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Effect of inbreeding on reproduction, weight and survival of Tazegzawt sheep lambs

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ABSTRACT

This study evaluated the effects of inbreeding on the reproduction, weight, and survival of Tazegzawt Kabylian lambs. The study focused on the growth performance of 67 lambs born during 2013 to 2015 at the level of the herd of INRAA experimental station of Bejaia. Because of the difficulty in finding breeding males, the rams used for mating came from individuals of the same herd. Analysis of the results indicated a decrease in reproductive parameters of 6 points for fertility, 16 points for prolificacy and 4 points for fecundity respectively between the first and third lambing. The mortality rate increased with inbreeding for the first, second and third lambing. This mortality was characterized by mortality pre-partum and post-partum, before the age of 10 days and before weaning. The appearance of anterior limb abnormalities and cases of blindness and inguinal hernia were observed. The change of males and the use of cryopreservation as a means of reducing inbreeding and for the preservation and conservation of this lesser known genetic potential thus becomes imperative.

Key words: Inbreeding, Mortality, Sheep, Tazegzawt, Weight

The local sheep population Tazegzawt (The Blue of Kabylie), discovered in the 1990s, was the subject of a national research project in 2011 for the identification and characterization of this population, from which a nucleus was formed with difficulty at the INRAA station of Bejaia. This population does not appear on the herd-book of local sheep breeds in Algeria. This breed is subject to erosion following uncontrolled crossings in the majority of sheep herds in the Kabylie region (the different sheep breeds are in the same herd). It should be pointed out that the ovine breeding management in Algeria is generally traditional and uncontrolled in the majority of sheep flocks, the rams remain permanently with the ewes and are used during several breeding cycles. As a result, rams may mate their daughters and sisters. This system of management leads to an increase in the level of inbreeding and a decrease in genetic diversity in the herd (Jannoune *et al.* 2014). Because of the difficulty of finding breeding males, the rams used for mating come from individuals of the same herd. The objective of this study was to measure the effect of inbreeding depression on the ewes' reproduction and offspring growth.

MATERIALS AND METHODS

The study was carried out at the INRAA experimental station of Bejaia located in coastal area of Algeria.

Animals: The animals used in trial were from the lot acquired as part of the research project in 2011. All animals were identified by a loop.

Feeding management: The herd was fed vetch-oat hay as a staple food produced at the station. The ewes were supplemented with a sheep concentrate bought from the National Livestock Feed Office (ONAB) @ 500 g/head/day. Added to this diet, a pasture area was reserved for females, especially during the lambing period. As for rams feeding, in addition to the basic diet, grain barley was distributed for rams @ 500 g/head/day.

Breeding management: The mating period runs from mid-October to the end of December. The mating is controlled to know precisely the paternity of lambs and lambing takes place from the end of March to the beginning of May. At the beginning of the mating period, ewes were randomly distributed in batches. Each batch comprised 8 to 12 ewes assigned to a ram for 7 weeks. The mating was done at night. Each evening, on their return from the pasture, the ewes of each lot were introduced into an enclosure with the same ram and they were removed the next morning.

Measured parameters: The growth characteristics studied were weight at birth, weight at 10 days (W10D), weight at 30 days (W30D), weight at 70 days (W70D), weight at 90 days (W90D), weight at 6 months (W6M) and weight at 1 year (W1Y). These were calculated by linear interpolation using the weighings taken before and after

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the typical age considered.

Calculated parameters: Rearing parameters, viz. litter size at birth (number of lamb per ewe at birth), litter size at weaning (number of lamb per ewe at weaning), weaning rate (Number of weaned lambs/ Number of born lambs × 100), litter weight at birth (kg), litter weight at weaning (kg), numerical productivity (Number of weaned lambs/ Number of mated females ×100), weight productivity at weaning (kg; Average weight at weaning × Weaning rate), mortality rate (Number of dead lambs/ Number of born lambs × 100) were calculated.

Growth parameters calculated included average daily gain [ADG; GMQ (n_n + 1) = (Weight at Dn + 1 – Weight n)/ measurement period] which represents the average weight gain between the beginning of the test and the end of each period (ADG10-0D, ADG30-0D, ADG30-10D, ADG70-30D, ADG90-30D and ADG90-70D). Reproduction parameters calculated were fertility rate (Number of females lambing/ Number of females mated × 100), prolificacy rate (Number of lambs born/ Number of lambing ewes × 100) and fecundity rate (Number of lambs born/ Number of females mated × 100). Milk production during the first 30 days of each lactation was calculated based on the equation proposed by Torres Hernandez and Hahenboken (1980). Genetic parameter i.e. the coefficient of inbreeding was calculated by the method of double strains of ascendancy, or tabular method (Regnier 2008). This method is based on the idea that the 2 genes present in an individual "I" come respectively from a draw among the 2 genes present in his father, and a draw among the 2 genes present in his mother (Rognon 2004).

Statistical analysis: The analysis of variance (ANOVA) and correlation was performed using IBM SPSS 19 software.

RESULTS AND DISCUSSION

General traits of the experimental flock: The average age of the mated ewes during the 3 years was 35.31±18.06 months for an average live weight of 56±7.63 kg.

The fertility rate of Tazegzawt ewes was 85% and was higher than those reported by Bouafia and Lamara (2009), Safsaf and Tlidjnane (2010) for the Ouled Djellal breed, and Adaouri *et al.* (2017) on ewes from the crossing of D'Man × Ouled Djellal (75.5%).

The prolificacy rate was 167% in Tazegzawt ewes. This value was higher than the rates reported by Yakhlef *et al.* (2000), ITELV (2001), Dekhili (2002, 2004) and Dekhili and Aggoun (2007) (120%, 111% and 110% and 123%, respectively) for Ouled Djellal breed. However, it was lower than that reported by El Dhaoui (2004) and El Fadili and Boulanour (2005) with respective rates of 243% and 260% in the D'man breed. Tazegzawt ewes housed in the station, recorded a fecundity rate of 138%. Dekhili (2002) and Lamrani *et al.* (2008) reported rates of 110% and 128% respectively for the Ouled Djellal breed. The litter size at weaning was 1.55±0.60 lambs. This number was higher than that reported by Chikhi and Boujenane (2003) for Boujaâd breed (1.24), and those obtained in the Sardi, Timahdite and Beni Guil breed ewes (0.99 to 1.19, 1.06 and 1.02 lambs respectively) (Boujenane 1999). The weaning rate recorded in lambs from Tazegzawt ewes was 73%. This rate was lower than those reported for the Ouled Djellal breed by Dekhili (2003), Dekhili and Aggoun (2005), Merghem (2008) and Berarma and Bouaoune (2007) with weaning rates of 82.5%, 80%, 88% and 79% respectively.

The average litter weight at birth of Tazegzawt ewes was 7.55±2.43, which was higher than that reported by Chikhi and Boujenane (2003) (5.03 kg). The weight of the litter at weaning was 35.52±13.65 kg. The litter weight at weaning was higher than the weights recorded in Boujaâd breed (26.9 kg) (Chikhi and Boujenane 2003).

The mortality rate of lambs recorded during the 3 years of monitoring the Tazegzawt herd was 33.33%. This rate was very high, and exceeded the conventional standard of 5% (Adaouri *et al.* 2017). The numerical productivity rate recorded was 105%. This rate was higher than those reported by Berarma and Bouaoune (2007) and Merghem (2008) with rates of 98% and 99% respectively. The weight productivity per 100 ewes and per lambing at 3 months of age in our study was 1,752 kg. This rate was superior to that of Ouled Djellal breed (1,393 kg), D'man breed (1,317 kg) and the ewes from the cross of D'Man × Ouled Djellal (1,328 kg) recorded by Adaouri *et al.* (2017). The sex ratio within the flock was 46.2% males and 53.8% females. For the mode of birth, the single lambing rate was predominant (56.72%) compared to double (38.80%) and triple (4.48%) lambing.

Milk production of Tazegzawt ewes in the first month of lactation ranged from 1.16 to 2.10 kg/d with an average of 1.73±0.18 kg/d with a coefficient of variation of 10.49% for the whole herd. This production was on average 1.71±0.24 kg/day for single births (CV=14%) and 1.77±0.03 kg/day for double births (CV=2%). This production was higher than that reported by Smaali and Chemmam (2017) in ewes of Ouled Djellal breed, which recorded a milk production of 1.50 kg/d.

The average birth weight was 5.23 kg for single births (CV=15.61%) and 4.53 kg for double and triple births (CV=13.64%). The average ADG between successive checks showed decreasing values as the lambs progressed in age (Table 1). The average daily gain (ADG) express very interesting values, which should be valorised in breeding programs.

This result was similar to that recorded by Benchohra *et al.* (2014), which had a birth weight of 4.29 kg in the Rembi breed.

The 67 lambs of the Tazegzawt breed had a mean weaning weight at 90 days of 24±4.91 kg. This value was different than that recorded by Adaouri *et al.* (2017) on ewes from the cross of D'man × Ouled Djellal (16.7%).

The average weight of the fleece of Tazegzawt rams and ewes sheared once a year was 2.61 kg, for a 48% post-wash yield. This production was estimated as 3.37 kg for males and 2.32 kg for females. However, it is lower than

Table 1. Performance of Tazegzawt breed lambs (2013–2015)

Parameter	Mean±SD				
	Total (N=67)	Male (N=30)	Female (N=37)	Twins (N=29)	Simples (N=38)
BW (kg)	4.85±0.79	4.98±0.66	4.77±0.88	4.53±0.62	5.10±0.82
W10 (kg)	7.15±1.14	7.36±1.00	6.97±1.22	6.67±0.91	7.51±1.16
W30 (kg)	11.79±2.22	12.16±2.18	11.49±2.24	10.59±1.69	12.71±2.15
W70 (kg)	20.22±4.00	20.92±4.40	19.66±3.60	18.80±3.65	21.31±3.96
W90 (kg)	23.98±4.91	24.80±5.62	23.31±4.21	22.40±4.32	25.18±5.04
W 6 month (kg)	32.25±8.00	32.87±8.54	31.76±7.62	30.10±7.43	33.89±8.12
W 1year (kg)	45.32±9.14	47.73±8.79	43.37±9.06	43.79±8.87	46.49±9.28
ADG 10-0 (g)	228±80.50	239±93.35	220±68.58	214±68.94	239±87.68
ADG 30-0 (g)	231±62.80	240±64.49	224±61.37	202±47.79	253±64.47
ADG 30-10 (g)	232±76.31	240±81.73	226±72.12	196±56.81	260±78.32
ADG 90-30 (g)	211±62.87	219±73.23	204±53.18	205±61.75	215±64.22
ADG 70-30 (g)	203±56.66	211±69.93	197±43.14	197±50.68	208±61.05
ADG 90-70 (g)	188±89.89	194±115	183±63.48	180±76.72	194±99.37

that reported by Chikhi and Boujenane (2003) in the Boujaâd breed, which was 3.47 kg (4.55 kg in rams and 3.34 kg in ewes).

Effect of inbreeding: The value of the inbreeding coefficient (F) calculated for all the lambs in the herd (n=93) was 6.28±11.25%. This value was slightly higher than that recorded by Jannoune *et al.* (2014) for the Timahdite (5.16%) and Sardi (4.28%) breeds.

With regard to inbred lambs (33.33% of the total number), this coefficient was estimated as 18.63±12.25%. Jannoune *et al.* (2014) recorded 12.3% and 12.1%, respectively, in Timahdite and Sardi breeds.

Inbreeding measured at the station level was 0±0% (MB1), 6.06±9.82% (MB2) and 10.38±13.97% (MB3) respectively for the periods 2013, 2014 and 2015.

Effect of inbreeding on rearing parameters: No inbreeding effects were observed for ewe age, ewe weight, litter size weaning, and litter weight at birth, which can be explained as the last 3 parameters are more related to the age of the ewes (Table 2). While depressive effect was visible for the parameters namely litter weight at weaning (–37.22%), weaning rate (–29 points), numerical productivity (–59 points) and weight productivity at weaning (–851 kg) between the first and the third lambing, and a depression of –29.12%, –19 points, –28 points, –860 kg respectively for the same parameters between the second and the third lambing. Wiener and Rouvier (2009) observed a dramatic drop in total weight performance (28 kg to about 13 kg) in the ewes which can be attributed to inbreeding.

Effect of inbreeding on reproduction parameters: The fertility rate was 87%, 87% and 81% respectively for the 1st, 2nd and 3rd lambing, and the depression was 6 points between the 1st, and the 3rd lambing.

The prolificacy rate was 177%, 160% and 168% respectively for the 1st, 2nd and 3rd lambing. This depression was 16 points between the 1st and the 3rd lambing, and 9 points between the 2nd and 3rd lambing. Ercanbrack and Knight (1991) observed a depression that affects prolificacy that can be as much as –0.476%, while Lamberson and Thomas (1984) reported an absence of inbreeding depression.

Table 2. Effect of inbreeding on rearing parameters

Parameter	Lambing 1 (F=0%)	Lambing 2 (F=6.06%)	Lambing 3 (F=10.38%)
Age of ewes (months)	33.83^{a}± 11.26	32.97^{a}± 17.65	41.19^{b}± 21.14
Weight of ewes (kg)	55.04^{a}± 6.89	55.24^{a}± 6.17	57.09^{b}± 7.87
Size litter weaning (%)	1.23^{a}± 0.44	1.60^{b}± 0.49	1.68^{b}± 0.57
Litter weight at birth (kg)	6.88^{a}± 2.24	7.77^{b}± 2.40	8.01^{b}± 2.58
Litter weight at weaning (kg)	43.22^{a}± 12.11	38.28^{a}± 14.76	27.13^{b}± 9.08
Weaning rate (%)	88	78	59
Numerical productivity (%)	140	109	81
Weight productivity at weaning (kg)	2100	2109	1249

Numbers with different superscripts are significantly different at P<0.05.

Effect of inbreeding on milk production: The effect of consanguinity on milk production indicates a 3.5% decrease between the first and third lambing, and a 7.22% decrease between the second and third lambing. Depending on the mode of birth, this decrease in milk production was 7.55% between the first and third births, and 13.58% between the second and third births for single births and was respectively 1%, between first and third births and 7% between second and third births for double births.

Effect of inbreeding on wool production: It showed a decrease of 3.57% between the first and third births, and a decrease of 4.33% between the second and third births. According to the sex of the lambs, this decrease in the wool production was 17.33% between the first and the third lambing, and 15.28% between the second and the third lambing in the females and 2.23% in males.

Lamberson and Thomas (1984) showed a decrease of 0.017 and 0.018 kg, respectively, in fleece weights before and after washing. For fleece yield, they reported no

statistically significant effect.

Effect of inbreeding on growth parameters: Analysis of the weight growth results of lambs in the experimental herd indicated a weight decrease of 8.52% between the first and the third lambing at the age of 10 days (P<0.05). The same observation was observed for the speed of growth (P<0.05). Inbreeding also affected the growth parameters of lambs in both sexes (Table 3).

Analysis of variance indicated significant differences for all parameters studied in lambs of both sexes and in lambs in the herd, except for the birth weight of the lamb. Ercanbrack and Knight (1991) recorded an average inbreeding depression of –0.007 kg for a 1% increase in inbreeding coefficient in lambs. Similarly, Lamberson and Thomas (1984) (using regression coefficients for 1% increase in inbreeding coefficient) indicated an average regression coefficient of 0.11 kg for a 1% increase in inbreeding coefficient of individual. With respect to weight in adulthood, Ercanbrack and Knight (1991) found regression coefficients of –0.168 (±0.013) in the Rambouillet and Columbia breeds.

Effect of inbreeding on the viability of lambs: Mortality increased with inbreeding (20.83%, 31.23% and 43.24% respectively for the 1st, 2nd and 3rd lambing). The frequency distribution of lamb mortality by age showed that 32.25% of overall mortalities will occur before birth, 48.38% occurred between birth and 10 days, and only 19.35% between 10 and 90 days. According to Lamberson and Thomas (1984), this is the character most affected by an increase in consanguinity and reported an average of 0.028 decrease in survival for a 1% increase in inbreeding coefficient with a wide disparity (from 0.7 to 7.2% less alive lambs at weaning).

This mortality is characterized by mortality before and after birth, before the age of 10 days and before weaning. The appearance of abnormalities in the forelimb and cases of blindness and inguinal hernia were observed.

The appearance of defects was observed by Ragab and Asker (1954). These authors reported cases of blindness in an Ossimi herd. The frequency of appearance of this tare was 0.07 or 1.75% of animals, and the average inbreeding coefficient of the animals affected was 25.5%.

Based on 3 years of monitoring of the Tazegzawt herd at the INRAA station, it can be concluded that the coefficient of inbreeding had increased in the population by 6.28% compared to the lot acquired in 2011. The inbreeding which is translated almost always, on average, by a drop in performance is called inbreeding depression. The results obtained confirmed this observation; hence the change of males and the use of cryopreservation as a means of reducing consanguinity and for the preservation and conservation of this genetic potential still unknown becomes imperative.

Table 3. Effect of inbreeding on herd growth parameters

Parameter	Lambing 1 (n°=23) (F=0%, n=24)	Lambing 2 (n°=23) (F=6.06%, n=32)	Lambing 3 (n°=21) (F=10.38%, n=37)	SS
BW (kg)	4.96±0.67	4.70±0.87	4.90±0.81	NS
W10 (kg)	7.51±1.07	7.03±1.20	6.87±1.08	*
W30 (kg)	12.51±2.11	12.02±2.14	10.75±2.14	**
W70 (kg)	20.82±2.73	22.41±3.46	17.17±3.95	**
W90 (kg)	24.43±3.56	26.54±4.26	20.67±5.12	**
W 6 months (kg)	36.43±6.47	35.46±5.39	24.17±5.70	**
W 1year (kg)	52.24±6.82	46.13±7.96	36.86±4.86	**
ADG 10-0 (g)	255±77.80	233±60.10	193±92.70	**
ADG 30-0 (g)	252±62.32	244±50.29	194±61.86	**
ADG 30-10 (g)	250±74.01	249±66.77	194±77.95	**
ADG 70-30 (g)	208±40.88	260±48.49	160±56.37	**
ADG 90-30 (g)	199±34.43	242±48.79	165±58.26	**
ADG 90-70 (g)	180±74.66	207±99.78	175±94.54	*

n, number of lambs born; n°, number of lambs that have reached adulthood; NS, not-significant; *P<0.05; **P<0.01.

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