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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Effect of Body Weight Uniformity on the Productivity of Broiler Breeder Hens

S.A. Abbas[1], A.A. Gasm Elseid[2] and M-K.A. Ahmed[1]
[1]Faculty of Animal Production, University of Khartoum, Khartoum, Sudan
[2]Arab Company for Livestock Investment and Development, Khartoum, Sudan

Abstract: Measurements on hen-day and hen-housed egg production, hatchability, fertility, total hatching eggs, mortality and cracked eggs were made on eight flocks belonging to the Arab Company for Livestock Investment and Development. There were 6000 females and 600 male parent broilers in each flock. Uniformity was calculated by taking a random sample of 7% of the birds in each pen and weighting them on a weekly basis. The flocks were assigned to uniformity groups ranging from 55-80%. The high uniformity group (75-80%) consistently had the highest hen-day and hen-house production over all ages, while the low uniformity group had the lowest hen-day production. The analysis of variance showed that effects of age and uniformity group on all studied traits were highly significant. The effect of age x uniformity group was significant only for total hatched eggs. Percentage hatchability of settable eggs varied from 69.19±1.93 in the 55-59% group to 83.93±1.65 in the 75-80%. The highest levels of uniformity had the highest percentage of cracked eggs (0.30±0.01), while the medium range of uniformity had the lowest percentage of cracked eggs (0.182±0.011 in the 65-69% group). The highest fertility (86.53±1.56) was found in the 65-69% group. The study demonstrates the importance of controlling body weight and the use of restricted feeding to achieve optimum production and fertility in broiler breeder hens.

Key words: Flock uniformity, broiler breeder hen, productivity, target weight

INTRODUCTION

Uniformity is measure of the amount of body weight variation in a flock. Attainment of the breeder target body weight at any specific age and flock uniformity are the two most important criteria of pullet quality. Flock uniformity is the percentage of birds that are within ±10% (Ensminger, 1980) or ±15% (Anonymous, 2007, 2008) of the average flock body weight recommended for a particular age. The goal of the producer is to have 80% of the pullets within these specified ranges. Flocks with high uniformity will reach peak egg production earlier, and have higher peaks than those of low uniformity values (North, 1980). Poor uniformity is associated with variation in the degree of sexual maturity of hens, where underweight pullets have delayed onset of egg production and overweight ones have an early start (Yuan *et al.*, 1994). Settable eggs from lighter hens vary in size (Petitte *et al.*, 1982), whereas heavier hens produce less number of eggs and with a higher percentage of double-yolk (Eluera, 1997).

Many factors may contribute to low uniformity in a flock such as hatching egg size (Deceuypere *et al.*, 2001; Meijerhof, 2006), genetic variability in the parent stock (Bruggman *et al.*, 2005); stocking density (Anonymous, 2008); amount and/or quality of feed (Koelkebeck *et al.*, 1993); diseases and parasites (Matthijs *et al.*, 2003) and environmental factors such as house temperature and ventilation.

Light and feed restriction programs are used in the management of breeder pullets to improve body weight uniformity and to regulate the age of sexual maturity (Gous *et al.*, 2000; Leeson *et al.*, 2005); improve egg shell quality (MC. Daniel *et al.*, 1981) and egg weight and some egg quality traits (Tolkamp *et al.*, 2005).

Poultry producers, such as the Arab Company for Livestock Investment and Development (ACOLID) have the advantage of raising their own pullets for the breeder hen flock and consequently have a greater control over costs and methods of production. Despite the fact that flock uniformity is an important aspect of layer production, it has received little attention by most poultry producers in the Sudan. The objective of this study was to monitor production performance of flocks of breeder hens at different body weight uniformities and to assess the impact of uniformity on egg production and reproduction traits.

MATERIALS AND METHODS

The data used in this study were collected on parent broilers in four farms of the ACOLID at (Teiba Alhasanab village), south of Khartoum in the year 2006. Each farm contained two houses 12 x 90 m and each house was divided into four pens. The number of birds in each house was 6000 females and 600 males. Houses were equipped with cooling pads on the sides and exhaust fans for evaporative cooling. Data were collected on

Corresponding Author: S.A. Abbas, Faculty of Animal production, University of Khartoum, Khartoum, Sudan

productivity (Measured as hen-day and hen-housed), fertility, total hatching eggs, cracked eggs, hatchability and Mortality. Uniformity was calculated by taking a random sample of 7% of the birds in each pen and weighting them on a weekly basis.

Fertile eggs of Hubbard grandparent stock were imported from Jordan and hatched at the ACOLID hatchery in Sudan. Day-old chicks were vaccinated against Marek's disease, detoed and dubbed on the first day, and beak trimming was done on the 10^{th} day. Pullets were allowed 3-4 h access to water on feed days and 2 h access on off feed days in the layer stage; water was restricted to 5-7 h/day. Nests with soft wood shaving or straw were provided at a rate of 1:4 and eggs were collected four times a day.

At the chick stage, the light duration was 24 h throughout the first three days and was decreased after the third day to 8 h a day up to the 19^{th} week in order to control body weight, delay sexual maturity and decrease number of double yolked eggs. After the 9^{th} week, the light hours were increased gradually up to 15 h at 24 weeks of age. At the chick stage, the light duration was 24 h throughout the first three days and was decreased after the third day to 8 h at 24 weeks of age.

The formulation and the nutrient content of the rations offered at the various stages are presented in Table 1. Feeding at the chick stage was *ad libitum* with both males and females given the same diet, but males were provided with extra pen feeders. Between 5 and 21 weeks, the pullets were fed the pullets diet (Table 1). The feed amounts were adjusted according to the body weight of the birds. Feed restriction was started at 4 weeks and continued up to 24 weeks. This feed restriction regimen was used as means of controlling body weight of broiler breeders. At the beginning, feed restriction was on a skip-a day basis and towards the end of the period was changed to skip-two-days. Males and females at 18 weeks of age and at a sex ratio of 1:10 were brought together. Culling was performed at 18 weeks to prepare for the laying period. Laying continued from 24 weeks up to the liquidation of the flock at 65 weeks. The layer diet offered is shown in Table 1. Hens were fed about 124-125 g at the onset of lay up to the peak of production and then the feed allotment was increased slowly to 150 g.

Statistical analysis was performed using a model in which the main effects were uniformity group, age and uniformity group X age interactions. The flocks were grouped according to uniformity into groups in which uniformity ranged from 55 to 80%. Percentage traits including fertility, hatchability, cracked eggs and mortality were transformed prior to the analysis using the arcsine of the square root of the percentage.

Statistical Model as follows:

$$Y_{ii} = \mu + P_i + A_i + (P*A)_{ii} + E_{ii}$$

Where:

- Y_{ii} : The observation on the i^{th} observation and j^{th} age group
- P_i : The ith uniformity group, I = 1.5
- A_i : The jth age in weeks, j = 1,40-41
- $(P*A)_{ii}$: The interaction term between uniformity group and age
- Eii : The random error term

RESULTS AND DISCUSSION

Table 2 shows the analysis of variance of hen-day, hen-housed production and total eggs hatched. The effects of both age and uniformity group on all three traits were highly significant. Age x uniformity interactions were significant only for total hatched eggs. Some of the flocks had uniformities well below the recommended level which requires that 80% or more of the birds should be within 10% of the standard weight for the particular age. This poor level of uniformity will be compounded during the subsequent productive cycle (North, 1980). Numerous factors may have played a role in the decrease of uniformity. However, the major factor was probably the fact that these flocks suffered from outbreaks of Marek disease, Gumboro and Chronic Respiratory Disease (CRD). Disease has a major impact on flock uniformity and early exposure to disease elements usually has the worst and most lasting effect on the uniformity of a flock (Matthijs *et al*., 2003). Uniformity had a highly significant effect on all traits under study.

Figure 1 demonstrates that the high uniformity group (75-80%) consistently had the highest hen-day production over all ages, while the low uniformity group consistently had the lowest hen-day production. The

Table 1: Feed formulation and nutrient composition of rations fed to birds at different stags

	Percent of ration				Nutrient composition		
Feed item	Chick stage	Pullet stage	Layer stage	Nutrient	Chick stage	Pullet stage	Layer stage
Maize	59.7	59.9	60.0	Energy (Kcal/kg)	2834.00	2885.60	2760.00
Groundnut meal	14.0	12.0	19.0	Crude protein (%)	18.30	16.00	17.50
Wheat bran	19.0	20.7	6.6	Phosphorus (%)	0.46	0.44	0.47
Concentrate	6.0	5.0	5.0	Calcium (%)	1.05	0.97	3.50
Calcium carbonate	1.0	2.0	7.4	Lysine (%)	1.10	0.90	0.99
Lysine	0.3	0.0	0.0	Methionine (%)	0.42	0.40	0.43
Sodium chloride	0.0	0.1	0.4	Sodium (%)	0.14	0.12	0.11
Dicalcium phosphate	0.0	0.0	1.4				

Table 2: Analysis of variance of egg production traits

Source	Trait	df	Mean squares	F
Age (weeks)	Hen-day	41	1276.06	15.36**
	Hen-housed	41	1394.24	11.32**
	Total hatched eggs	40	658.22	6.97**
Uniformity group	Hen-day	4	3561.63	42.87**
	Hen-housed	4	6503.67	52.80**
	Total hatched eggs	4	3231.84	34.21**
Age x uniformity group	Hen-day	149	16.36	0.20
	Hen-housed	149	16.66	0.14
	Total hatched eggs	132	175.02	1.85**
Error	Hen-day	115	83.09	
	Hen-housed	115	123.16	
	Total hatched eggs	78	94.47	

** = Significant at p = 0.01

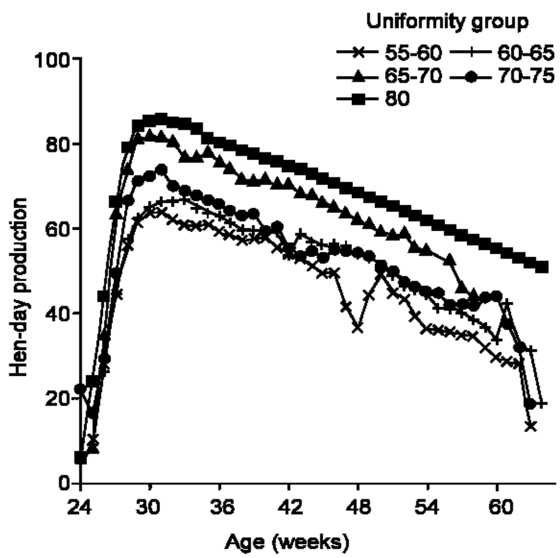

Fig. 1: Hen-day egg production at different levels of uniformity

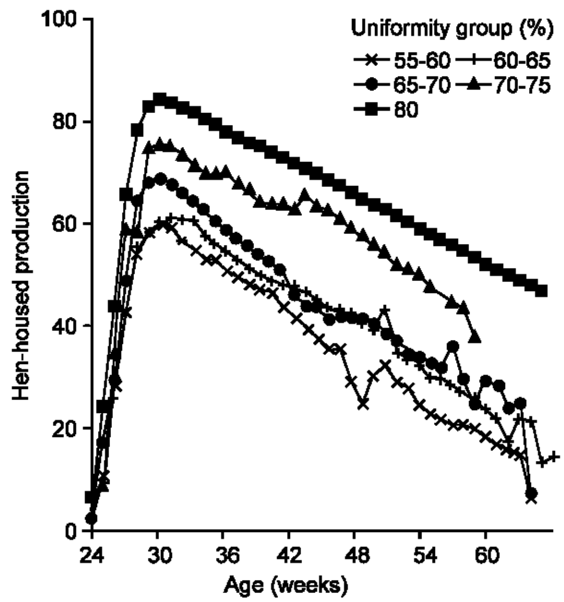

Fig. 2: Hen-housed egg production at different levels of uniformity

same was true for hen-housed production (Fig. 2). There was a clear trend for increased hen-day and hen-housed production with improved uniformity. The high uniformity group (75-80%) reached peak production earlier and peaked higher than non-uniform flock. Hudson *et al.* (2000) divided 20-week old 400 female broiler breeders into high and low uniformity groups and found that hen-day production was higher in the high uniformity treatment between 26 and 35 weeks of age, but differences were significant ($p<0.01$) only between 29 and 35 weeks of age.

Age had highly significant effects on both hen-day and hen-housed production. However, peak production was reached by all groups at about the 30th week of production. Both hen-day and hen- housed at peak production were much lower in the low uniformity flocks than the high uniformity flock. Petitte *et al.* (1982), in a study of two groups of broiler breeders of high and low uniformity, found that the more uniform flock exhibited higher egg production than the less uniform flock. They also found that uniformity did not influence cumulative egg weight, fertility or mortality. Hudson *et al.* (2001) reported that high initial uniformity was associated with increased egg production.

Uniformity group and age had a highly significant effect on cracked eggs, mortality, fertility and percent hatched of total eggs set (Table 3). There was no clear trend in the percentage of eggs hatched and fertility despite the fact that there were significant differences between uniformity groups (Table 4). The lack of trend in fertility with uniformity groups inspite of significance can be explained in terms of the natural mating used in these flocks as opposed to artificially inseminated hens in other reports. In natural mating sexual unresponsiveness by females and/or preferential mating by the males were probable reasons for intermittent periods of infertility. Such mating patterns could mask treatment effects with respect to fertility

Table 3: Analysis of variance of production traits

Source	Trait	df	Mean squares	F
Age (weeks)	Cracked egg	41	0.013	2.03**
	Mortality	41	0.004	1.62**
	Fertility	40	0.103	12.45**
	Eggs hatched of total set	40	0.123	9.82**
Uniformity group	Cracked egg	4	0.137	31.71**
	Mortality	4	0.056	23.18**
	Fertility	4	0.076	9.25**
	Eggs hatched of total set	4	0.292	23.35**
Age x uniformity group	Cracked egg	114	0.004	0.81
	Mortality	147	0.002	0.77
	Fertility	132	0.009	1.08
	Eggs hatched of total set	132	0.008	0.63
Error	Cracked egg	114	0.004	
	Mortality	114	0.002	
	Fertility	78	0.008	
	Eggs hatched of total set	78	0.012	

** = Significant at p = 0.01

Table 4: Least squares means and standard errors of studied production traits at different levels of uniformity

Trait	Uniformity group	Mean	SE
Cracked egg	55-59	0.267	0.010
	60-64	0.252	0.006
	65-69	0.182	0.011
	70-74	0.243	0.007
	75-80	0.300	0.010
Mortality	55-59	1.452	0.133
	60-64	1.068	0.080
	65-69	0.698	0.147
	70-74	1.270	0.099
	75-80	0.300	0.132
Fertility	55-59	80.90	1.56
	60-64	80.49	0.99
	65-69	86.53	1.56
	70-74	77.76	1.11
	75-80	79.00	1.33
Egg hatched of total set	55-59	69.19	1.93
	60-64	69.35	1.23
	65-69	79.20	1.93
	70-74	65.79	1.38
	75-80	83.93	1.65

(Fontana *et al.*, 1992). Total hatched eggs and percentage hatchability of settable eggs varied from 69.19±1.93 in the 55-59% group to 83.93±1.65 for the 75-80% group, respectively. However, the highest levels of uniformity also had the highest percentage of cracked eggs (0.30±0.01) and the medium range of uniformity also appeared to have had the highest fertility (86.53±1.56 in the 75-80% uniformity group). The highest percentage of cracked eggs recorded for the best uniformity group (75-80%) could be attributed to their high egg production. These high producers may have greater needs for nutrients and were unable to draw upon their-reserves to maintain production and egg shell quality, especially with respect to calcium. MC. Daniel *et al.* (1981) reported that feed restriction programs limit the increase in egg weight and decrease in egg shell thickness which is generally accepted to contribute to the decrease in hatchability occurring during post-peak production.

There is a direct relationship between the pullet's development during rearing and subsequent performance and the bird's ability to reach optimum peak production during the laying cycle. In addition, body weight at 16 weeks of age has been shown to be positively correlated with performance (Hudson *et al.*, 2001). Usually, when flock uniformity is high at 16 week of age, egg production is higher and mortality is lower after 55-60 weeks of age. Thus, every attempt should be made to attain a good uniformity and proper body weight at 16 weeks of age. Pullets on or above target body weight at this age are usually the best performers during the laying period. If a pullet is not on target body weight by 12 weeks of age, she will more than likely to be a small pullet entering the laying house and possibly a financial burden for the rest of the laying period. The restricted feeding regimen used during the rearing period in this study was designed to control pullet body weight and to reduce reproductive problems resulting from the intensive selection of meat type chicken for growth, however, it is difficult to determine the optimum degree of restriction, because of strain differences and changes in the genetic constitution of stocks by primary breeders (Robinson *et al.*, 1993). Such programmes require intensive management to avoid under estimation of feed allotments (Dozier *et al.*, 2003). Renema *et al.* (1999) found that improving body weight and uniformity would be beneficial for a more uniform onset of lay and reduced early production losses from small hens. Hocking *et al.* (2002) reported that conventional feed restriction results in a decrease in average daily feed consumption during rearing and early lay and in an increase after the peak rate of egg production. Mortality was decreased by more than half. Restricted birds had higher total and settable egg production, fewer defective or damaged eggshells and higher fertility and hatchability than those fed *ad libitum*. Peak and Brake (2000) reported that alternate day feeding produces birds with lower body weight and similar flock performance when compared to every day feeding.

In the present study, only one of the flocks approached the breeders acceptable uniformity standard of 80% or more and this flock was clearly superior in both egg production and fertility traits. Since the body weight uniformity had a significant effect on productivity (Table 3), greater efforts have to be exerted to achieve and maintain the breeder's uniformity standards. Experience shows that under Sudan conditions it is difficult to maintain body weight uniformity because of the prevalence of disease and sub-clinical infections. However, this may be achieved through the judicious use of feed restriction and effective disease control. Feed restriction must be used carefully since prolonging such restricted feeding to non-uniform hens may result in a delay in the onset of lay and low cumulative egg production up to 35 weeks (Hudson *et al.*, 2001). The rate at which feed is withdrawn may also have an important impact on productivity (Sun and Coon, 2005).

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