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ESTIMATES OF HERITABILITY COEFFICIENTS FOR GROWTH TRAITS OF DJALLONKE SHEEP REARED ON THE STATE FARM OF BETECOUCOU IN BENIN

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ABSTRACT

This paper aims to estimate the coefficients of heritability of growth traits in Djallonke sheep. The data on growth (birth weight, the weight at 90 days and at 180 days, as well as the average daily gain from birth to 90 and 180 days) were collected on 334 Djallonke sheep including 140 females and 194 males over two consecutive generations in the Betecoucou Breeding Farm in Benin. The estimation of the heritability coefficients for the characters considered was performed by analysis of variance using the general linear model procedure through a mixed model. Analyses of variance revealed the significance of factors such as year, season and sex on birth weight (BWT), weaning weight (WWT) and average daily gain from birth to 90 days (ADG0-90). The year*season interaction is significant for all dependent variables, with the exception of the body weight at 6 months (BOWT) and the average daily gain from 90 to 180 days (ADG90-180). The heritability values estimated were 0.21±0.007, 0.30±0.021, 0.29±0.030, 0.17±0.023 and 0.43±0.037 respectively for BWT, WWT, BOWT, ADG0-90 and ADG90-180. In the view of a genetic improvement program for Djallonke sheep, WWT and ADG90-180 could be used as selection criteria

Keywords: Sheep, Djallonke, heritability, growth, Benin.

1. INTRODUCTION

The demand for meat products as a source of protein is steadily increasing in Benin due to the rapid growth of the population and the rise of the middle class. Since the year 2000, the demand for meat has exceeded national production, which has led to the massive importation of animal products, thus causing a great loss of foreign exchange for the country (FAO, 2016). The analysis of the current situation suggests that the phenomenon will accelerate in the coming years. Sheep farming, by its multifunctionality and its prevalence in rural households, could contribute significantly to the increase of meat production in Benin where the Djallonke breed is the most widespread representing about 70 to 80% of the sheep population national (ANOPER, 2013). It is trypanotolerant and rustic (Gossen *et al*., 1997), which facilitates its breeding

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throughout on the territory. In Benin, the Djallonke sheep is mainly raised for meat production, hence the importance of research on the improvement of the characters of weight growth in this breed. Estimation of heritability coefficients of growth traits is a prerequisite for the planning and optimization of breeding programs aimed at improving these characters. In Benin, very little work has been devoted on the evaluation of genetic parameters.

The objective of the present work is to estimate the heritability coefficients of certain traits related to weight growth in Djallonke sheep.

2. MATERIALS AND METHODS

Study area

The data were collected at Betecoucou state farm from July 2016 to October 2016. The farm is located in collines department, between longitude east 2 ° 20 'and 2 ° 28 'and latitude north 7 ° 45' and 7 ° 52 ', at an altitude 156 m above sea level. It covers a total area of 11,127 hectares with a Sudano-Guinean climate characterized by a rainy season from March to October and a dry season from November to March. The average rainfall is 1200 mm per year and the mean annual temperature ranges are included between 25 and 30°C. The relative humidity oscillates between 47% and 60%. The specific vegetation consists of savannahs, clear forests and fallows. It gathers bush and tree savannas at *Terminalia macroptera* and *Pseudocedrela kotschyi* (Sinsin *et al*., 1996).

Breeding management

The breeding management on the Bétécoucou farm is semi-improved. The grazing hours in all seasons ranged from 8 at 12 hours. The farm has five sheepfolds built in concretes materials of about 128 m each, which are divided into 3 compartments of 40 m^2. Pasture of *Panicum Maximum C1* provides animals with green forage used as staple food. The animals receive at the end of the day a food supplement based on cotton seed cake or cottonseed at a rate of 360 to 400 g per raim; 260 to 350 g per ewe. During the dry season, the forage deficit is compensated by hay produced from Brachiaria ruziziensis, Panicum maximum C1, peanut leaves or rice straw. In place of hay, animals receive corn silage, Pennisetum purpureum or Andropogon gayanus.

Water was given *ad-libidum* and blocks of stone to lick are constantly present inside the sheepfold. Prophylaxis includes daily and routine maintenance of all parks and shelters, after animals leave for grazing, washing once a week of feeders and watering place. External deworming is done twice a month with baths to remove ticks with amitix®. Animals are vaccinated against la peste des petits ruminants using ovipeste®.

Data collected

The data as the date of birth, the number of the animal, the number of father, the year of birth, the season, the sex, the birth weight (BWT), weaning weight (WWT) and body weight at 6 months (BWOT) were collected from 334 Djallonke sheep including 140 females and 194 males. The average daily gain from birth to 90 days (ADG_{0-90}) and average daily gain from 90 to 180(ADG_{90-180}) days were also calculated.

Statistical analysis

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Statistical analysis was performed using the GLM procedure of the SAS 9.2 package (SAS, 2010). The mixed model used includes the random effect of the sire and fixed effects of which the year with 5 levels (2011, 2012, 2013, 2014, 2015), sex with 2 levels (male and female), season with 2 levels (dry season, rainy season) and as cofactor the age of the animal. The standard error of heritability coefficients was calculated according to Falconer (1981). The model used is the following:

$$Y_{ijklm} = \mu + Year_i + Season_j + Sex_k + (Year * Season)_{ij} + (Year * Sex)_{ik} + sire_l + e_{ijklm}$$

Where Y_{ijklm} is the weight of the animal m, of sex k, born of sire l, in year i and the season j; μ the overall mean; $Year_i$ the fixed effect of year i (2011, 2012, 2013, 2014, and 2015); $Season_j$ the fixed effect of season j (dry season, rainy season); Sex_k the fixed effect of sex k (male, female); $(Year * Season)_{ij}$ the interaction of year i by season j; $(Year * Sex)_{ik}$ the interaction of year i by Sex_k ; $Sire_l$ the fixed effect of sire l ; e_{ijklm} the random error term. Significance level was chosen at 5%.

3. RESULTS AND DISCUSSIONS

Growth performances

Overall means, standard errors and coefficient of variation are given in table 1. The average value of 2.07 kg for BWT is higher with those reported by Armbuster *et al.* (1991) in Ivory Coast (1.90 kg), by London and Weniger (1995) in Ghana (1.75 kg) and by Gbangboche (2005) in Benin (1.90 kg). It's slightly higher than the value of Bosso *et al*. (2007) in Gambia (2.01kg). On the other hand, BWT is lower than 2.2 kg reported by Yapi-Gnaore *et al.* (1997) in farms participating in the open core breeding program in Ivory-Coast.

The average value of 9.46 kg for WWT found in the present study is lower than those reported by Armbuster *et al.* (1991) in Ivory Coast (10.2 kg), by Poivey *et al*. (1986) in Ivory Coast (12.7 kg), by Gbangboche *et al*. (2005) in Benin (11 kg). The value of body weight at 6 months (BWOT) is also lower to those mentioned by Poivey *et al*. (1986) in Ivory Coast (15.1 kg) in and by Gbangboche *et al*. (2005) in Benin (17.3 kg). The daily weight gain in the three month of the pre-weaning period (83.42 g/d) is higher than that obtained in the three month after the weaning (42.10 g/d). The values of $ADG_{0\text{-}90}$ and $ADG_{90\text{-}180}$ indicated in this study are much lower than to Gbangboche *et al.* (2005) in Benin (respectively 100.3 g/d and 71.2 g/d for $ADG_{0\text{-}90}$ and $ADG_{90\text{-}180}$). The gap observed with some authors may be due to rearing conditions, the environment and the genetic level of animals (Fall *et al.*, 1982; Adeleye, 1984; Van Vlaenderen, 1985; London and Weniger, 1995; Yapi-Gnaoré *et al.*, 1997).

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Table 1: Descriptive statistics of productive performances in Djallonke sheep

Variables	Unit	Means	Standard errors
BWT	kg	2.07	0.02
WWT	kg	9.46	0.19
BWOT	kg	13.60	0.22
ADG_{0-90}	g/d	83.41	1.90
ADG_{90-180}	g/d	42.10	2.09

Environmental effect

The influence of the year on growth performance is similar to the results reported by several authors (Rajab *et al.*, 1992 ; Ebangui *et al.*, 2001 ; Gbangboche *et al.*, 2005) who relate this effect to the usual variations in climate, breeding management, feeding and hygiene conditions. The inter-annual variations of growth traits are the result of fluctuations climatic conditions which, through food availability, can increase or decrease the milk production of lactating ewes and thus influence the growth of lambs.

The effect of sex on some of the variables studied (BWT, WWT and BWOT) is consistent with the observations of some authors (Adeleye and Oguntola, 1975; Fall *et al*., 1982; Poivey *et al*., 1982; Taïwo *et al*., 1982; Adeleye, 1984; Otesile, 1993) who specify that under the same breeding conditions, males are born heavier than females. The results of the effect of sex on ADG_{0-90} and ADG_{90-180} are similar to those reported by Poivey *et al*. (1982) according to which, the advantage related to the male sex would be expressed essentially after weaning.

This study reveals that the weight growth of Djallonke sheep is higher in the rainy season than in the dry season (BWT, WWT, ADG_{0-90}), Similar observations have been reported by London and Weniger (1995). However Gueye *et al*. (1994) and Hounzangbé-Adoté *et al*. (2001), report that weight growth may be lower in the rainy season than in the rainy season due to high parasitism that occurs during this period. In this study, BWOT and ADG_{90-180} are similar to those of Gueye (1994) and Hounzangbé-Adoté (2001).

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Table 2: Means values (x^{-}±standard error) of growth traits according to the year, season and sex

	BWT	WWT	BWOT	ADG_{0-90}	ADG_{90-180}
Overall mean	2.07±0.02	9.46±0.19	13.60±0.22	83.41±1.90	42.10±2.09
CV (%)	19.52	25.17	17.08	29.58	49.80
YEAR	***	***	NS	***	**
2011	2.16^{b}±0.06	7.15^{c}±0.68	13.22^{a}±0.52	58.57^{c}±6.55	67.46^{a}±6.83
2012	1.82^{d}±0.04	8.86^{b}±0.42	12.68^{a}±0.53	77.46^{b}±4.54	44.84^{b}±4.12
2013	1.97^{c}±0.03	10.57^{a}±0.28	13.75^{a}±0.34	94.91^{a}±2.98	34.39^{b}±2.34
2014	1.99^{c}±0.03	9.13^{b}±0.29	13.73^{a}±0.42	79.89^{b}±3.05	46.17^{b}±2.53
2015	2.48^{a}±0.04	-	-	-	-
SEASON	*	*	*	**	**
Dry season	1.94^{b}±0.03	9.12^{b}±0.29	13.91^{a}±0.28	79.67^{b}±3.02	48.63^{a}±2.52
Rainy season	2.17^{a}±0.02	9.84^{a}±0.24	13.00^{b}±0.36	87.74^{a}±2.57	29.41^{b}±2.65
SEX	**	*	NS	*	*
Male	2.11^{a}±0.03	9.79^{a}±0.22	13.72^{a}±0.27	86.95^{a}±3.66	38.16^{b}±2.07
Female	2.01^{b}±0.03	8.76^{b}±0.35	13.21^{a}±0.41	76.08^{b}±2.37	53.29^{a}±4.92
Interaction A*Sa	**	***	NS	**	NS
Interaction A*Se	NS	NS	NS	NS	**

*** p < 0.05; ** p < 0.01; *** p < 0.001; ns: not significant.**

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Heritability coefficients

Estimated heritability for growth traits are summarize in table 3. The estimates of heritability for BWT, ADG_{0-90} are generally low to medium, which is due to the importance to the maternal effect especially in milk production and to competition between litter mates (Rao, 1997). The heritability estimates for BWT is consistent with the values reported in the literature: Boujenane *et al*. (2001) in Sardi breed (0.21), Bedhiaf *and al.* (2000) on Barbarine breed. It's larger than those estimated by El Kihal (1990) in Timahdite breed and Tidjani *et al*. (1993) in Timahdite breed and by Boujenane and Mharchi (1992) in Beni Guil breed. Boujenane and Kerfal (1990) observed larger estimates of 0.34 in D'man breed, while Gbangboche *et al*. (2005) reported a value of 0.43 for the djallonke breed.

Estimated heritability for WWT is higher than that observed by Tijani and Boujenane (1993) in Timahdite breed (0.06), by Gbangboche *et al*. (2006) in Djallonke breed (0, 10), by El Kihal (1990) in Timahdite breed (0.12), and by Boujenane *et al*. (1992) in Beni Guil breed (0.12), but lower than that obtained by Boujenane and Kerfal (1990) in D'man breed (0.52).

Table 3. Heritability estimates

Variables	Heritability	Standard error
BWT	0.210	**0.007**
WWT	0.307	**0.021**
BWOT	0.298	**0.030**
ADG_{0-90}	0.172	**0.023**
ADG_{90-180}	0.432	**0.037**

Estimated heritability for BWOT (0.29) is within in the range of values mentioned by Gbangboche *et al*. (2005) and Poivey *et al*. (1982) in Djallonke breed (0.13 and 0.46, respectively). This difference could be due to the analysis model used and to data structure. Estimated heritability for ADG_{0-90} and ADG_{90-180} are much higher than the estimates reported by Boujenane and Kerfal (1990), Boujenane and Mharchi (1992), Tijani and Boujenane (1993) and those of Gbangboche *et al*. (2005) in Djallonke breed. This difference could be due to the analysis model used, the data structure but also to the sheep population considered.

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CONCLUSION

This work estimated the heritability coefficients of some growth traits of the Djallonke sheep; prerequisites for the success of any selection program in Benin. It's has also highlighted the non-genetic factors which affect the productivity of Djallonke sheep. In view of the estimated heritability of WWT (0.30) and $ADG_{90\text{-}180}$ (0.43), this paper identifies the characters that can be used for the success of such a program. However, genetic and phenotypic correlations of growth traits must be evaluated to better appreciate the relationships between them.

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