant ($P<0.001$) treatment x age interaction for feed intake occurred. Feed intake significantly ($P<0.001$) increased over time.

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Table 1 - Effect of limestone particle size distribution on weekly feed intake (g) of layers					
week	Particle size			Significance (P)	CV
	1 mm	1-2 mm	>2-3.8 mm		
18	716	665	769	0.1682	23.6
19	770	748	803	0.5618	18.0
20	740	729	749	0.9330	14.0
21	717	732	734	0.9583	12.5
22	740	747	751	0.1767	9.7
23	762	745	755	0.7155	9.4
24	775	741	749	0.3524	9.7
25	771	759	773	0.2956	10.1
26	777	772	802	0.1556	8.9
27	737	715	729	0.2923	8.0
28	748	734	734	0.8497	7.8
CV = coefficient of varianceFine <1.0 mm, Coarse >2.0-3.8 mm					

Body weight

In accordance with feed intake, no significant (P>0.05) influence of particle size distribution on the body weight of the birds could be detected (Table 2). A statistically significant (P<0.001) increase in body weight of layers occurred from week 18 to 28. The average body weight of hens with the 100, 75, 50 25 and 0 fine limestone particles in the diet were 1.78 kg, 1.77 kg, 1.75 kg, 1.78 kg and 1.83 kg, respectively.

Table 2 - Body weight (g) changes of layers					
week	Particle size			Significance (P)	CV
	1 mm	1-2 mm	>2-3.8 mm		
18	1784	1789	1828	0.8186	10.2
20	1844	1852	1867	0.9934	8.5
24	1873	1897	1860	0.8513	7.1
28	1929	1944	1900	0.8104	7.2
CV = coefficient of variance. Fine <1.0 mm, Coarse >2.0-3.8 mm					

Egg production

From Table 3 and Figure 1 it seems that different ratios of limestone particle sizes did not influence (P = 0.3041) egg production. These results are in agreement with that of Watkins et al. (1977) and Guinotte and Nys (1990) who fed commercial laying hens fed ground and particulate sizes and found that egg production is not affected by particle size.

Table 3 - The influence of limestone particle size on egg characteristics at peak production					
Parameter	Particle size			Significance (P)	CV%
	< 1 mm	1-2 mm	>2-3.8 mm		
Egg. production (%/h/d)	79.82	74.87	79.73	0.1114	14.0
Egg weight (g/egg)	43.87	49.36	51.69	0.2159	12.9
Egg output (g)	56.72	51.97	56.00	0.2388	22.3
Egg volume (ml)	41.53	38.16	38.94	0.1114	17.0
Egg contents (g)	38.63	44.35	46.45	0.2317	13.3
Egg surface area (cm^2)	57.33	62.31	64.37	0.1011	16.4
Shell weight (g)	5.24	5.01	5.24	0.4710	17.1
SWUSA (mg/cm^2)	91.40	80.40	81.40	0.2099	18.0
Shell percentage (%)	10.42	10.15	10.14	0.2229	22.3
Shell thickness (mm):					
Sharp end	0.432	0.422	0.432	0.1335	4.1
Equator	0.442	0.432	0.422	0.7994	14.5
Blunt end	0.432	0.422	0.422	0.4613	4.5
Means within rows with different superscripts differ at P<0.05, SWUSA = Shell weight per unit surface area, CV = Coefficient of variation. Fine <1.0 mm, Coarse >2.0-3.8 mm					

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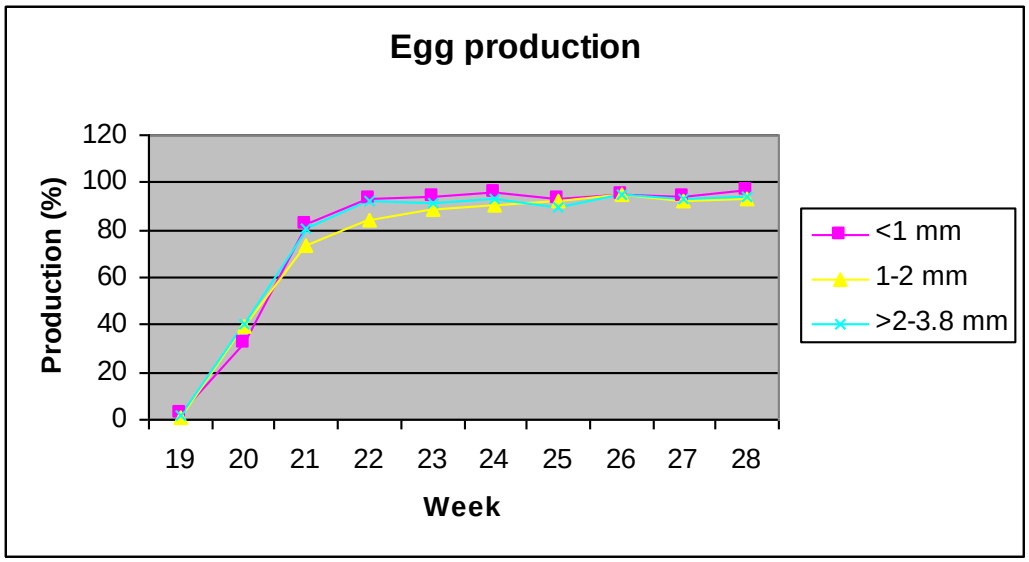

Fig. 1 - Effect of different ratios of limestone particles on egg production in layers

Figure 1 illustrates that there was a significant (P<0.05) increase in production from week 18 to 21 and thereafter egg production remained constant. Leeson and summers (1982) and McDaniel (1983) found a non-significant (P> 0.05) increase in egg production in hens fed oyster shells from 21 to 30 weeks of age.

Egg production increased (P<0.001) significantly over time (Figure 1). An average production percentage of 80% was observed up to week 28. This result is in agreement with Sreenivas (1997) who found that a constant egg production occurred at peak.

From 19 to 28 weeks, cracks and shell-less eggs accounted for 9% of the total egg production. Previous study of Guinotte and Nys (1990) reported 13-20% for cracks and shell eggs from 20 to 30 weeks of age. Most of the cracks and shell-less eggs were from birds fed a calcium source with fine particles. Watkins et al. (1977) is of the opinion that ground limestone produce poor egg shells compared to coarse ones.

Egg weight

Egg weight (P = 0.4558) and egg output (P= 0.5066) were not significantly influenced by limestone particle size in the diet (Table 3). These findings are consistent with Cheng and Coon (1987) who concluded that switching from ground limestone to coarse oyster shell resulted in no significant differences in egg weight. It is evident from Figure 2 that egg weight increased (P<0.05) from week 19 to 28. Egg weights of all the rations increased from ±40 g and to ±50 g by the 24th week and maintained the trend up to the 28th week. These findings confirmed the previous observations (Leeson and Summers, 1982; McDaniel, 1983) that egg weight is lowest at the beginning of the production cycle and increases throughout the laying period.

Egg quality

Data on the influence of limestone particle size distribution on egg volume, egg contents and egg surface area are given in Table 3. No significant differences occurred in egg volume (P=0.1310) and egg surface area (P=0.1393). The highest (P<0.001) values of egg contents were recorded when 100 and 75 % fine limestone particles were included in the diet. Although significant differences for shell weight (P<0.0017) and shell percentage (P<0.0001) occurred, no clear influence of particle size distribution on these characteristics could be detected.

From Table 3, it seems that SWUSA was significantly (P<0.0142) different amongst treatments but this was not confirmed by Tukey's test. In accordance with SWUSA no significant (P> 0.05) difference in eggshell thickness occurred. The findings of this study are in disagreement with the findings of Watkins et al. (1977) who observed that replacement of two-thirds of fine calcium particles with hen size particles of improved egg-shell strength. Dekalb (1998) states that one third of the layer dietary calcium should be supplied in large particle form (2-5 mm). The source of calcium and the time of laying period could probably explain these contradictory results. According to Zhang and Coon (1997), the limestone retention of calcium in the gizzard of laying hens for improving shell quality may be dependent upon particle size, porosity of the calcium source and overall *in vitro* solubility of the calcium source.

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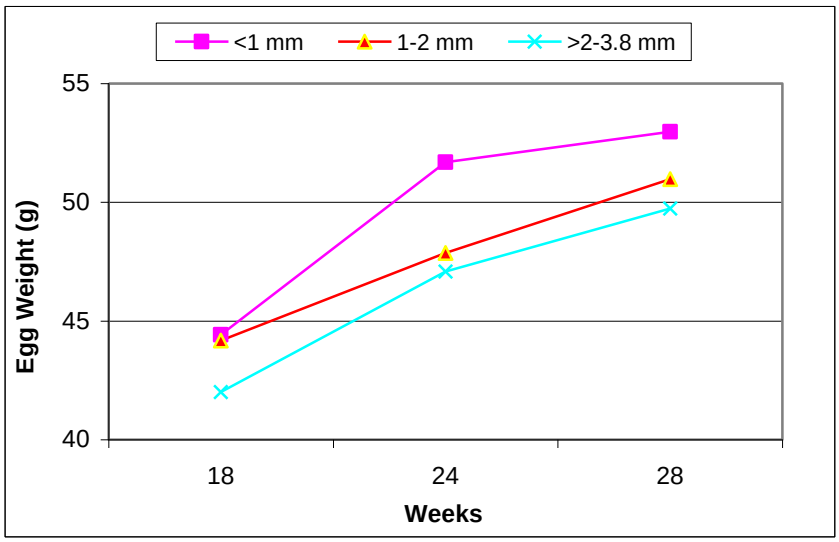

Fig. 2 - Effect of dietary particle size distribution on egg weight

CONCLUSION

From these results it seems that the ratio of fine (<1.0 mm) and coarse (>2.0-3.8 mm) limestone particles in a layer diet does not influence egg production and egg shell quality (shell thickness, egg weight, egg output, egg surface area, shell percentage and SWUSA) at 24 weeks of age. However, the results apply only for the specific limestone used in this study and for peak production. These results suggest that the influence of dietary limestone particle size distributions at a later stage of the laying period on egg production and egg quality needs further research.

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INFLUENCE OF SOME MAJOR GENES ON EARLY LAY TRAITS OF CROSSBRED LOCAL PULLETS IN A HUMID TROPICAL ENVIRONMENT

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ABSTRACT: *The study evaluated the effect of some major genes on early lay characteristics of Nigerian local pullets in randomized complete block design experiment. A total of 210 day-old crossbred local chicken were generated from a main and reciprocal crossing of local chickens possessing some major genes (naked-neck (Na), frizzle (F), and normal feathered genes (na). Results indicate that feed per hen, feed per dozen egg, and percent hen-day production did not differ significantly (P>0.05) among the genotypes. However, significant difference (P<0.05) were observed in body weight at first egg, age at first egg , age at sexual maturity, weight of first egg and egg number at 56 days with greater (P<0.05) value favoring F genotypes. Highest significant (P<0.05) values of weight at 1st egg were also noted in F/F genotypes (38.22±0.70g) and shell thickness (0.92mm±0.01), respectively. Highest significant means of yolk weight, yolk height, and yolk index and yolk width were obtained from F/F, Na/F and Na/Na genotypes. There were no significant difference (P>0.05) observed in albumen weight, albumen height and Haugh unit among genotype groups. However, HU values were very high in all the genetic groups. Highest positive significant correlation among egg weight, yolk weight, albumen weight and Hough unit were obtained in Na/Na, Na/F, and F/Na. Eggs laid by F/F, F/Na, Na/F and Na/Na were better in external egg qualities than other genetic groups. It is suggested that F and Na genes should be involved in the improvement of egg quality traits in the humid tropics.*

Keywords: *Major genes, early lay traits, crossbred local chicken, humid tropics*

ORIGINAL ARTICLE

INTRODUCTION

The major genes also called advantageous genes complexes or plumage reducing genes (Ibe and Nwohu, 1999), have been described as genes that reduce feather coverage in chicken. Yunis and Cahaner (1999), Horst (1988), describe nine of such major genes and stated that they could be used in genetic improvement programs. These genes are relevant to hot tropical regions because they enable the local chicken to adapt favorably to the tropical environment. Naked-neck (na) and frizzle (f) genes constitute the two types of the major genes found in the local fowl population. Naked-neck is caused by a single autosomal gene, Na. The gene is incompletely dominant with Na/na$^+$ chicken showing an isolated tuft of feathers on the neutral side of the neck above the crop, while the Na/Na chicken either lack this tuft or it is reduced to just a few pinfeathers or small feathers (Somas, 1990). On the other hands, frizzling is caused by a single incompletely dominant autosomal gene F restricted by an autosomal recessive modifier, mf. In unmodified homozygous frizzled chickens, the rachises of all feathers are extremely reserved.

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The advantages of these genes over their normal feathered counterparts in a hot humid environment are in terms of feed intake, growth rate, and weight gains which have been fully reviewed (Hanzle and Somas, 1983, Merat, 1990, Lout et al., 1992, Cahaner et al., 1993). The quality of eggs, apart from determining their food value, market desirability, or economic value (Singh and Kumar, 1994) is significant in poultry for their influence on the embryo development and successful hatching (Namshin and Ramanov, 2002). It has been reported that external and internal qualities of egg in both hens (Hurnick et al., 1978, Norstron and Ousterhout, 1982) had significant effects on the hatchability of incubated and fertile eggs, weight and development of the laying chickens. Egg quality can be external or internal. The external qualities of an egg are based on the size, shape, shell colour and texture of the eggs.

Genetic and phenotypic heterogeneity have been observed to exist in the domestic chickens. The diversity, which constitutes a valuable genetic resource, informs the reason for incorporating the local chicken into breeding programs aimed at producing an indigenous meat and egg type breed adapted to the tropical environment. Moreover, there is a major global thrust on genetic preservation and biodiversity as reflected in the efforts on development of genome and data banks. Following this strategy the local chicken especially the naked neck and frizzle which are tropically relevant should be preserved from becoming extinct. More importantly, the use of management practices to ameliorate the adverse effects of heat stress on poultry in many cases are not economical and alternative approach of breeding pullet lines with better heat tolerance has been suggested. Genetic improvement of heat tolerance may therefore provide a low-cost that is particularly attractive to developing countries with hot climates like Nigeria. The objective of this study therefore was to determine the effect of major genes on early lay traits of crossbred local chicken and to recommend the genotypes with the best performance for selection for further improvement.

MATERIALS AND METHODS

The experiment was conducted at the Poultry unit, Teaching and Research farm, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, located on latitude 05^{0} 21^{l} N and longitude 07^{0} 33^{l} E. It is approximately 122 meters above sea level with maximum and minimum daily temperature of 27-36^{o} C and 20-26^{o}C respectively. The relative humidity is 57-91% and annual rainfall of 2177mm.

Mating procedure

A base population of 180 local chickens consisting of 10 naked neck males, 50 naked - neck females, 10 frizzle males, 50 frizzle females, 10 common males and 50 common feathered females obtained from the University of Agriculture fowl were used for the study. The birds were randomly selected and moved into deep litter pens and mating was in the ratio of 1:4. The entire mating scheme resulted in 3 homozygous and 2 heterozygous main crosses, each of naked-neck and frizzle, 2 reciprocal crosses between naked-neck and frizzle and one main cross of common feathered birds as shown in Fig 1. The hens after being mated produced fertile eggs which were identified and set in a western type.

Cabinet incubator. Incubation and hatchery condition were 0-23days temperature 37.5^{0} C and relative humidity of 55-60%; 24days to hatching, the temperature was 37.C and relative humidity of 98%. A total of 400 day-old local chicks were produced.

Table 1 - Mating scheme of the base population for the production of F1 crossbred local chickens

Naked neck male (Na/Na)	**x**	**Naked neck female (Na/Na)**
(Na/Na = Homozygous naked neck cross)		
Naked neck male (Na/Na)	**x**	**Frizzle female (F/F)**
(Na/F = Naked neck reciprocal cross)		
Naked neck male (Na/Na)	**x**	**Normal female (na/na)**
(Na/na = Heterozygous naked neck main cross)		
Frizzle male (F/F)	**x**	**Frizzle female (F/F)**
(F/F = Homozygous frizzle main cross)		
Frizzle male (F/F)	**x**	**Naked neck female (Na/Na)**
(F/Na = Frizzle reciprocal cross)		
Frizzle female (FF)	**x**	**Normal male (nana)**
(F/na = Heterozygous frizzle main cross)		
Normal male (nana)	**x**	**Normal female (nana)**
(na/na Homozygous normal main cross)		

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Management of crossbreed local pullets

The chicks were brooded for the first five weeks of life under continuous illumination. There after they were raised on the deep litter under natural light until 26 weeks of age. At this age 280 pullets were sexed and separated from their male counterparts. Sexing was achieved by placing the fingers at the rear of the animal and applying a gentle upward thrust on the testicles to make it sexually excited. The resultant effect was a simultaneous jerking of the body and stretching of the two shanks if the chicken was a male. Each genetic group were randomly selected and kept in an open-sided deep litter pen with 40 birds per genotype group of which 39 birds were selected with 3 replicates of 13 birds per sub group. The pullets were fed growers mash containing 2700Kcal/kg ME and 16% CP. Thereafter, they were fed layers mash containing 2500 Kcal/kg ME and 18.5% CP at 24 weeks. The birds had access to feed and water *ad-libitum.* The experiment lasted for 42 weeks. Age at first egg was determined as the number of days from day of hatch to the day the first chicken of a given genetic group laid the first egg and its weight in grammas. Age at sexual maturity was determined as the age in days when 50% rate of lay was achieved. Feed per dozen egg measured as feed consumed divided by dozen egg laid, percent hen-day production =

$$\frac{\text{Number of egg laid}}{\text{Number of hens alive}} \times 100.$$

Daily egg production records were kept.

The number of hen-day was obtained as the product of the number of days in lay and the number of hens alive (Singh and Kumar (1994)

Egg traits measurements were taken on all eggs lay first two days of each week throughout the laying cycle. Egg index value was derived from the ratio of egg width to mean egg length. Egg length and egg width of individual eggs were each measured thrice and their means used to compute the EI with the aid of scalpel, the egg shell was broken, the egg content were emptied into a Petridis. The albumen and yolk height were measured with the aid of a spherometer. The albumen was separated from the yolk; the yolk was placed in a weighed Petridis. Weighed again and weights of the yolk found by difference. A micrometer screw gauge was used to measure shell thickness in millimeters. The average of the 3 readings at the broad, narrow and mid sections was taken as the shell thickness for each bird in the week. Yolk index value was calculated as the ratio of yolk height (mm) to yolk diameter. Haugh unit was estimated using the equation according to Haugh (1937).

$$HU = 100wg\ (H + 7.57 - 1.7W^{0.37}),$$

H = observed albumen height (mm), W = observed weight of egg (g)

Data collected from the study were subjected to analysis of variance (ANOVA) in a randomized complete block design. SPSS (2004) and Genstat (2007) computer application programmers' were used for the analysis. The model is shown below.

$$Y_{ijk} = \mu + B_i + G_j + E_{ijk}$$

Y_{ikj} = k^{th} observation of the j^{th} genetic group in the i^{th} hatch

μ = population mean

B_i = Effect of the i^{th} hatch, I = 1—— 5

Gj = Effect of the j^{th} genetic group , j =1 — 7

E_{ijk} = Random error, assumed to be independently, identically, normally distributed with zero mean and homogenous variance (iind (0, σ^2))

Means with significant difference were separated using least significant difference at 0.05 level of probability. Pearson correlation analysis (Snedecor and Cochran, 1989) was carried out to determine the relationships among the various egg quality parameters.

RESULTS AND DISCUSSION

The physical composition of the egg of crossbred local chickens is shown in Table 2. Mean body weight at first egg of these chickens showed a significant difference ($P<0.05$) among genetic groups, ranging from 975±15.00g to 1299.00±1.06g for the genotypes respectively. This observation indicates that these birds are light bodied chickens. The importance of body weight in egg production is fully recognized (Yeasmin et al., 2003). Ibe and Nwohu (1999), reported that both F and Na genes which did not improve growth of pullets as in cockerels are needed in selection for egg production in layers since fast growth is usually discouraged in the management of pullets to avoid precocious maturity during laying phase.

The results indicate significant difference ($P<0.05$) in age at first egg among the genetic groups. The homozygous frizzle gene which had the highest body weight at first egg was mostly delayed to attain age at first egg and age at sexual maturity. This is in agreement with the observation of Nwachuckwu et al. (2006) and Ricklefs (1993), that within the same level of management, genetically heavier birds attain sexual maturity later than light bodied birds. However, the values obtained did not agree with the result of Adedukun and Sonaiya (2001), who reported lower ages at first eggs. The

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naked-neck lines which had earliest age at first egg (177.600±6.60) also attained age at sexual maturity earlier than the frizzle crosses. This result supports the finding of Zeman et al. (2003), who utilized naked-neck males in crossbred and reported that age at sexual maturity was significantly better for the naked neck carrying genotypes.

Table 2 – Influence of major genes on physical composition of the crossbred local chickens at age 26-52 weeks

	Means of genetic group						
Parameter	**Na/Na**	**Na/F**	**Na/na**	**F/F**	**F/Na**	**F/na**	**na/na**
WAF	1176.^{b}	209.^{b}	975.^{a}	1299.^{a}	1209.^{b}	1024.c^{d}	1082.^{c}
	34.7	51.4	15.0	5.0	9.00	10.6	32.5
AFE	177.^{a}	196.^{b}	184.^{ab}	211.^{c}	191.^{ab}	199.^{b}	195.^{b}
	6.60	1.36	3.93	5.37	6.12	7.00	7.35
ASM	191.00^{a}	196.^{b}	192.^{a}	212.^{b}	206.^{b}	210.^{b}	194.^{a}
	0.00	0.00	0.00	3.60	0.00	0.00	0.00
WFE (g)	36.8^{ab}	35.7^{b}	29.8^{c}	38.2^{a}	36.3^{ab}	32.0^{c}	34.9^{b}
	0.90	1.22	0.24	0.70	0.68	0.56	1.04
FPH (g/hen/day)	61.8	63.2	75.6	65.4	66.2	62.8	55.5
	1.66	2.40	12.24	1.51	1.43	1.47	2.46
FPDE	1.56	2.27	2.27	2.72	2.06	3.13	3.74
	0.25	0.07	3.89	0.00	0.02	0.00	0.00
EN	38.0^{a}	12.5^{c}	32.0^{ab}	12.6^{c}	20.6^{bc}	21.4^{bc}	12.9^{c}
	7.88	7.96	5.27	6.34	7.85	4.60	5.33
HDP (%)_	68.8	65.3	66.0	49.6	52.9	56.5	49.08
	11.11	6.90	9.00	6.74	4.91	9.97	12.65
Laying mortality	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$^{a-c}$Means in the same row with different superscripts are significantly different (P<0.05); Standard errors are below the values; WAF = weight of bird at first egg (g); ASM = Age at sexual maturity; FPH = Feed per hen (g/hen/day); EN = egg per hen; ASM = Age at sexual maturity (days); WFE = Weight at first egg (g); FPDE = Feed per dozen egg; HDP = Percentage hen-day production (%).

Table 3 - Influence of major genes on egg quality of the crossbred local chickens at age 26-32 weeks

	Means of genetic group						
Parameter	**Na/Na**	**Na/F**	**Na/na**	**F/F**	**F/Na**	**F/na**	**na/na**
EWT (g)	39.8^{a}	38.7^{a}	34.0	40.0^{a}	36.7^{b}	36.6^{b}	35.3^{bc}
	0.42	0.69	0.45	0.45	0.50	0.40	0.38
EL	48.2^{b}	48.3^{b}	46.8^{c}	50.3^{a}	47.6^{bc}	46.6^{c}	47.2^{bc}
	6.19	0.57	0.32	0.33	0.53	0.31	0.84
EW (mm)	41.2^{a}	35.8^{b}	33.8^{c}	36.3^{b}	33.2^{c}	35.4^{b}	34.5^{b}
	0.19	0.27	0.27	0.20	1.18	0.24	0.26
EI	0.73^{bc}	0.72^{bc}	0.72^{bc}	0.72^{bc}	0.84^{a}	0.76^{b}	0.73^{bc}
	0.01	0.00	0.00	0.01	0.05	0.00	0.16
ST	0.86	0.88^{b}	0.84^{c}	0.92^{a}	0.87^{b}	0.88^{b}	0.81^{c}
	0.03	0.01	0.01	0.01	0.02	0.01	0.04
YWT (g)	12.7^{a}	12.9^{a}	11.2	13.1^{a}	12.6^{a}	11.6^{c}	12.3^{b}
	0.24	0.24	0.24	0.26	0.31	0.20	0.26
YH (mm)	13.2^{a}	12.5^{b}	12.9^{b}	13.0a^{b}	13.2^{a}	12.2^{b}	12.8^{b}
	0.23	0.23	0.23	0.25	0.30	0.19	0.25
YW (mm)	36.5^{bc}	37.4^{a}	35.7^{c}	38.0^{a}	37.3^{ab}	36.1^{bc}	37.4^{ab}
	0.43	0.43	0.44	0.47	0.56	0.36	0.47
YI	0.37a	0.34^{b}	0.34^{ab}	0.34^{b}	0.39^{a}	0.35^{ab}	0.35^{ab}
	0.01	0.00	0.00	0.01	0.01	0.01	0.01
AWT (g)	21.0	23.5	19.0	21.7	21.6	20.1	19.7
	2.23	2.25	2.28	2.47	2.95	1.89	2.46
AH (mm)	6.25	6.46	5.94	6.42	6.37	6.13	6.42
	0.14	0.14	0.15	0.16	0.19	0.12	0.16
HU	83.7	89.0	84.6	86.6	84.4	83.7	87.4
	1.32	1.33	1.35	1.46	1.74	1.12	1.45

$^{a-c}$Means in the same row with different superscripts are significantly different (P<0.05); Standard errors are below the values; EWT = Egg weight (g); ST = Shell thickness (mm); YW = Yolk width (mm); AH = Albumen height (mm); EL = Egg length (mm); YWT + Yolk weight (g); YI = Yolk index. HU = Haugh unit. EW = Egg width (mm); YH = Yolk height (mm); AWT = Albumen weight; (mm). EI = Egg index.

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There was a significant difference (P<0.05) in weight of the first egg among the genetic groups. These weights 29.30±0.24 - 38.22±0.07 fall within the range of values previously reported.

Studies by Nwosu and Omeje (1985), Akinokun (1990), Adedokun and Sonaya (2001). It was observed that the homozygous naked-neck genetic groups which had heavier weights at first egg also laid heaviest eggs. This result support the work of Ayorinde and Oke (1995) that bigger birds normally laid larger eggs than those with smaller body weights.

There were no significant differences (P>0.05) in feed per hen, feed per dozen egg, and hen day production. The laying mortality which was zero indicates that these hens were capable of withstanding laying stress and as such given good management can be selected for hardiness in a stressed environment. The result of egg number from 26-52 week of age shows a significant difference (P<0.05) in favour of the naked neck. This observation is in line with previous findings of Merat (1990) that naked neck genes causes increase in egg number. From the foregoing, it can be said that weight at first egg is an important trait in selection process and the value obtained for body weight at first egg, weight of first egg, age at sexual maturity and egg number tend to present the naked neck lines as potential egg laying chickens, while frizzle lines as potential meat-type birds.

The means of the egg quality parameters of the crossbred local chickens are shown in Table 3 significant differences (P<0/05) were observed in egg weight, egg length, yolk weight, yolk width, yolk index, shell thickness and yolk height but no significant difference (P>0.05) in albumen weight, albumen height and haugh unit in all the genetic groups respectively.

Table 4 - Correlation among egg quality parameters of crossbred local chickens at week 32

Genetic Group	Parameter	EWT	YWT	AWT	AH	HU
Na/Na	EWT					
	YWT	0.31				
	AWT	0.16	-0.86**			
	AH	0.18	-0.55	0.74**		
	HU	0.08	-0.56*	0.70**	0.99**	
Na/F	EWT					
	YWT	0.92**				
	AWT	0.84	0.85**			
	AH	0.29	0.23	0.49		
	HU	-0.43	-0.44	-0.14	0.74**	
Na/na	EWT					
	YWT	0.77				
	AWT	0.78	0.40			
	AH	0.92	0.46	0.89		
	HU	0.89	0.39	0.88	0.99**	
F/F	EWT					
	YWT	-0.28				
	AWT	0.74*	-0.44			
	AH	-0.08	0.11	0.15		
	HU	-0.22	0.07	0.02	0.97**	
F/Na	EWT					
	YWT	0.44				
	AWT	0.05	0.16			
	AH	0.07	0.61	0.09		
	HU	-0.22	0.60	0.9	0.99**	
F/na	EWT					
	YWT	0.76**				
	AWT	0.75**	0.39			
	AH	0.73**	0.56*	0.71**		
	HU	0.004	-0.16	-0.06	-0.003	
na/na	EWT					
	YWT	0.45				
	AWT	0.26	0.14			
	AH	-0.33	-0.80*	-0.08		
	HU	0.40	-0.82*	0.04	0.99**	

**Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed); EWT = Egg weight; YWT + Yolk weight (g); AWT = Albumen weight (mm); AH = Albumen height (mm); HU = Haugh unit

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Except for egg index, the values obtained in this study were lower than what Peters et al. (2007) reported for exotic pullets but fall within the range reported by Adedokun and Sonaiya (2001). This indicated that these progeny were indigenous chicken origin. Egg weight, egg index determine egg resistance to cracking and are considered very important traits when eggs are packed in container (Peters et al., 2007, Kul and Seker, 2004). The acceptable value for egg index and haugh unit are reported to be 0.75 (Smith, 1990) and at least 40% (Ayorinde et al., 1999). These results showed that the eggs of the local chickens were good quality in terms of resistance to cracking, market desirability and the quality of chicks to be produced from them.

The result of correlation among some of the egg quality traits of the crossbred local chicken is shown in Table 4. In Na/Na genetic group, correlation among egg weight, yolk weight ($r = 0.31$), Albumen weight ($r = 0.16$), albumen height ($r = 0.18$), haugh unit (0.08) were all positive and non-significant ($P>0.05$). In Na/f, F/F, F/Na, genetic groups, egg weight and haugh unit were all negatively correlated ($P>0.05$). However, haugh unit and albumen height in these groups were highest and positively significantly ($P<0.05$) correlated among groups. The positive correlation observed among egg weight, yolk weight, albumen weight, and haugh unit in these genetic groups are in agreement with earlier report of Jaya Laxim et al. (2002). This implies that improvement in egg weight could lead to corresponding improvement in other egg quality traits.

CONCLUSSION

Egg lay by F/F, F/Na, Na/F and Na/Na were better in egg quality traits than other groups. These genetic groups also gave highest positive correlations of egg quality traits. The values of HU of the eggs of the crossbred local chicken were very high above 40% baseline below which the quality of an egg should be ranked poor. It is suggested that F and Na genes should be involved in the improvement of egg quality traits. For rapid improvement in the egg production characteristics of the indigenous chickens, selection within the existing population of the local chicken and crossbreeding with exotic breeds should be considered promising.

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REPRODUCTIVE PERFORMANCES OF FOGERA CATTLE AT METEKEL CATTLE BREEDING AND MULTIPLICATION RANCH, NORTH WEST RTHIOPIA

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ABSTRACT: *The study was conducted to evaluate the reproductive performance and to asses non-genetic factors affecting the reproductive performance of Fogera cattle breed kept at Metekel ranch. For this purpose data collected from 1996 to 2008 in the ranch were used. The data were analyzed using the general linear model procedures of statistical analysis system. The effect of mating system, parity of dam, year of birth and calving, season of birth and calving, sex of calf, and sire breed were considered as fixed effects for evaluating different reproductive parameters. The overall least square means for number of services per conception (NSP), age at first calving (AFC), calving interval (CI), gestation length (GL) and days open (DO) were 1.28±0.06 and 50.8±0.36 months, 587±5.44, 282±0.26 and 285±4.3 days, respectively. The number of services per conception was significantly (P<0.05) affected by mating system. Age at first calving was affected significantly (P<0.05) by year of birth. Calving interval was significantly influenced by parity of dam and season of calving (P<0.05) and year of calving (P<0.01). Gestation length was significantly affected by season of calving and breed of sire (P<0.01) and parity of dam (P<0.05) but not affected by sex of calf (P>0.05). Days open was significantly (P<0.01) affected by year of birth. From the present study, it can be concluded that the non-genetic factors had exerted significant effects on the reproductive performance of Fogera Cattle breed kept at ranch. Thus, to improve reproductive performance of the Fogera cattle breed, great effort should be made towards mitigating negative impacts of those non-genetic factors.*

ORIGINAL ARTICLE

Keywords: *Age at first calving, calving interval, days open, Fogera cattle, gestation length*

INTRODUCTION

Cattle are very important livestock species in the traditional mixed crop livestock production systems of Ethiopia by providing mainly drought power, a small amount of milk, meat usually when they retire and manure. The cattle population of Ethiopia, estimated at 47.57 million (CSA, 2008), are well adapted to the tropical environment producing and reproducing under stresses of high degree of temperature, high disease prevalence and low level of nutritional status. However, they are said to be low in milk and meat production. The Fogera cattle are among the 27 recognized indigenous cattle breeds in Ethiopia and it is found distributed around Lake Tana in south Gonder and west Gojjam zone of Amhara region, Ethiopia (Addisu et al., 2010). Though there is no objective data confirming their utility, they are called triple use; drought, milk and meat (Addisu et al., 2010). The population of Fogera cattle was estimated to be around 800,000 in 1980s (Alberro and Haile-Mariam, 1982) and 15,000 heads in 2000s (Gebeyehu et al., 2004). Phenotypicaly, they are characterised as large size and tall animals with long legs. Their identifiable coat color being white with black spots or

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pure white, have small horns, very large dew-lap, pendulous naval flap and preputial sheath, and they are docile. The hump is small and cervical or cervico-thoracic in position representing the sanga influence. These cattle are as intermediate zebu-sanga type, the so-called zanga (Alberro and Haile-Mariam, 1982).

Fogera cattle breeding and multiplication ranch was established on the aim of conserving and improving the breed for its milk yield. Reproductive parameters are among the most important traits affecting progress in selection. This paper reports some reproductive performance traits and non-genetic factors affecting it of Fogera cattle kept in government cattle breeding and multiplication ranch.

MATERIALS AND METHODS

Description of the study area

Metekel cattle breeding and improvement ranch is found in Agew-Awi zone of the Amhara national regional state, Ethiopia. Metekel is located at 10º55´ North latitude and 36º26´ East longitude. It has an elevation ranging between 1500 and 1680 m a.s.l and it is rimmed by hills reaching up to 2000 m a.s.l high (MOA, 1988).The climate of the area can be classified as sub-humid, characterized by contrasting very wet and very dry seasons. Metekel has a bi-modal distribution of rainfall receiving the highest amount of precipitation from May to October (*Kiremt*) while the short rainy season (*Belg*) is between February and April. The dry season is from November to January. The mean annual rainfall is 1615 mm. Average temperature ranges from 12 to 27ºC, with monthly mean minimum and maximum occurring in December (7.9ºC) and in April (31.2ºC), respectively (ENMA, unpublished).

The soil at the ranch can be broadly classified as red, brownish-red and dark brown, derived from basaltic rocks and characterized by moderate drainage. The vegetation is mostly composed of perennial grasses. Few scattered trees (5%) are also present. The range condition varies from poor to fair due different environmental and human factors. According to MOA (1988) the vegetation is divided in to three (less desirable, desirable and undesirable) based on their nutritional importance to the cattle. The less desirable species prevail in the pasture and their proportion is around 35%. They are mainly represented by *Digitaria abyssinica, Cynodon dactylon, Sporobolus natalensis, Setaria pumila, Kullinga odorata,* and *Digitaria ternata.* Among the desirable species (25%) the most representative ones are *Paspalum orbiculare, Setaria sphacelata* and *Hyperrhenia* species. Undesirable species which accounts to 30% are *Coreopsis* species, *Borreria* species, *Guizotia scabra.* Scattered bushes not grazed by animals such as *Argyrolobium* species, *Clemtis hirsuta, Leonotis* species are also found (MOA, 1988).

Management practices

Cattle breeding and management

The breeding program has two components, selection and crossbreeding. In the selection program, Fogera bulls used to run with Fogera cows with a ratio of one bull per 50 cows to which the bull could be changed when it loses condition. The heifers were allowed for mating for the first time when they are two years of age. Mating was seasonal and confined to the months from June to October. However, since June 1995 a year round mating scheme has been introduced. Replacement bull calves and female calves were selected based on their physical characteristics, growth performance and health status. For the crossbreeding program, Fogera cows were artificially inseminated with Friesian semen throughout the year.

Cattle were herded based on breed, sex and age groups. During the day time, animals graze on natural pasture. The main sources of water are year-round rivers; namely Ardi and Dura bounding the ranch and also tap-water for lactating Fogera cows, crossbred stock and sick animals.

As to the herd health management, there was vaccination against blackleg, pasturellosis, and anthrax in every 6 to 8 months and once per year for Contagious Bovine Pleuro Pneumonia (CBPP). Deworming was practiced twice a year, at the beginning and end of the rainy season. To control external parasites, Fogera cattle were sprayed once in every two weeks when infestation is high, usually during March to October and once in a month in November to February, when infestation was low. Crossbreds were treated every week in peak season and once in two weeks when infestation was low.

Data source and management

Data collected from 1996 to 2008 at Metekel cattle breeding ranch was used for the study. The data were extracted and compiled from records kept on each individual animal record and field books. Records had date of entry, calving date, identification number, sex of animal, date and reason of exit, weight records with calving date, calf number, dam and sire number, birth and weaning weight and date, service date and calving date. Data were entered and managed using Excel spread sheet.

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Number of services per conception (NSC) was calculated for heifers and cows that are successfully conceived either from natural mating or artificial insemination. Those which didn't conceive were excluded. Days open (DO) and calving interval (CI) were estimated from all Fogera cows having more than one normal calving while gestation length (GL) was estimated for cows with proper parturition. Ages at first calving was calculated for cows born in the ranch and have full information about their breeding performances. Gestation length was evaluated by subtracting the date of conception from the date of parturition. Similarly, days open was calculated from date of last parturition to the next successful conception mating date and calving interval was calculated by adding gestation length and days open.

Statistical analysis

Data were analyzed using the general linear model procedures (GLM) of SAS (2003). The fixed effects considered in the model were parity of the dam, sex of calf, year and season of calving and mating system. Probability of differences was used to determine any significance differences between the means.

The model used to analyse the data was,

$Y_{ijklm} = \mu + M_i + P_j + R_k + S_l + Z_m + e_{ijklm}$

Where: Y_{ijklm} = observation on NSC, DO, CI, AFC and GL

μ = overall mean

M_i = effect mating system (i = Natural, AI) only for NSC

P_j = effect parity of the dam (j = 1, 2, ..., ≥7)

R_k = effect sex of calf on gestation length (k = Male, Female) only for GL

S_l = effect season of calving (l = Main rain, Dry, Short rain)

Z_m = effect year of service, calving (m = 1996, 1997, ..., 2008)

e_{ijklm} = random error

RESULTS AND DISCUSSION

Number of services per conception

Number of services per conception is the number of services (natural or artificial) required for successful conception. The number of inseminations required to produce a live calf is one of the most useful parameters of reproductive efficiency which mainly depends on the breeding system used. It is higher under uncontrolled natural breeding than hand-mating and artificial insemination.

The overall least squares mean NSC obtained in the present study was 1.28±0.06 (Table 1). Usually, according to Mukassa-Mugrewa (1989), values of NSC greater than 2 are regarded as poor. This estimated value is higher than the value, 1.11, reported for Barka cattle (Haile-Mariam and Mekonen, 1996). However, it is less than the indigenous cattle breeds' performance reported for highland zebu (Adebabay, 2009), 1.54 for Fogera cattle (Giday, 2001; Gebeyehu et al., 2005), 1.81 for Ethiopian Boran (Haile-Mariam and Kassamersha, 1994).

Among the fixed effects considered, only mating system showed significant effect ($P<0.05$). Cows that were mated by natural mating had lower number of services per conception than cows artificially inseminated (1.27±0.04 vs. 1.38±0.03). This might be due to the inefficiency of artificial insemination operations as reported by Enyew (1992) and/or might be because of insemination resulting from improper heat detection by herds men. The same result was observed in previous studies by Negussei et al. (1999) at Assella and Fisseha (2007) at Allage for Holstein Friesian cows.

Days open

The overall least squares mean of days open (DO) was found to be 285±4.3 days (Table 1) which is in comparison with the findings of Giday (2001) with 280±3.4 days for the same breed at Andassa cattle breeding ranch. On the other hand, Haile-Mariam and Mekonnen (1987) reported a mean DO of 151±13 days for the same breed which was significantly lower than the present study. In addition, Azage (1981) reported 215 days and 250 days of DO for highland and lowland zebu cows, respectively. Factors like delayed resumption of ovarian activity after calving, longer interval to first oestrus and a brief shorter duration of oestrus along with its silent symptoms, scarcity and deterioration of available feeds, might have contributed to difficulty in heat detection and timely insemination of the cows resulting in prolonged DO. In addition, allowing calves to suckle their dams up to weaning may interfere with ovarian function (Giday, 2001).

Year of birth showed significant ($P<0.01$) influence on DO. The lowest DO (183±15.1 days) was recorded in the year 2008, while the highest (311±16.2 days) was recorded in 2000. In general, the trend of DO over the years was inconsistent showing a variation of up to 128 days within a breed. The increased DO observed in the years might be because of inconsistency in the level of management related to shortage of supplementary feed in dry period, poor

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oestrus detection, insufficient AI services, absence of regular follow up of breeder cows and other related technical problems. Similar effect of year of birth on DO was also reported by Giday (2001) on the same breed in another location. Season of birth showed no significant (P>0.05) effect on days open. Similar results were also reported in the literature (Haile-Mariam and Mekonnen, 1987; Agyemang and Nkhonjera, 1990; Asheber, 1992). On the other hand, significant effects of season were also reported by Azage (1981), Rao et al. (1984) and Giday (2001).

Parity of dam had no significant (P>0.05) effect on DO which agrees with the reports of Haile-Mariam and Mekonnen (1987) and Agyemang and Nkhonjera (1990). In contrast, Asheber (1992), Enyew (1992) and Giday (2001) found significant influence on DO.

Table 1- Least square mean and standard error (LSM±SE) of number of service per conception, days open and calving interval of Fogera cattle

Parameter	Number of services per conception		Days open (days)		Calving interval (days)	
	N	LSM±SE	N	LSM+SE	N	LSM+SE
Overall	1410	1.28±0.06	378	285±4.3	536	587±5.44
Mating system		*				
Natural	756	1.27±0.04^{b}				
Artificial Insemination	654	1.38±0.03^{a}				
Parity		NS		NS		*
1	364	1.29±0.03	78	271±8.4	181	599±7.5^{a}
2	340	1.31±0.03	90	286±7.7	137	581±8.8^{ab}
3	277	1.27±0.04	81	288±8.4	101	559±9.8^{b}
4	173	1.38±0.05	63	285±9.3	59	572±12.8^{ab}
5	140	1.36±0.05	41	287±11.2	32	564±17.2^{b}
6	74	1.28±0.07	19	275±16.3	20	561±21.6^{b}
7	42	1.42±0.09	6	316±28.4	6	536±38.4^{c}
Year		NS		**		**
1999	26	1.35± 0.12		-	40	566±16.9^{ab}
2000	25	1.57±0.12	20	311±16.2^{a}	57	581±14.6^{ab}
2001	75	1.41± 0.07	22	297±15.6^{ab}	21	551±21.6^{b}
2002	71	1.31± 0.08	20	305±16.8^{ab}	62	606±13.7^{a}
2003	223	1.30± 0.04	12	310±20.6^{a}	31	586±17.9^{a}
2004	139	1.30± 0.05	67	298±9.9^{ab}	125	588±10.2^{a}
2005	166	1.23± 0.04	43	306±11.3^{ab}	153	571±9.8^{ab}
2006	283	1.30± 0.03	61	276±9.9^{b}	47	492±14.5^{c}
2007	359	1.27±0.03	110	295±7.8^{ab}		-
2008	43	1.22±0.09	23	183±15.1^{c}		-
Season				NS		*
Main rain			194	287±7.2	275	577±9.06^{a}
Dry			69	292±9.7	125	567±10.47^{ab}
Short rain			15	281±8.1	136	558±10.58^{b}

^{ab} Means in a column with different superscripts are significantly different; NS: Non-significant (P>0.05); *:p<0.05; **:P<0.01; N: Number of observations

Calving interval

The overall mean calving interval (CI) obtained in the present study was 587±5.44 days (Table 1). The value obtained is lower than the value from previous findings (780 days) of Mukasa-Mugerwa (1989), for traditionally managed Ethiopian highland zebu but higher than the reports of Getinet et al. (2009) 492±13.2 days for Ogaden cattle, 534±17.6 days and 479 days for Boran breed (Azage 1981 and Ababu 2002) and Giday (2001) for Fogera cattle.

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The longer calving interval obtained than the ideal value might be due to too long days open emanated from difficulties in heat detection and overall managerial activities. In addition, occurrence of silent and night heats and short heat periods are common phenomena among zebu cows (Trail et al., 1985).

Season of calving had a significant (P<0.05) effect on calving interval. Short CI was observed for cows which calved during the short rainy season than those calved during dry and long rainy season. This could be due to the availability of adequate pasture during this and the coming main rainy season which may enable the cow in good condition during and after calving for re-conception in the following breeding season. On the contrary, cows calved during the main rainy season had the longest CI. This might be because of lack of green pasture and supplementary feed in the coming dry season and due to the incidence of skin disease (Demodex) during main rainy season. Significant effect of season of birth on CI was also reported by Haile-Mariam (1987), and Ababu (2002) working on Boran, Asheber (1992), Addisu (1999) and Giday (2001) on Fogera cattle.

The CI was affected significantly (P<0.01) by year of calving. However, there was no clear trend of effect of year. The possible reason might be the differences in nutritional and management aspects between years. This significant effect of the year is in agreement with other findings (Enyew, 1992; Haile-Mariam and Mekonnen, 1996; Addisu, 1999; Giday, 2001; Getinet et al., 2009).

Parity of the dam was an important source of variation (P<0.05) on calving interval. The general trend obtained was calving interval decreases as parity increased. The longest and shortest calving intervals were recorded at the first and seventh parities, respectively. The longer calving interval in younger cows might be due to higher nutrient requirement for growth in addition to milk production and maintenance thus delays the onset of postpartum heat. Similar effect of parity is reported by other scholars (Rege et al., 1994; Addisu, 1999; Giday, 2001; Ababu, 2002; Getinet et al., 2009). However, others (Agyemang and Nkhonjera, 1990; Haile-Mariam and Mekonnen, 1996) reported non-significant effect of parity on CI.

Age at first calving

The least squares mean age at first calving (AFC) obtained in the present study is presented in Table 2. The reported value (50.83±0.36 months) is comparable with the value obtained for Ogaden cattle (Getinet et al., 2009). However, it is relatively higher than the values reported for Boran cattle (Swensson et al., 1981; Kassa and Arnason, 1986), for *Bos indicus* cattle *(*Mukasa-Mugerwa, 1989) and for Fogera cattle (Adissu, 1999). On the contrary, it is lower than values reported for Fogera cows at Andassa (Giday, 2001).

Year of birth had a significant (P<0.01) effect on AFC to which heifers born in 1997 calved at younger age than heifers born in the preceding years. In general, AFC increased as year goes from 1996 to 2004. Significant effect of year of birth on AFC is reported in the literature (Kiwuwa et al., 1983; Haile-Mariam, 1987; Asheber, 1992; Haile-Mariam and Mekonnen, 1996; Adissu, 1999; Gebeyehu, 1999; Giday, 2001; Getinet et al., 2009).

Season of birth had no significant (P>0.05) influence on AFC. This may be for the reason that the time gap between birth and AFC is long enough to mask the effect of season of birth. This was similar to finding of researchers (Azage, 1981; Saeed et al., 1987; Asheber, 1992; Haile-Mariam and Mekonnen, 1996; Adissu, 1999; Giday, 2001; Getinet et al., 2009) while disagrees with Haile-Mariam (1987) who reports significant effect of birth season on age at first calving.

Gestation length

The overall least squares mean gestation length (GL) in the present study was 283±0.26 days (Table 3) which is in comparison to the report of Azage (1981) for lowland local pure Zebu and Barka cattle, Ababu (2002) for Boran cattle, Giday (2001) for Fogera cattle. However, the figure is higher than the finding of Enyew (1992) reported for Arsi cattle.

In the present study, sex of the calf had no significant (P>0.05) influence on GL. Non significant effect of sex of the calf on GL was also reported by Taylor et al. (1984), Asheber (1992), Haile-Mariam and Mekonnen (1996), Addisu (1999) and Giday (2001). On the contrary, Getinet et al. (2009) found significant influence of sex of the calf on GL.

Season of calving had a significant influence (P<0.01) on GL that cows calved in the main rainy season had longer GL than those calved in the dry and short rainy seasons. This finding is in agreement with the reports of Asheber (1992) for Fogera cows, Enyew (1992) for Friesian-Arsi crosses, Haile-Mariam and Mekonnen (1996) for Boran and Barka breeds and Addisu (1999) for Fogera cattle breed.

Parity also affected (P<0.05) gestation length. Longer gestation length was observed in the seventh parity while shorter gestation length in the second parity showing that older cows carried their calves for longer days than younger cows because of relatively larger uterus. Similar result was observed by Hafez (1980) and Haile-Mariam and Mekonnen (1996). Breed of sire had significant (P<0.01) effect on gestation length. Cows mated to pure Fogera bulls carried their calves for 6.2 days longer than those artificially inseminated with Fresian semen. Similarly, Addisu (1999) observed that cows mated to Fogera bulls carried their calves longer than cows inseminated artificially with Friesian semen on the same

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breed. Similar result was reported by Haile-Mariam and Mekonnen (1987). This might be due to the reason that the birth process is initiated at earlier stage of gestation among fast growing breeds than among slow growing breeds (Bourdon and Brinks, 1982). It is also a well-established fact that gestation length is influenced by paternal genotype.

Table 2 - Least square mean and standard error (LSM±SE) of age at first calving and gestation length of Fogera cattle

Parameter	Age at first calving (months)		Gestation length (days)	
	N	LSM±SE	N	LSM±SE
Overall	406	50.8±0.36	1264	282±0.26
Season		NS		**
Main rain	195	49.6±0.33	656	284±0.25^{a}
Dry	78	50.0±0.49	260	282±0.36^{b}
Short rain	133	50.6±0.38	348	282±0.31^{b}
Year of birth		**		
1996	20	47.0±0.93^{c}		
1997	21	46.9±0.91^{c}		
1998	30	48.8±0.76^{bc}		
1999	43	52.6±0.63^{a}		
2000	82	50.7±0.47^{ab}		
2001	91	52.5±0.44^{a}		
2002	68	52.1±0.52^{a}		
2003	39	49.6±0.66^{b}		
2004	12	50.6±1.20^{ab}		
Sex of calf				NS
Male			654	283±0.26
Female			610	282±0.26
Parity				*
1			321	282±0.32^{b}
2			310	281±0.31^{c}
3			246	282±0.35^{b}
4			161	283±0.43^{b}
5			124	283±0.49^{b}
6			65	283±0.68^{ab}
7			37	284±0.89^{a}
Sire breed				**
Fogera			663	286±0.29^{a}
Friesian			601	279±0.25^{b}

^{ab} Means in a column with different superscripts are significantly different; NS: Non-significant (P>0.05); *: p<0.05; **P<0.01; N: Number of observations

CONCLUSSION

The reproductive performance of Fogera cattle are within the range of values reported for other tropical and particularly Ethiopian cattle breeds. Almost all the non-genetic factors considered affected the traits considered indicating the importance of improving the factors on the performances of productivity. Similarly, the present study implies the decline of management as compared to previous reports made which needs due attention.

In general, to improve the reproductive performance, follow up and continuous evaluation of herd reproductive performance needs to be taken to identify the major environmental factors that affect the herd fertility and devise management strategies for improved performance.

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EFFECT OF SUPPLEMENTED DIETS WITH GARLIC ORGANIC EXTRACT AND STREPTOMYCIN SULPHATE ON INTESTINAL MICROFLORA AND NUTRIENTS DIGESTIBILITY IN BROILERS

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ABSTRACT: *This experiment was carried out to study the effects of garlic organic extract and streptomycin sulphate on intestinal microflora and nutrients digestibility in broilers. Forty eight Hubbard line one day-old chicks with equal numbers of males and females were randomly allocated to eight treatment combinations to conduct a 4 x 2 factorial experiment in a completely randomised design. The diets were supplemented with: no supplement (control), garlic organic extract at 40 ppm/kg (GOE 40 ppm), garlic organic extract at 60 ppm/kg (GOE 60 ppm) and streptomycin sulphate at 30 ppm/kg (SS 30 ppm) administered by oral gavage from day 13 to day 47 of experiment. There were two birds (males or females) per experimental unit, replicated three times in twenty four deep litter pens. The colony forming units of Escherichia coli were significantly reduced (P<0.001) in the ileo-caecal digesta of birds on streptomycin sulphate (3.33 x 10^5) followed by the garlic organic extract treated groups (4.08 x 10^5) compared with the control (8.50 x 10^5). The same observation was made for Staphylococcus aureus (P<0.001). The colonies of Salmonella and Shigella spp were statistically similar between streptomycin sulphate and garlic extract treated groups (1.65 x 10^5), but they significantly (P<0.001) decreased compared with the values obtained in the control group (4.53 x 10^5). Female broilers had higher (P<0.001) colony forming units of enterobacteriaceae, Salmonella and Shigella spp and Staphylococcus aureus in their ileo cecal digesta than the males. Even within the treatment and sex interaction, female birds generally recorded higher number of colony forming units as compared with the males. Only mold fungi were found in the ileo-cæcal digesta of all the groups. Significant improvement in apparent digestibility of nutrients except for the calcium and inorganic phosphorus absorption rates in birds on supplemented diets was observed (P<0.01) compared with those on the control. There were no significant differences (P>0.05) in nutrients absorption between male and female broilers. Treatment and sex interaction significantly (P<0.05) affected all the parameters studied indicating a synergistic effect of the two factors on nutrients absorption. It could be concluded that GOE even at 40 ppm/kg controlled pathogens and improved nutrients digestibility in birds.*

ORIGINAL ARTICLE

Keywords: *Garlic organic extract, ileo- cecal digesta, intestinal microflora, nutrients digestibility, streptomycin sulphate.*

INTRODUCTION

The strongest determinant factor of the gut microbial profile is the host's diet. Factors such as diet composition, nutrient concentration, feed physical traits, feed processing, feed additives and environmental pollutions play significant roles in the dynamics of gut microflora (Hume et al*.*, 2006; Oviedo-Rondón et al., 2006; Parker et al*.*, 2007; Nalian et al., 2009). Microbes have profound effects in some of the physiological processes of their animal host (Lan et al*.*, 2005;

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Uscebrka et al., 2005). Digestive microflora populations affect broiler and layer hen performance and health (Hume et al., 2006; Oviedo-Rondón et al., 2006; Parker et al., 2007). These effects in the host may be due primarily to the complex interactions that influence the intestinal environment, and secondly to the responses of the host immune system against pathogenic and non-pathogenic antigens (Uscebrka et al., 2005; Dl Ines, 2009). Plant organic extracts have been shown to have antimicrobial effects (Komgeum et al., 2005; Tamokou et al., 2008). Their antimicrobial mode of action consists of interactions with the cell membranes of micro-organisms by changing permeability for cations such as H^+ and K^+ (Belguith et al., 2009). Moreover, there are evidences that herbs, spices and various plant extracts have appetizing, digestion-stimulating properties and antimicrobial effects (Zhang et al., 2005). The improvement in feed efficiency achieved with plant organic extracts mixtures could be attributed to their positive effects on nutrients digestibility (Jamroz et al., 2005; García et al., 2007; Loh et al., 2008). Thus, this study was conducted to determine the effects of garlic organic extract and streptomycin sulphate on gut microflora and nutrients digestibility in broilers.

MATERIALS AND METHODS

Animals and experimental design

Twenty four male and twenty four female day-old chicks of *Hubbard* line were selected from the batch kept in a brooding room of Abubakar Tafawa Balewa University Poultry Research Farm, Bauchi state, Nigeria for two weeks and transferred to experimental pens. The brooding room temperature decreased from 32°C during the first week of life to 28°C in the second. In order to boost their immunity, they were vaccinated against Infectious bursal disease on the fourteenth day of the experiment while Newcastle disease vaccine was administered at 21 days of age. Experimental diets and water were given *ad libitum* to birds every day. The entire flock was subject to deworming on the 35th day of age using piperazine. The experiment lasted for five weeks during which feed intake, weekly weight gain and feed conversion ratio were monitored. Two broilers died of coccidiosis in the fourth week of experiment giving a percentage mortality of 4.16% and the whole flock was thereby subject to five days of cure with pure amprolium.

The forty eight chicks were randomly allocated to eight (8) treatment combinations to conduct a 4x2 factorial experiment in a completely randomised design in which garlic organic extract and streptomycin sulphate were supplemented to the basal diet as follows: Control (Water), Garlic organic extract at 40 ppm/kg (GOE 40 ppm), garlic organic extract at 60 ppm/kg (GOE 60 ppm) and streptomycin sulphate at 30 ppm/kg (SS 30 ppm) [(Fraser et al., 1991; Radostits et al., 1997; Group Zhongnuo Pharmaceutical (shijiazhuang) Co., Ltd)]. Oral intubation of birds started when they were thirteen days old till day 47 of experiment. There were two birds (males or females) per experimental unit, replicated three times in twenty four deep litter pens. Weekly weighting of birds were carried out to determine the concentration of treatments to be given to birds. The quantity of garlic extract and streptomycin sulphate administered were calculated taking into account the proportion of the major component in the extract, the minimum recommended oral route dose of the antibiotic and the chicken live weights.

Diets and feeding regimens

Birds were fed with commercial starter and finisher diets (NRC, 1994) formulated to meet their nutrient requirements throughout the experiment (Table 1). As for the supplement, garlic extract was obtained by organic solvent extraction (Soxhlet, 1879) and oil analysis was carried out according to Adams (2001) method (Table 2).

Garlic organic extract and streptomycin sulphate control on gut pathogens

Four males and four females from each treatment were randomly selected, weighted and slaughtered. Faecal samples collected from the ileo-caecal junction of the thirty two eviscerated birds on the farm were put into sterilised vials and conveyed immediately to the laboratory. Then 1 g of digesta taken from each sample was added to 10 ml sterile distilled water and mixed for 1 minute in test tube. A tenfold serial dilution was made. Finally 0.1 ml was pipetted from the 1/1000 dilution test tube of each sample and inoculated on the solid culture medium prepared in Petri dishes the previous day. Dispersion was done using a sterile spreader sterilised after each step over a bunsen flame (AOAC, 1995).

Yeast and mold fungi were cultured on Sabouraud agar medium mixed with 250 mg chloramphenicol in order to inhibit any bacterial growth. They were incubated at 37°C for 24 hours and kept on the media preparation bench up to two weeks for identification. Bacterial counts were performed using *Salmonella/Shigella* agar medium for *Salmonella* and *Shigella* species, MacConkey agar for *Escherichia coli*, then the medium for identification of *Staphylococci spp* was prepared using Nutrient Agar + 12% (w/v) dilution of sodium chloride (NaCl). They were all subjected to incubation at 37°C for 24 hours (Johnston and Booth, 1983; Sinclair and Dhingra, 1995).

Digestibility studies and proximate analyses of feed and dried faecal collections

Four males and four females per treatment were randomly selected and subjected to digestibility study in battery cages for five days. Birds were all fed with the commercial broiler finisher diet. On the first day of digestibility study in battery cages, birds were given only the supplementations in the morning as usual without feed till 3.0 pm. Materials for

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faecal collections were placed under the cages in the morning of day 2 and wet faecal collections started on the third day in the morning before feed distribution coupled with oral supplementations. Dried matter digestibility was calculated for each sample. The sun-dried faecal collections and the basal diet as well were subject to laboratory analyses to determine their contents in crude protein, crude fibre, and ether extract according to the AOAC (1995) procedures. Calcium and inorganic phosphorus rates were obtained by UV absorption spectrophotometry [(Atomic Absorption Electronic Machine, Shimadzu, UV-1201, Japan)].

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Table 1 - Composition of experimental starter and finisher diets

Ingredients	Percent starter	Percent finisher
Maize (7.6.% CP)	51.25	56.80
Rice bran (11.8% CP)	8.00	10.00
Soybean meal (44% CP)	33.50	30.00
Fish meal (72% CP)	3.50	—
Bone meal	3.00	2.50
Vitamin/Mineral Premix[k] (0.25%)	0.25	0.25
Sodium chloride (NaCl)	0.30	0.25
Methionine (99%)	0.20	0.20
Totals in kilogramme	100.00	100.00
Feed nutrients proximate analysis		
Metabolizable Energy (Kcal/kg)	2818.33	2855.37
Crude protein (%)	22.05	19.08
Crude fibre (%)	4.21	4.31
Fats (%)	4.58	6.31
Calcium (%)	1.02	1.00
Available Phosphorus (%)	0.49	0.47
Lysine (%)	1.25	1.03
Methionine (%)	0.58	0.51

[k]each 2.5kg premix contained the followings: Vit A 10,000,000 IU; Vit. D_3 3,000, 000 IU; Vit. E 30,000 IU; Vitamin K_2 3 g; Vit $B_1$1.7g;Vit B_2 5.0 g; VitB_6 3.1g;Vit. B_{12} 16 mg; Biotin 60 mg; Niacin 1.0 g; Pantothenic Acid 8 g; Folic Acid 0.8 g; Manganese 85 g; Zinc 50 g; Iron 25 g; Copper 6 g; Iodine 1.1 g; Selenium 120 mg; Cobalt 220 mg; B.H.T 60 g; Ethoxyquin 65 g; Choline Chloride 200 g

Table 2 - Chemical composition (%) of the garlic organic extract

No	Retention Index	Compound Name	Percent in oil
		Thioethers	**83.67%**
1	660	Allyl methyl sulfide	3.49
2	849	1-propene, 3,3'-thiobis-sulfide	3.99
3	1099	Disulfide, di-2-propenyl	9.78
4	1131	Trisulfide, methyl 2-propenyl	26.82
5	1134	3-vinyl-1,2-dithiacyclohex-5-ene	32.72
6	1350	Trisulfide, di-2-propenyl	6.86
		Fatty acids	**16.33%**
7	1968	n-hexadecanoic acid	6.51
8	2183	Linoleic acid	9.82

Statistical analysis

The data collected were compared using the analysis of variance (ANOVA) option of Minitab (version 11.0) and Compare Means option of Statistical Package for Social Sciences software (version 11.0) as described by Steel and Torrie (1980). Significantly different means among treatments were separated using the Duncan's Multiple Range Test (Duncan, 1955) at ($P<0.05$).

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RESULTS

Effects of garlic organic extract and streptomycin sulphate supplementations on intestinal microflora of chickens

The intestinal microbial counts in ileo-caecal digesta of broilers are given in Table 3. At first glance, it can be noticed that birds in the control group had the highest number of colony forming units (CFU) of enteropathogens studied as compared with those on garlic extract and streptomycin sulphate. We could also observed that these colonies reduced as the dosage of garlic extract increased and the drop in CFU was even better with streptomycin sulphate except for *Salmonella and shigella spp.* Only mold fungi were observed in the ileo-cecal digesta of all the groups.

Sex effects of garlic extract and streptomycin sulphate supplementations on gut microbial population of broilers

The sex effects of garlic extract and streptomycin sulphate supplementations on gut microbiota of broilers are shown in Table 4. Female broilers had higher (P<0.001) colony forming units of *Escherichia coli, Salmonella and Shigella spp* and *Staphylococcus aureus* in their ileo cecal digesta than the males. However, the effect of treatments significantly decreased (P<0.001) the mean values of population of these enteropathogens per gramme of digesta collected from males as compared with those observed in female boilers. Mold fungi alone were found in the digesta of female birds and the males as well.

The treatment and sex interaction (Table 5) also significantly affected (P<0.01) the count of *Staphylococcus aureus,* the counts of *Salmonella and shigella spp*, and that of *E.coli* (P<0.001) per gramme of digesta studied indicating that the two factors contributed synergistically to the decrease in number of these parasites in broiler chickens. Even within the treatment and sex interaction, female birds generally recorded higher number of colony forming units as compared with the males. Only mold fungi were found in the ileo-cecal digesta of all the groups.

Treatments effect of garlic extract and streptomycin sulphate supplementations on nutrients absorption

Table 6 presents the results of nutrients digestibility in broilers. Garlic extract and streptomycin sulphate fortified diets significantly improved digestibility of nutrients in birds compared with the control except for the calcium and inorganic phosphorus absorption rates.

Sex effects on nutrients digestibility

Sex effects on nutrients digestibility (Table 7) in broilers subjected to garlic organic extract and streptomycin sulphate supplementations showed no significant differences (P>0.05) between male and female broilers. However, the mean values of nutrients digestibility in female birds were slightly superior to those of the males for all the parameters studied.

Treatment and sex interaction (Table 8) on nutrients digestibility significantly (P<0.05) affected all the parameters studied indicating a synergistic effect of the two factors on nutrients absorption. Even within the interaction, the nutrients digestibility values in female birds were generally higher as compared with those in males except for the apparent digestibility of crude fiber and the values found in birds on diets fortified with streptomycin sulphate.

Table 3 - Effects of garlic organic extract and streptomycin sulphate supplementations on the gut microbiota expressed in colony forming units per gramme of ileo-cecal digesta of broilers

Parameters	Control	Garlic Organic Extract		Streptomycin	SEM
		40 ppm	60 ppm	30 ppm	
Staphylococcus spp X 10^5	8.36 ^{a}	5.51 ^{b}	4.76 ^{c}	4.51 ^{c}	24138.75
Salm. & shig. spp X 10^5	4.53 ^{a}	2.28 ^{b}	1.65 ^{b}	2.70 ^{b}	42561.27
Escherichia coli X 10^5	8.50 ^{a}	4.97 ^{b}	4.08 ^{c}	3.33 ^{d}	23433.36
Yeast & Mold fungi	Mold (+)	Mold (+)	Mold (+)	Mold (+)	

^{a,b,c,d}Mean values in the same row with different superscripts are significantly different (P<0.001).

Table 4 - Sex effects of garlic organic extract and streptomycin sulphate supplementations on gut microbial counts in broilers

Parameters	Male	Female	SEM	P value
Staphylococcus aureus x 10^5	5.17	6.40	4217.78	<0.001
Salmonella & *Shigella* species x 10^5	2.67	2.91	2645.13	<0.001
Escherichia coli x 10^5	5.01	5.43	2242.17	<0.001
Yeast & Mold fungi	Mold (+)	Mold (+)		

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Table 5 - Treatment x Sex interaction of garlic organic extract and streptomycin sulphate supplementations on gut microflora of broilers

Parameters	Control		GOE 40 ppm		GOE 60 ppm		SS 30 ppm		SEM
	♂	♀	♂	♀	♂	♀	♂	♀	
Staphylococcus aureus x 10⁵	7.81 b	8.91 a	4.90 f	6.12 c	3.95 h	5.58 d	4.03 gh	5.00 ef	8435.57
Salmonella & Shigella spp x 10⁵	4.50 a	4.57 a	2.25 e	2.32 ed	1.30 g	2.00 f	2.65 c	2.75 cb	5290.27
Escherichia coli x 10⁵	8.00 b	9.00 a	4.75 d	5.20 c	4.00 f	4.17 fe	3.32 h	3.35 hg	4484.34
Yeast and Mold fungi	Mold (+)		Mold (+)		Mold (+)		Mold (+)		

a,b, c, d, e, f, g, h Mean values in the same row with different superscripts are significantly different (P<0.001). *GOE: Garlic Organic Extract; SS: Streptomycin Sulphate

Table 6 - Treatments effect of garlic organic extract and streptomycin sulphate supplementations on nutrients absorption

Parameters	Control	Garlic Organic Extract		Streptomycin	SEM	P value
		40 ppm	60 ppm	30 ppm		
ADDM	60.49 b	72.96 a	72.07 a	70.26 a	1.499	0.003
ADCP	51.48 b	65.61 a	64.91 a	60.80 a	1.843	0.001
ADCF	2.45 b	17.34 a	14.94 a	15.01 a	1.990	0.022
ADEE	90.28 b	93.42 a	93.10 a	92.11 a	0.365	0.044
CaAR	19.28 b	45.43 a	42.82 a	32.74 ab	3.023	0.034
PiAR	3.46 b	18.62 a	10.65 ab	7.11 b	1.890	0.020

a, b Mean values in the same row with different superscripts are significantly different. ADDM: Apparent digestibility of dry matter, ADCP: Apparent digestibility of crude protein, ADCF: Apparent digestibility of crude fiber; ADEE: Apparent digestibility of ether extract, CaAR: Calcium Absorption Rate, Pi AR: Inorganic phosphorus Absorption Rate

Table 7 - Broilers' sex effect of garlic organic extract **and streptomycin sulphate supplementations on nutrients digestibility**

Parameters	Males	Females	SEM	P value
ADDM	58.32	62.66	3.540	0.600
ADCP	49.00	53.96	4.694	0.586
ADCF	1.68	3.22	5.124	0.762
ADEE	89.58	90.98	0.838	0.388
CaAR	17.93	20.63	7.042	0.952
PiAR	1.49	5.43	4.820	0.992

Table 8 - Treatment x Sex interaction of garlic organic extract **and streptomycin sulphate supplementations on nutrients digestibility**

Parameters	Control		GOE 40 ppm		GOE 60 ppm		SS 30 ppm		SEM	P value
	♂	♀	♂	♀	♂	♀	♂	♀		
ADDM	58.32c	62.66 cb	71.56 a	74.37 a	72.20 a	71.95 a	71.03 a	69.49ba	3.540	0.032
ADCP	49.00 c	53.96 cb	63.88 ba	67.35 a	64.74 a	65.09 a	61.50 ba	60.11ba	4.694	0.046
ADCF	1.68 b	3.22 ba	13.75 b	20.93 a	15.01ba	14.88 ba	17.07 ba	12.94ba	5.124	0.004
ADEE	89.58 c	90.98 cb	93.01 ba	93.83 a	93.10 ba	93.10 ba	92.17 cba	92.05cba	0.838	0.002
CaAR	17.93 d	20.63dc	42.05 ba	48.82 a	45.03 ba	40.61ba	34.66 cba	30.82dcb	7.042	0.042
PiAR	1.49 d	5.43 dcb	16.44 ba	20.81 a	12.90 cba	8.40 dcba	8.94 dcba	5.28 dcb	4.820	0.020

a, b, c, d Mean values in the same row with different superscripts are significantly different. GOE: Garlic Organic Extract ; SS: Streptomycin Sulphate; ADDM: Apparent digestibility of dry matter, ADCP: Apparent digestibility of crude protein, ADCF: Apparent digestibility of crude fiber; ADEE: Apparent digestibility of ether extract, Ca AR: Calcium Absorption Rate, Pi AR: Inorganic phosphorus Absorption Rate

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DISCUSSION

The intestinal microbial population of *Staphylococcus aureus of* broilers on control was heavier than that of birds on garlic extract which was in turn heavier than the values in birds on diets fortified with streptomycine sulphate. Likewise, Guo (2003) used mushroom and herb polysaccharides as alternative for antimicrobial growth promoters in poultry and observed alteration of gut microbial activities and composition of chikens' caeca. The highest number of colony forming units (CFU) of *Escherichia coli* in ileo-cecal digesta was found in birds on the control and the lowest number in birds on streptomycin sulphate and they were all significantly different ($P<0.001$) from one another even as the dosage of garlic extract used increased. Likewise, Juneja and Friedman (2007) in an in vitro study using carvacrol, cinnamaldehyde, oregano oil, and thymol observed an inhibition of *Clostridium perfringens* spore germination in ground turkey during chilling. The colony forming units of *Salmonella and shigella spp* in ileo-caecal digesta of birds on supplements were significantly reduced ($P<0.001$) compared with the values in birds on control. Ben-Mahdi et al., (2010) studied the effect of the thyme essential oil in the improvement of growth performance and sanitary status of broiler chickens and observed a significant reduction ($P<0.05$) of the number of CFU of *Escherichia coli* in the groups supplemented with thyme essential oil compared with the control.

The effects of garlic organic extract and streptomycin sulphate supplementations on nutrients absorption showed that the values of apparent digestibility of dry matter from birds on garlic extract (40-60 ppm) and streptomycin sulphate did not differ but were significantly greater ($P<0.01$) than that of birds in the control group. This result followed the same pattern in the apparent digestibility of crude fiber, apparent digestibility of fats, except for the calcium and inorganic phosphorus absorption rates. These results tally with the findings of García et al*.,* (2007) who studied the effect of formic acid and plant extracts on growth, nutrient digestibility, intestine mucosa morphology, and meat yield of broilers and reported an improvement in apparent ileal digestibility of nutrients in birds on supplemented diets with plant extracts compared with those on the control.

Apparent digestibility of crude protein mean values of birds on garlic organic extract (40-60 ppm) did not differ but were significantly higher ($P<0.05$) than the lowest value observed in birds on the control diet whereas that of birds on streptomycin sulphate supplementation was statistically similar to both. The same observation was made for the calcium absorption rate. Loh et al*.,* (2008) studied the effects of feeding phytogenic substances and phytase on growth performance and nutrient digestibility of young broilers and reported that birds on supplemented diets had better digestibility of nutrients such as crude protein, phosphorus and calcium compared with the control.

CONCLUSION

It was concluded that diets fortified with garlic organic extract at minimum 40 ppm level of inclusion could efficiently control enter pathogens and improve upon nutrients digestibility while boosting the immune system for a good health and carcass yield of broiler chickens.

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INFLUENCE OF THE NATURE OF THE ENERGY SOURCE IN THE CONCENTRATE ON THE CONCENTRATION AND MOLAR PROPORTIONS OF VOLATILE FATTY ACIDS IN THE RUMEN OF THE SICILO-SARDE SHEEP BREED

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ABSTRACT: *The effect of the nature of the source of energy supplementation on ruminal pH, concentration of volatile fatty acids (VFA) and the proportions of the main acids in the rumen of the dairy Sicilo-Sarde breed were evaluated. Four rams with an average live weight at the beginning of the experience of 45.25 ± 3.5 kg and aged 4.8 ± 0.5 years, fitted with permanent cannulas in the rumen were used in this experiment. The animals had a common basal diet at 1.5 kg DM / head / day of oat hay supplemented in turn by four concentrate at 500 g / head / d. Concentrates differed by the nature of energy ingredients they contain. The concentrate A: included 10% barley, 43.3% corn, 25% wheat bran, 17.7 % soybean meal and 4% CMV; The concentrate B was made of 66% white sorghum, 30 % beans and 4% CMV; the concentrate C had 71% triticale, 18% horse bean, 7% soybean meal and 4% CMV; and finally the D concentrate included 71.5% barley, 17.5% field bean, 7% soybean meal, and 4% CMV. 50 ml samples were taken before, 2, 5 and 8 hours after the distribution of the morning meal, and were filtered through four layers of surgical gaze. These samples were used for the analysis of volatile fatty acids (VFA) concentrations by gas chromatography. Results showed that the rumen pH was statistically different (P<0.05) before and 2 hours after the morning meal distribution among concentrates. It was in favour of C and D (P<0.05) concentrates but it has stabilized at the end of the day (P>0.05). The concentration of total VFA was significantly higher (P<0.05) for diets C and D just after the distribution of the meal before it became comparable (P>0.05) among concentrates after 5 and 8 hours post prandial. The proportion of acetate and butyrate (C2 and C4) acids evolved in the same way during the day regardless of the regimen but were in a reversed manner for the propionic acid (C3).*

Keywords: *Acetate, butyrate, supplements, energy source, pH, propionate*

ORIGINAL ARTICLE

INTRODUCTION

Rumen microbial population and network convert all carbohydrates into monosaccharides (hexoses or pentoses) with special enzymatic equipment. The soluble carbohydrates are hydrolyzed very rapidly and completely. Cereal starch is degraded from 90 to 95% in the rumen by bacterial amylase (Grinari et al., 2000; Russell and Gahr, 2000). Microbial population degrades carbohydrates walls (cellulose, hemicellulose and pectin) into monosaccharides that are then fermented anaerobically in ways known as metabolism (Cuvelier et al., 2005). The products of this fermentation is a mixture of short chain organic acids, known as volatile fatty acids, mainly acetic, propionic and butyric acids, and carbon dioxide and methane (Fonty et al., 1995). The ruminant gets most of the energy it needs from volatile fatty acids (VFA) by

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the degradation of cytoplasmic and cell wall carbohydrates by rumen microorganisms. They can provide 65 to 75% of the energy absorbed (Jouany, 2000; Moujahed et al., 2003). With the usual diet forage-based used by ruminants, the relative proportions of VFA in % molecules are: Acetic acid (C 2) from 60 to 70%, Propionic acid (C3) from 15 to 20%, butyric acid (C4) from 10 to 15% and other VFA from 2 to 5% (Bergman, 1990). The VFA are then absorbed through the rumen epithelium, with more efficiency for longer carbon chains, presumably by passive diffusion of undissociated acid on the one hand, and mainly in anionic form in the other hand (Russel and Gahr, 2000). The VFA are in fact weak acids (pK ≤ 4.8) and with rumen pH approaching neutrality, they are mainly present as anions acetate, propionate and butyrate rather than as acetic, propionic and butyric acid (Bergman, 1990). The proportions of different VFA products are mainly dependent on the nature of the regimen. Indeed, rumen microorganisms depend upon the substrates they are capable of degrading and / or fermenting (Cuvelier et al., 2004). Nutrients in the diet therefore determine the nature of the rumen microorganisms, which guide the production of VFA metabolism by their respective companies. Diets rich in forage promote the production of acetate propionate. Butyric acid production is, in turn, increased in diets containing ingredients high in soluble sugars, such as beets (sucrose) or whey (lactose) (Jouany et al., 1995). Rouissi (1994) reported that the concentration of VFA in the rumen was significantly higher for a diet based on hay + concentrate compared to a diet made of hay whatever the species and sampling time during the day were. In the same context, Peyraud (1993) showed that the addition of concentrate to forage composed of rapidly fermentable carbohydrates such as barley and wheat compared to maize and sorghum fermentation causes a deviation towards a higher proportion of propionic acid and / or butyric acid at the expense of acetic acid.

Moreover, a decrease in the level of ingestion causes a decrease in the amount of organic matter fermented in the rumen, and thus a significant reduction in the production of VFA and especially propionate (Doreau et al., 2000). This trend is more pronounced with diets rich in concentrate (Merchen et al., 1986) while a decrease in particle size or increasing the particle density by grinding increases the VFA content of rumen fluid and the molar proportion of propionic acid at the expense of that of acetic acid (Sauvant, 2000).

The effect of the nature of the ingredients of the concentrate on the production of VFA and the proportions of the main acids in the rumen of Sicilo–Sarde sheep was the subject of this study when replacing maize (imported feed resource) by different local energy feed resources (white sorghum, triticale and barley).

MATERIALS AND METHODS

Animals, diet and feeding regimen

Four Sicilo - Sarde rams with an average live weight at the beginning of the experience of 45.25 ± 3.5 kg and aged 4.8 ± 0.5 years, fitted with permanent cannulas in the rumen were used in this experiment. The animals had a common basal diet at 1.5 kg DM / head / day of oat hay supplemented in turn by four concentrated feed at 500 g / head / day. Concentrates were made of different energy sources, maize, white sorghum, triticale and barley. The experiment was conducted in a Latin Square design. The ration was distributed twice a day at fixed times throughout the test (9am and 17 pm). The chemical composition (AOAC, 1995) and food values (Sauvant, 1981) concentrated feed used are summarized in Table 1.

Table 1. Centesimal composition and nutritive value of fed concentrates

Ingredients (%)	Concentrates			
	A	B	C	D
Corn	43.3	-	-	-
Wheat bran	25	-	-	-
Barley	10			71.5
white sorghum	-	66	-	-
Triticale			71	
Faba bean meal	-	30	18	17.5
Soybean meal	17.7	-	7	7
VMC	4	4	4	4
UFL	0.98	0.99	0.98	1.1
PDIE (g/kg of DM)	104.9	95	103	103
PDIN(g/kg of DM)	99	96	102	100

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Sampling procedure

The samples for the determination of various parameters of rumen fermentation (pH, total VFA and VFA molar proportion) were taken just before the distribution of the morning meal (0:00), 2, 5 and 8 hours after the same meal. The inoculum (a mixture of the solid phase and the liquid phase of rumen) was collected using a plastic rod of length 35 cm and internal diameter of 2.5 cm. The pH of the inoculum was measured immediately after each sampling to avoid changes in air using a digital pH meter (Hanna, HI 9024/HI 9025). Before each measurement, the instrument was calibrated using two buffer solutions pH 4 and pH 7, the electrode tip in a solution of KCl. 50 ml samples filtered through four layers of surgical gauze were used for analysis of VFA concentrations by gas chromatography. The samples were centrifuged for 20 minutes at a rate of 4000 revolutions / min in a centrifuge Hettich centrifuges type EBA 21. The device used is a chromatograph type GC - FID (Agilent 6890 N) equipped with a flame ionization detector and using a column headed HP-removable type INNOWX stationary phase polyethylene glycol and having a length of 30 m and an inner diameter of 250 µm and the thickness of the wire is 0.25 µm.

Statistical analyses

The results of the effects of diets on ruminal pH, total VFA concentration and proportions of different acids were subjected to analysis of variance using the GLM procedure of SAS (1989) and compared by a Duncan test (1955). $Yij = \mu + R + Eij$

Where Yij: measured parameter
µ: overall mean
R: effect of the ith diet (1, .., 4)
Eij: residual error for the jth replicate

RESULTS AND DISCUSSION

The pH of the rumen before the morning meal distribution was statistically comparable ($P>0.05$) for plans A, C and D, respectively. Measured mean values were 6.67 (STD = 0.34) 6.60 (STD= 0.27) and 6 71 (STD= 0.27) and low ($P<0.05$) for the regimen B (6.28 (STD = 0.22)). This result is similar to those of Rouissi (1994) and Hammami (2009) and below the range of pH in the rumen of sheep receiving hay alone (Giger et al., 1988). Two hours postprandial, the pH decreases for the four feeding schemes, but the decrease was greater for diets C and D (0.44 and 0.49 points respectively), while the other two systems the decrease was minimal (0.19 to 0.1 for A and B). After 5 hours, the pH continues to decline, it was 6.22 (STD = 0.42) 5.97 (STD = 0.22) 6.06 (STD = 0.29) and 6.01 (STD =0.12) for the A, B, C and D concentrates, respectively. The statistical analysis revealed that there is no difference between rumen pH among the four regimens ($P>0.05$). This trend reached those reported by Santra et al. (2007) and Hammami et al. (2009). At the end of the day, the pH increased significantly ($P<0.05$) and was more stable and buffered diets C and D compared to diets A and B.

The general trend of the change in pH in the rumen of Sicilo- Sarde rams is in the same direction as those of Giger et al. (1988); Rouissi (1994) and Hammami et al. (2009). This variation during the day is explained by the fact that the addition of different types of concentrates in the diet causes changes in the flow of digesta leaving the rumen on the one hand, the amount and nature of the products absorbed in ruminal walls on the other hand (Oetzel et al., 1999). Just before the distribution of the morning meal, the pH is at its maximum value explained by the role of bicarbonate ions (HCO-3) and phosphate (HPO^{-2} 4) in the saliva that occurs in a massive way in rumination (Sauvant et al., 2006). Concentrate feed with their energy source are grains of cereals (triticale and barley) have the highest values with significant differences ($P<0.05$) compared to the concentrated energy source which is the white sorghum. This can be explained by intense production of saliva and the rapid digestion of sorghum grain compared to white corn (Michalet-Doreau and Sauvant, 1989). The significant difference ($P<0.05$) between the A and B concentrates before the distribution of the meal may be due to the fact that the concentrate A contains besides the corn, a proportion of barley and wheat that are grains with large sizes and that the size of type A is concentrated cap while the B concentrate is starchy. This joins the conclusion of Sauvant (2000) who showed that the decrease in pH is almost routine when the size of particles from the feeding plan or any of its components is reduced which may explain the decrease in the daily duration of rumination and therefore the decrease in saliva production. The decrease in pH two hours after the meal distribution is highly significant ($P<0.05$) for concentrated energy based on cereals (barley, triticale). These values are within the ranges noted in the results found by Giger et al. (1988) and Sauvant et al. (2006). The latter other reported that the pH is lower for the concentrate rich in cereals (barley, triticale), which is explained by the amount of rapidly fermentable starch in it and the high production of VFA which in turn promote the stability of the pH after absorption through the rumen wall. In

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this context, Sauvant and Van Milgen (1995); Claps et al. (2000) reported that the close relationship between rumen pH and rumen VFA profile may be an indicator of the nature of the rumen fermentation, especially the ratio acetate / propionate (A / P). This ratio is an index of energy status of specific microbes and rumen pH. 5 hours post-meal, the pH continued to decrease with no statistical differences among the different regimes (P>0.05) and the fall is most notable for plans A and B (- 0.26 and - 0.21). This is attributed to the slow degradation of corn starch and sorghum-white. At the end of the day (after 8 hours of the morning meal distribution), the ruminal pH stabilizes again with significant differences between diets (p <0.05), the highest values are displayed Plans for the grain.

Volatile fatty acids are the end products of rumen digestion of carbohydrate foods that include various compounds which are derived from either plant cell walls such as cellulose, hemicellulose and pectin, or the cell contents, such as the starch and soluble sugars (Jarrige et al. 1995; Sauvant, 1997), their concentration depends on the amount of energy provided by the food and the quality of starch degradation in slow or fast (Sauvant et al. , 1994; Cuvelier et al., 2005).

The study of the effect of the nature of the energy source at the complementation showed that the concentration of total VFA in the rumen just before the distribution of the morning meal is low compared to other periods of control during the day with a minimum value observed for the concentrate B (P<0.05). This can be explained by the absorption of VFA across the rumen wall used by the bacteria to produce their own proteins. Two hours after the distribution of the morning meal, the concentration increases with an intense speed (P<0.05) for diets C and D (86.5 ± 1.76 and 85.45 ± 0.69 mmol / l respectively) compared to diets A and B. This result is consistent with that of Chikagwa-Malunga et al. (2009). This trend can be explained by the quality of the starch found in the seeds of barley and triticale.

After five hours of the morning meal, the concentration of VFA from the schemes A and B reached the peak (89.03 ± 0.82 and 87.28 ± 1.05 mmol / l respectively), this would be attributed to the degradation of starch grains of white maize and sorghum. This corroborates with the results of Russell and Gahr (2000), no statistical difference among the means of four concentrates (P>0.05). It is also noted that the high concentration of VFA for concentrate C is correlated with the low gas production especially at the beginning of incubation. At the end of the day, the VFA concentration is stabilized (P>0.05) for the different regimes, this decrease in concentration can be explained by the rate of absorption and activity of microorganisms in the rumen (Rouissi, 1994) (Table 2).

Table 2. Effect of the nature of energy sources on the ruminal pH and Total VFA (mmol/l)

	Hours after the morning feeding			
	0	2	5	8
Ph				
A	6.67 ^{a} ± 0.34	648 ^{a} ± 0.38	6.22 ^{a} ± 0.42	6.25 ^{b} ± 0.34
B	6.28 ^{b} ± 0.22	6.18 ^{b} ± 0.13	5.97 ^{a} ± 0.22	5.99 ^{b} ± 0.31
C	6.60 ^{a} ± 0.27	6.16 ^{b} ± 0.21	6.06 ^{a} ± 0.29	6.40 ^{a} ± 0.35
D	6.71 ^{a} ± 0.27	6.16 ^{b} ± 0.12	6.01 ^{a} ± 0.12	6.34 ^{a} ± 0.24
SME	0.084	0.069	0.083	0.091
Total VFA (mmol/l)				
A	76.85^{a} ±1.1	81.4^{b} ± 1.46	89.03^{a} ± 0.82	86.3^{a} ± 0.83
B	70.33^{b} ±1.58	78.36^{b} ± 1.3	87.28^{a} ± 1.05	83.9^{a} ± 1.22
C	75.45^{a} ± 0.59	86.5^{a} ± 1.76.	88.55^{a} ± 07	83.3^{a} ± 1.24
D	74.68^{a} ±1.49	85.45^{a} ± 0.69	87.58^{a} ± 0.74	84.66^{a} ± 1.03
SME	1.96	2.74	1.09	1.87

$^{a, b \text{ and } c}$: Means with different superscripts within a row differ significantly (P <0.05).

The proportion of acetic acid changes the same way for concentrated feed C and D, the minimum value was observed after two hours of the distribution of meals (65.4 and 66.06% respectively). Then increases after 5 hours and stabilized at the end of the day with no statistical difference among the regimes (P>0.05). This trend is similar to that demonstrated by Chikagwa-Malunga et al. (2009) and can be explained by the orientation of the fermentation of starch grains of barley and triticale with a strong and rapid degradation thereby reducing the synthesis of acetate and promoting that of propionate increase after the circulation of morning meal and the maximum value was displayed after two hours (P>0.05) (17, 08 and 16.83% for the C and D diets, respectively) (Jouany et al., 1995). This can partly explains what is reported by Giger et al (1988) that the concentration of acetate and propionate in the rumen are reversed during the day. For diets of slowly degradable starch resources, minimum values are reached after 5 hours (65.63 and 65.58%) as shown in Figure 1, while propionate is highest at this time (Figure 2). The proportion of acetate is stable at the beginning and the end of the day

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(P>0.05). This is mainly due to the rate of absorption of through the rumen wall and its use by bacteria in the presence of ammonia nitrogen for the synthesis of their protein, whereas it is statistically higher (P<0.05) for A and B 2 hours post prandial. On the concentration of butyric acid in the rumen, it has a profile similar to that of acetate as shown in Figure 3; the proportion was 11 to 13% during the day. This is consistent with results reported by Rouissi (1994) and is lower than that determined by Jouany et al. (1995) especially when the plan is based on beet.

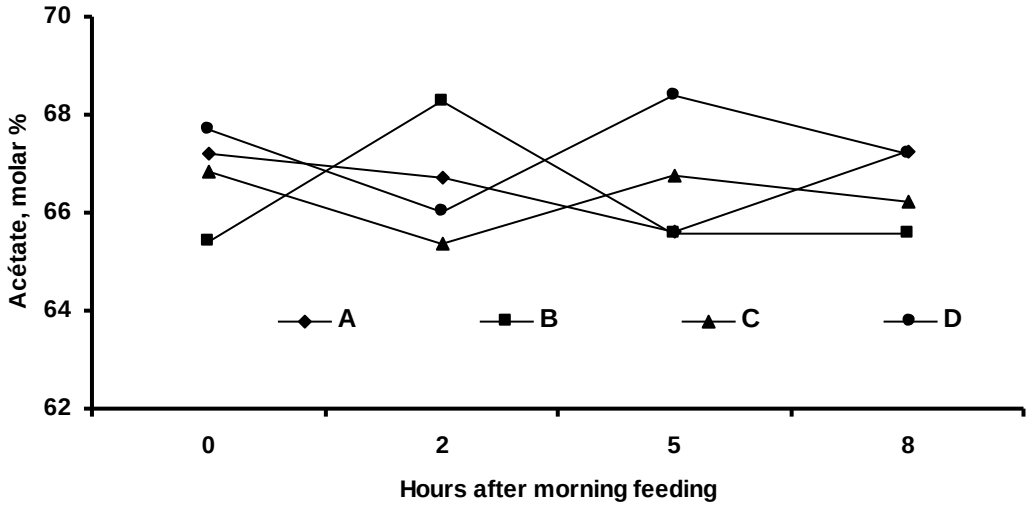

Figure 1. Ruminal acetate proportion (%) in the rumen of Sicilo- Sarde rams fed different concentrate

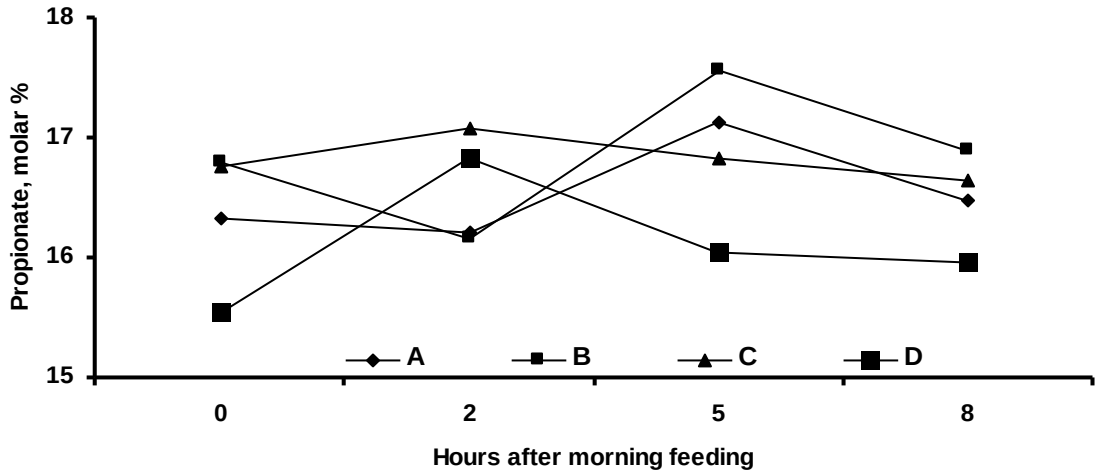

Figure 2. Ruminal propionate proportion (%) in the rumen of Sicilo- Sarde rams fed different concentrate

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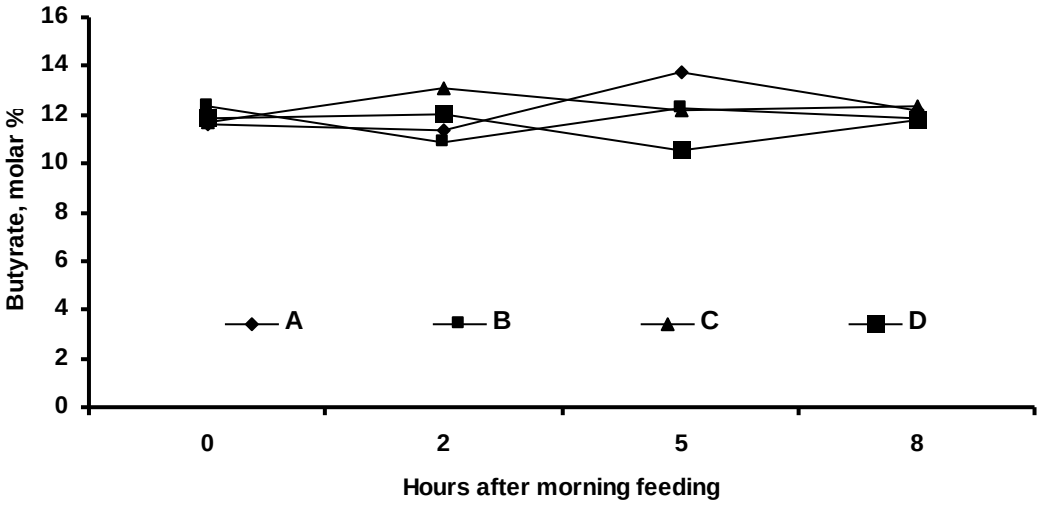

Figure 3. Ruminal Butyrate proportion (%) in the rumen of Sicilo- Sarde rams fed different concentrate

CONCLUSION

Through this experiment, it appears that the effect of the incorporation of local raw materials rich in energy such as white sorghum, triticale and barley to replace corn in the formulation of concentrates for feeding dairy sheep can have a significant concentration of volatile fatty acids with a significant superiority for the diet based on barley and triticale for the nature and amount of starch they contain and results in a change in other parameters such as fermentation, pH, and total gas production, especially of methane, which is closely related to the amount of acetic acid and butyric acid.

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REPRODUCTIVE PERFORMANCE OF RAHMANI AND CHIOSE SHEEP AND THEIR LAMBS UNDER UPPER EGYPT CONDITIONS

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ABSTRACT: *The differences of fertility and prolificacy traits for Rahmani and Chios ewes were studied in this investigation. The study was conducted during two consecutive years that included three lambing season with a total of 273 ewes (162 Rahmani and 111 Chios) bred, 230 ewes lambing, 280 lambs born and 237 lambs weaned. Breed of ewes had a significant effect on fecundity, lambing rate and weaning rate. Mating season and year did not significantly affect fertility traits. Age of ewes had a significant effect on fecundity, lambing rate and weaning rate. Breed of ewes had a significant (P<0.01) effect on prolificacy traits. Mating season and year had no significant effect on prolificacy traits. Age of ewes had a significant effect on prolificacy traits, except litter weight at weaning, Chios ewe lambs reached puberty and maturity at younger age and they had heavier body weight than Rahmani ewe lambs. The effects of birth type and weaning system on reproductive traits of ewe lambs were not significant. Early weaned lambs reached puberty and maturity earlier than normal and late weaned lambs. Breed of lambs, birth type and weaning system had no significant on age and weight at puberty of ram lambs, except age at puberty which was significantly affected (P<0.05) by weaning system.*

ORIGINAL ARTICLE

Keywords: *Reproductive performance, Rahmani sheep, Chios sheep, puberty, sexual maturity.*

INTRODUCTION

Number of lambs weaned per ewe is one of the most important factors determining the efficiency of meat production from sheep. It is a complex trait controlled by both genetic and environmental factors, and responds slowly to genetic selection within breeds (Smith et al., 1979). Fertility varied greatly among the different breeds of sheep raised at different conditions. Litter size depends primarily on the number of eggs shed by the ewe, i.e. her ovulation rate. Secondary factors are the proportion of eggs fertilized, losses of embryos and fetuses causing reduction of multiple fetuses, and perinatal deaths (Gatenby, 1986). Total litter weight weaned per ewe lambing is a trait often used as an overall measure of range lamb production (Bromley et al., 2001).

Puberty in the ewe is defined as the time when oestrous cycles start. Awassi lambs on a good diet first display oestrous at 274 days of age (Younis et al., 1978), while, Rambouillet crossbred lambs in Rajasthan are about 615 days old before they display oestrous (Kishore et al. 1982). This difference was largely due to the different growth-rates resulting from different nutrition. In Egypt, the average age at puberty of Ossimi and Barki ewe lambs was 347 days, when reared on a high plane of nutrition, and 366 days on a low plane (El-Hommosi and Abd El-Hafiz 1982). Sexual maturity is the time when the animal expresses its full reproductive power (Asdell, 1946). Age at first behavioural estrus was considered as puberty age for ewe lambs (Quirk et al., 1985), age and weight at sexual maturity after three regular cycles from puberty (Aboul-Naga et al., 1982). Reports of puberty in rams, defined as age at first ejaculate, vary from 132 days

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for Tabasco [Pelibuey] x Dorset lambs on the high plateau in Mexico (Valencia et al., 1977) to as 738 days for ¾ Rambouillet ¼ Malpura lambs in Rajasthan, India (Tiwari and Sahni, 1981). In Egypt, El-Tawel (1980), working on Ossimi and Saidi ram lambs, observed that average age at puberty was 324 and 368 days, respectively. Awassi sheep reached puberty at earlier age than Ossimi and Chios ram lambs. The results reported by Mohamed (1998) indicated that averages age and weight of Ossimi ram lambs at puberty were 376 days and 32.4 kg, respectively.

Objective of the study is to examine the effect of some factors such as lambing season, weaning system and age of ewes on reproductive performance in Rahmani and Chios sheep under the conditions of Upper Egypt.

MATERIALS AND METHODS

The present study was carried out during the period from Augusts–September 2005 to May-June 2008 at the Experimental Farm of Animal Production Department, Faculty of Agriculture, Al-Azhar University, Assiut. To assess the possible effect of season of birth, mating was planned in such a way that lambs would be born into the two main season (winter and summer). According to the mating practice of the station, breeding ewes were mated at the middle of the winter season (January–February) and at the beginning of the summer season (may–June) so that lambings could occur within the winter and summer season respectively. Mating started at the age of one year for the ewe lambs and 2 year for the rams. The system of three lambing season per two years was adopted. Mating per breeding season lasted for 45 days. Sires were randomly selected from rams kept for breeding purposes; the sires chosen were all over 45 kg and had at least two permanent teeth (incisors). Those selected were again physically checked for any scrotal deformity or any history of reproductive problems. Four rams per breed were then randomly picked for each mating season. Ewes within breed were assigned to sire groups by a stratified random sampling method taking body weight and parity into consideration.

Management of the flock

A total of 273 ewes (162 Rahmani and 111 Chios) were bred and housed under semi-open sheds which provided enough shade and ventilation in summer and protection from rain in winter. Lambs born were kept with their dams till weaning age. All ewes were grazing on Egyptian clover from December to May. During summer months they were fed on crop residues available besides the green maize (Darawa) in addition ewes were supplemented with pelleted concentrate mixture, starting with 0.5 kg / head / day and increased to 0.750 kg / head / day during late pregnancy and lactation periods. The concentrate pelleted diet containing (68% ground corn, 15% wheat bran, 15% decorticated cotton seed meal, 1.5% calcium carbonate, 0.5 % salt blocks minerals and vitamins mixture were also provided). However, fresh and clean water is available at all times. The flock was sheared twice yearly on April (spring) and September (autumn). They were subjected to routine vaccination program against infectious diseases (foot and mouth disease, Rift fever valley, sheep pox and clostridium disease). The flock was also injected or drenched against internal and external parasites.

Reproductive performance of lambs

Ewe lambs of Rahmani and Chios breeds were born during winter 2006. At four months of age behavioral estrus was detected by introducing a sexually active ram twice daily to the ewe lambs, early in the morning and at 4 p.m. for a period of one hour each. Once the heat symptoms were observed, age and weight of the ewe lambs were recorded. After three regular cycles from the onset of estrus (maturity), length of estrus cycle was recorded (period from previous to next estrus). The age at first conception of each ewe was obtained by subtracting the gestation period from the age of the ewe at first lambing according to Tuah and Baah (1985). This method was adopted since it was not possible to determine the age at puberty by direct observation of first oestrus. Age at first lambing was computed as the average of the ages in days between birth and first lambing of all ewe lambs.

Ram lambs from both breeds were introduced into pens containing five adult females (with oestrus was observed in at least three of these five ewes) of their own breed for a period of 30 min. The manifestations of sexual behavior were observed and recorded. This procedure was repeated twice a week from week 16 to puberty which in the present study was defined as the first observed mounting with ejaculation. According to Belibasaki and Kouimtzis (2000). Age and weight at puberty of ram lambs was recorded.

Data were statistically analyzed using the GLM procedure of the SAS package, 8.1 version (SAS, 1996). Analysis was performed according to the following linear model:

$$Y_{ijklm} = \mu + B_i + MS_j + Y_k + A_l + e_{ijklm}$$

Where: Y_{ijklm} = the trait of study, B_i = fixed effect of the j^{th} breed (j = Rahmani and Chios ewes), MS_j= fixed effect of the j^{th} mating season (j = autumn, summer, winter), Y_k= fixed effect of the k^{th} mating year (k = 2006, 2007), A_l = fixed

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effect of the l^{th} age of dam (l = 1, 2, 3, 4 and 5) where. 1 = 2yr–old or less, 2 = ≤ 3yr–old, 3 = ≤ 4yr–old, 4 = ≤ 5yr–old, and 5 = > 5yr–old., e_{ijklm}= effect of the m^{th} random error.

RESULTS AND DISCUSSION

Reproductive performance of ewes:

Fertility traits

Least squares means, analysis of variance and the significant levels for some factors affecting fertility traits are illustrated in Table (1).

The Chios ewes were slightly more fertile than Rahmani ewes, but the difference between breeds was not significant. On the other hand, significant (P<0.01) difference was found between both breeds regarding fecundity, lambing rate and weaning rate. The estimates of these parameters were 0.89 %, 88.14 % and 75.99 % for Rahmani ewes, and 1.19, 120 and 95.10 for Chios ewes, respectively. These results indicated that Rahmani ewes had lower fertility rate than Chios ewes. Increase fecundity in Chios than Rahmani ewes may be attributed to implying difference in ovulation rate that directly affects fecundity.

Table 1 - Least-square means and their standard errors of some factors affecting fertility traits of Rahmani and Chios ewes

Items	No	Fertility traits			
		Fertility	Fecundity	Lambing rate	Weaning rate
Overall means	273	0.87 ± 0.14	1.04 ± 0.17	104.8 ± 21.28	85.55 ± 19.0
Breed of ewes		Ns	**	**	**
Rahmani (R)	162	0.86 ± 0.03	0.89 ± 0.05	88.14 ± 5.49	75.99 ± 4.91
Chios (C)	111	0.89 ± 0.04	1.19 ± 0.05	120.0 ± 6.54	95.10 ± 5.84
Mating season		Ns	Ns	NS	Ns
Autumn	74	0.88 ± 0.05	1.04 ± 0.06	104.2 ± 7.98	81.89 ± 7.13
Summer	86	0.86 ± 0.05	1.05 ± 0.06	100.7 ± 7.24	86.06 ± 6.47
Winter	113	0.87 ± 0.04	1.03 ± 0.05	107.4 ± 6.73	88.69 ± 6.01
Mating year		Ns	Ns	NS	Ns
2006	160	0.87 ± 0.03	1.05 ± 0.04	102.4 ± 5.14	83.90 ± 4.67
2007	113	0.87 ± 0.04	1.03 ± 0.05	107.4 ± 6.40	88.69 ± 5.81
Age of ewes		Ns	*	*	*
2yr-old or less	77	0.76 ± 0.06 ^{b}	0.84 ± 0.07 ^{b}	82.99 ± 8.69 ^{b}	71.16 ± 7.76 ^{b}
≤3yr-old	53	0.85 ± 0.06 ^{ab}	0.95 ± 0.07 ^{ab}	95.21 ± 8.69 ^{ab}	87.38 ± 7.76 ^{ab}
≤4yr-old	53	0.89 ± 0.06 ^{ab}	0.98 ± 0.07 ^{ab}	98.18 ± 8.69 ^{ab}	85.09 ± 7.76 ^{ab}
≤5yr-old	45	0.88 ± 0.06 ^{ab}	1.14 ± 0.08 ^{a}	118.5 ± 9.78 ^{a}	102.3 ± 8.74 ^{a}
>5yr-old	45	0.98 ± 0.07 ^{a}	1.27 ± 0.09 ^{a}	125.5 ± 11.1 ^{a}	81.86 ± 9.95 ^{ab}

The Chios breed was superior (P<0.01) than Rahmani breed regarding lambing rate, probably due to its higher ovulation rate as postulated by Brown and Jackson (1995). The lower lambing rate in Rahmani ewes may be as a result of a higher prenatal mortality rate. Weaning rate of Rahmani ewes was significantly (P<0.01) lower than the Chios ewes, probably due to the fact Rahmani ewe produces less milk, hence less vigorous lambs being produced and having a poor mothering ability. Similar results were reported by Ahmed et al. (1992) in Barki ewes.

There was no significant difference between seasons of mating in fertility traits observed in this study. However, autumn season (September–October) was the best season in fertility (88%) compared to 86% in summer (May–Jun) and 87% in winter season (January–February). This finding is in agreement with those reported by Fahmy (1990), Marzouk and Mousa (1998) and Abd Allah (2005). Season of mating influenced fecundity insignificantly and litters were larger in the dry (summer) mating season than the autumn or wet (winter) mating season. Larger litters in the summer mating season may be due to the extra supplementation of concentrate mix to ewes during the dry season, which probably resulted in higher ovulation rates. Mating season affected the lambing rate and weaning rate significantly (P<0.01) and ewes lambing in winter season recorded a higher lambing rate and weaning rate than ewes lambing during autumn and summer seasons. The reason for this response was probably related to the fact that ewe lambing in the winter season had access to better quality and quantity feed during this season. The present results are partly consistent with those reported by Aboul-Naga et al., (1985) who found that the oestrous activity of some subtropical fat tailed sheep was the highest in

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autumn breeding and the lowest in early winter and late spring. In Egypt, Aboul-Naga et al., (1987) concluded that the local breeds showed oestrus activity around all the year without a clear anoestrus period, but with a drop during the period from February to July.

Results showed that mating year had no significant effect on fertility traits. These results are in agreement with the findings of Osinowo et al. (1992). Kilograms born or weaned per ewe exposed were not significantly affected by mating year. These estimates partly agree with those reported by (Morsy, 2002; Abd Allah, 2005 and Hamdon, 2005). Fertility traits tended to increase with advancing age of the ewes. The effect of age on fertility rate is in agreement with Mukasa and Lahlou-Kassi (1995), where the reproductive rate of older ewes was higher than that of younger ewes. Significant ($P<0.05$) increase in fecundity with increase age of ewes may result from an improved ovulation rate, uterine capacity or other maternal traits affecting the reproductive efficiency of the ewe (Fahmy, 1990). The improvement of lambing rate with an increase in ewe age may be due to the fact that, with the increase in the age of ewes, more ova are matured and the ewe's ability to maintain pregnancy Increases (Mukasa and Lahlou-Kassi, 1995). However, age of ewe affected weaning rate significantly ($P<0.05$) with older ewes (3 to 5 year) had higher weaning rates than younger ewes. This may be due to the high pre-weaning lamb mortality rate as a result of poor mothering ability and less milk production of the younger ewes.

Prolificacy traits

Breed of ewes had a significant ($P<0.01$) effect on all prolificacy traits studied. The Chios ewes had a higher litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning than Rahmani ewes. Despite the expected higher lamb losses in the ewes with a higher litter size, Chios ewes had higher litter size weaned than the Rahmani breed, indicating the superiority of the Chios breed in prolificacy reflected in litter size at weaning. The results obtained of litter size at birth and litter size at weaning for Chios ewes were lower than those recorded by Marzouk (1997) who reported 1.53 for litter size at birth and 1.13 at weaning. In addition, Morsy (2002) found that values of litter size at birth and at weaning in Chios ewes were 1.52 and 1.3, respectively. The present results were higher than those reported by Hamdon (2005) who found values of litter size at birth and at weaning for Chios ewes of 1.3 and 0.89, respectively. The estimates of litter size at birth of Rahmani ewes were approximately similar to those reported by Abd Allah (2005). Which results of the present study follow the same trend as reported in the literature by Ahmed *et al.,* (1992), Morsy (2002), Abd Allah (2005) and Hamdon (2005) who reported that genotype of ewe affected all prolificacy traits studied significantly.

There was no significant effect of lambing season on prolificacy traits. However, ewes lambed in Oct-Nov season had slightly higher litter size at birth than ewes lambed in Feb-Mar or June-July seasons. In contrast, ewes lambed in Feb-Mar season had a slightly higher litter weight at birth and at weaning than ewes lambed in Oct-Nov or June-July seasons. Feb-Mar lambing season was the best season by considering values of litter weight at birth and litter weight at weaning as compared with either Oct-Nov or June-July lambing seasons (4.33 vs. 4.28 & 4.13 kg) and (19.99 vs. 19.36 & 19.89 kg), respectively. These results are in agreement with Maharem (1996), Barghout (2000) and Morsy (2002) who reported that lambing season had no significant effect on each of litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning.

No significant differences in prolificacy traits have been observed between both lambing years. Similar results were obtained by Sallam et al. (1987) and Ahmed et al. (1992) who reported that year of breeding had no significant effect on prolificacy traits.

Litter size at birth and litter size at weaning were influenced significantly ($P<0.05$) by ewe age at mating. Highly significant ($P<0.01$) effect of ewe age on litter weight at birth was also observed, but no significant effect was observed on litter weight at weaning. These results may be attributed to significant increase in litter size as ewe advance in age due to the higher increase in ovulation rate, which was strongly correlated with litter size, (Mukasa and Lahlou-Kassi, 1995). These results can be due to the fact that older ewes (4 years old) had mature body size and better conformation. These provide higher ovulation rate and convenient uterus cavity that increase percentage of twins. These results are in good agreement with those reported by Hamdon (2005) who reported that the effect of ewe age at mating on prolificacy traits were highly significant. Abd Allah (2005) reported that age of ewes had no significant effect on litter size at birth.

Ewes aged 5 year-old or more had the highest value of litter weight at birth and litter weight at weaning than younger ewes. Presumably, the nursing ability as well as the milk production merit is stronger in the older ewes than younger ones. These results follow the same trend reported by Maharem (1996) that litter weight at birth and litter weight at weaning tended to increase with age of the ewe up to 5 years and then decreased with advancing age. Morsy (2002) found that age of ewe had a significant effect either on litter size at birth and at weaning or litter weight at birth and at weaning.

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Table 2 - Least-square means and their standard errors of some factors affecting prolificacy traits of Rahmani and Chios ewes

Items	N	Prolificacy traits			
		Litter size at birth	Litter size at weaning	Litter weight at birth	Litter weight at weaning[1]
Overall means	230	1.20 ± 0.15	1.01 ± 0.19	4.25 ± 1.21	19.75 ± 5.39
Breed of ewes		**	**	**	**
Rahmani (R)	139	1.03 ± 0.04	0.89 ± 0.05	3.73 ± 0.10	17.63± 0.51
Chios (C)	91	1.37 ± 0.05	1.13 ± 0.06	4.77 ± 0.14	21.87± 0.69
Mating season		Ns	Ns	Ns	Ns
Autumn	65	1.19 ± 0.06	0.96 ± 0.07	4.33 ± 0.17	19.99 ± 0.82
Summer	73	1.22 ± 0.05	1.03 ± 0.07	4.28 ± 0.14	19.36 ± 0.68
Winter	92	1.19 ± 0.05	1.03 ± 0.06	4.13 ± 0.13	19.89 ± 0.60
Mating year		Ns	Ns	Ns	Ns
2006	138	1.20 ± 0.04	0.97 ± 0.05	4.23 ± 0.14	19.33 ± 0.68
2007	92	1.19 ± 0.04	1.06 ± 0.06	4.12 ± 0.13	20.00 ± 0.61
Age of ewes		*	*	**	Ns
2yr-old or less	57	1.10 ± 0.06 ^{b}	0.94 ± 0.08 ^{b}	3.73 ± 0.17 ^{b}	19.95 ± 0.79 ^{ab}
≤3yr-old	44	1.13 ± 0.06 ^{ab}	1.04 ± 0.08 ^{ab}	4.10 ± 0.18 ^{ab}	18.94 ± 0.85 ^{a}
≤4yr-old	47	1.10 ± 0.06 ^{b}	0.95 ± 0.08 ^{b}	4.14 ± 0.18 ^{ab}	18.98 ± 0.84 ^{ab}
≤5yr-old	41	1.35 ± 0.07 ^{a}	1.24 ± 0.09 ^{a}	4.77 ± 0.21 ^{a}	20.53 ± 0.94 ^{b}
>5yr-old	41	1.31 ± 0.08 ^{ab}	0.85 ± 0.10 ^{b}	4.52 ± 0.21 ^{ab}	21.36 ± 1.07 ^{ab}

[1] Litter weight at weaning (at 3 month old)

Reproductive performance of lambs

Puberty and sexual maturity of ewe lambs

The breed of ewe lambs had a significant effect on age (P<0.01) and weight (P<0.05) at puberty. Chios ewe lambs reached puberty at younger ages and heavier weights (275.1day and 32.28 kg) than Rahmani ewe lambs (Table 3). These results conformed to those reported by Mousa (1991) and Hassan, *et al*. (2002) who found that Chios lambs reached puberty at younger ages than Awassi and Ossimi ewe lambs. Similar results were recorded by Michailidis (1985) who found that age at puberty was (243-290 days) which breed. The average puberty age reported in the present study (298.9 day) of Rahmani ewe lambs was very near to that previously reported by Aboul-Naga, *et al.* (1982) who obtained age and weight at puberty in Rahmani ewe lambs of 300.9 day and 34.1 kg, respectively. Such differences may be attributed to flock differences, location, as well as nutrition.

The effect of breed on age at maturity was highly significant (P<0.01). Chios lambs reached maturity significantly at younger age (329.1 vs. 352.9 day) and they were insignificantly heavier than Rahmani ewe lambs. Fahmy (1990) reported that breed had a significant effect on maturity in Finnsheep, Suffolk and Booroola ewe lambs. However, Attallah (1993) reported that breed of lambs had no significant effect on age at maturity, while the effect of breed on body weight at maturity was significant (P<0.05).

There was no significant difference in gestation length between Rahamni and Chios ewe lambs. Moreover, breed of lambs had a significant (P<0.01) on age at first lambing. Chios ewe lambs reached age at first lambing at younger ages (477 day) than Rahmani ewes (501.1 day). Age at first lambing of Djallonke sheep was 408 days obtained by Oppong-Anane, (1971), 575 days by Fall et al., (1982) and 638 days by Tuah and Baah, (1985). Generally, the effect of breed on estrous cycle length was significant (P<0.05), Chios ewe lambs had shorter estrous cycle length than Rahmani ewe lambs by 1.15 days.

Generally, the effect of birth type on age and weight at first estrus (puberty), age and weight at maturity was not significant (Table 3). Also, type of birth had no significant effect on gestation length, age at first lambing and estrus cycle length. This could be attributed to the variation in body weight between single and twin ewe lambs. These observations are in agreement with the findings of Mousa (1991) who reported a no significant effect on both pubertal age and pubertal weight. Hamdon (2005) reported that type of birth had no significant effect on age and weight at puberty.

Age at weaning had no significant on reproductive performance of ewe lambs, the early weaned ewe lambs attained puberty 8.7 and 11.1 day earlier than their contemporaries that weaned normally or late. This result is in agreement with those reported by Roux et al., (1978) on Karakul sheep, who found that early weaning did not increase the age at which lambs reached puberty. The results of this study were also in agreement with those reported by Aboul-Naga et al., (1982) and Mohamed (1986) on Rahmani and Barki ewe lambs, respectively.

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Table 3 - Least square means ± standard errors of some factors influencing puberty and maturity parameters for ewe and ram lambs of Rahmani and Chios breed.

Sources of variation	Ewe lambs							Ram lambs	
	Age at puberty (day)	Weight at puberty (kg)	Age at Maturity (day)	Weight at Maturity (kg)	Gestation length (day)	Age at first lambing (day)	Oestrus cycle length (day)	Age at first ejaculation (day)	Weight at first ejaculation (day)
Overall mean	287.0 ± 11.7	31.6 ± 1.72	341.0 ± 11.7	35.0 ± 2.89	148.9 ± 3.12	483.7 ± 12.9	17.57 ± 1.19	324.0 ± 28.48	36.65 ± 2.45
Breed of lambs	**	*	**	Ns	Ns	**	*	Ns	Ns
Rahmani	298.9 ± 3.83	30.92 ± 0.57	352.9 ± 3.83	34.41 ± 0.56	149.6 ± 1.14	501.1 ± 4.72	18.14 ± 0.39	328.5 ± 7.78	36.0 ± 0.76
Chios	275.1 ± 3.26	32.28 ± 0.48	329.1 ± 3.26	35.58 ± 0.47	148.2 ± 1.03	477.0 ± 4.26	16.99 ± 0.33	319.4 ± 12.1	37.3 ± 1.04
Type of birth	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
Single	285.5 ± 4.92	32.04 ± 0.38	339.5 ± 4.92	35.44 ± 0.38	148.3 ± 0.75	490.3 ± 3.08	17.45 ± 0.27	317.6 ± 11.1	37.0 ± 0.86
Twins	288.5 ± 2.58	31.16 ± 0.73	342.5 ± 2.58	34.56 ± 0.72	149.5 ± 1.56	487.8 ± 6.45	17.69 ± 0.50	330.4 ± 9.98	36.2 ± 0.96
Weaning system	Ns	Ns	Ns	Ns	Ns	Ns	Ns	*	Ns
Early	280.4 ± 4.28	31.99 ± 0.63	334.4 ± 4.18	35.76 ± 0.62	149.9 ± 1.52	480.8 ± 6.26	17.78 ± 0.44	298.3 ± 12.0^{b}	37.8 ± 1.04
Normal	289.1 ± 3.38	31.53 ± 0.50	343.1 ± 3.38	34.97 ± 0.49	148.5 ± 1.01	492.6 ± 4.17	17.69 ± 0.36	333.2 ± 13.0^{ab}	35.4 ± 1.12
Late	291.5 ± 4.18	31.28 ± 0.62	345.5 ± 4.28	34.27 ± 0.61	148.4 ± 1.14	493.8 ± 4.71	17.23 ± 0.43	340.4 ± 10.8^{a}	36.6 ± 0.93

*= P < 0.05, ** = P < 0.01, NS = P > 0.05.

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The effect of age at weaning on age and weight at maturity was not significant. Ewe lambs of the early weaned group were not significantly younger (334.4 day) and heavier (35.76 kg) at maturity than those of the normal and late weaned groups. Similar results were reported by Mohamed (1986) in Barki ewe lambs, stating that the effect of age at weaning on age at maturity was not significant. Also, Attallah (1993) found that the effect of age at weaning on age at maturity was not significant. On the other hand, Aboul-Naga *et al* (1982) reported a significant effect of age at weaning on age at maturity of Rahmani ewe lambs. In the present study, early weaned lambs reached age at first lambing earlier by (12- 13 days) than normal and late weaned ewe lambs, but the differences was not statistically significant. Also, age at weaning had no significant effect on estrous cycle length of ewe lambs. This result was in agreement with those reported by Attallah (1993) who found that age at weaning had no significant effect on estrous cycle length of ewe lambs.

Age and weight **at puberty of ram lambs:**

The Chios ram lambs performed their first ejaculation at a slightly older age and heavier weight than Rahmani ram lambs. They showed better performance in terms of pubertal weight and age than Rahmani ram lambs, possibly due to slower growth rates (Aboul-Ela and Chemineau, 1988). Variation in pubertal age and weight within each breed was low.

Single born lambs reached puberty at younger age (317.6 vs. 330.4 days) and heavier body weight (37.3 vs. 36.0 kg) at first ejaculation than twins born lambs. Results obtained in Table (3) show that the difference in age at first ejaculation (puberty) between early, normal and late weaned ram lambs was a significant ($P<0.05$). Moreover, weight at first ejaculation did not differ significantly between the early, normally and late weaned ram lambs of both Rahmani and Chios. Early weaned ram lambs reached puberty at younger age (298.3 day) compared to normal and late weaning (333.2 and 340.4 day, respectively). Also early weaned lambs had heavier body weight (37.8 kg) than those normally (35.4 kg) and late weaned (36.6 kg) ram lambs.

These values were lower than those recorded by Mousa (1991) who indicated that the averages age at puberty for Ossimi and Chios were 296.8 and 334.9 days, respectively. Mohamed (1998) found that averages of age and weight of Ossimi ram lambs at puberty were 330 days and 38 kg. These results were higher than those recorded by Ali and El-Saidy (2003) who reported averages of age and weight of (½ Rahmani ½ Romanove) were 245 days and 38 kg at puberty. The results obtained by Hamdon (2005) for average age and weight of Farafra ram lambs at first ejaculation were approximately similar in magnitude, being (329.17 days and 36.19 kg).

CONCLUSSION

Chios ewes in this study had higher fertility, prolificacy, and total lamb weight weaned per ewe than did Rahmani ewes. It can be concluded from the present results that crossing the local subtropical fat-tailed Rahmani sheep with the mutton prolific Chios may improve lamb production from the local sheep. In the present study, Chios lambs reached puberty, maturity and age at first lambing at a younger age and heavier weight than Rahmani ewe lambs. Early weaning had no deleterious effect on lamb performance either in weight or in age at puberty and maturity. Early weaning is therefore recommended.

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