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EFFECT OF INBREEDING ON SOME BODY WEIGHTS IN EGYPTIAN BARKI SHEEP

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SUMMARY

The present study utilized the pedigree records of 3191 Barki lamb progenies of 186 sires and 1640 dams reared at two research stations; Ras-Elhekma (from 1963 to 1972) and Maryout (from 1973 to 2004). The current study investigated the effect of inbreeding on body weights at birth, BW, weaning, W120, yearling, W360 and at first mating, W480 in Egyptian Barki sheep flock of the Desert Research Centre. The non-genetic factors affecting the studied traits were investigated. It was found that 4.92% of the present dataset were inbred animals. Average inbreeding coefficient of inbred animals was estimated as 3.57% and appeared to be ranged from 0.05% to 25.20%. Estimate of inbreeding regression coefficient on year of birth for inbred animals were significantly negative in Ras-Elhekma (-0.015) and was not significant in Maryout research station (0.003). Results of pooled data from both stations showed that each one percent increase in inbreeding coefficient resulted in a reduction in BW (-0.0156 kg), W120 (-0.0364 kg) and W360 (-0.0079 kg) together with an increase in W480 (0.0559 kg). The effect of inbreeding seemed to be negligible for the studied body weights with no consistent trend in both research stations.

Keywords: inbreeding, body weight, Barki sheep

INTRODUCTION

Barki sheep is the main fat-tailed breed that dominates the north western coast of Egypt and being well adapted to the prevailing settings of food shortage and harsh environmental conditions. The Desert Research Centre has established a Barki sheep flock in 1963 where animals were subjected to a breeding plan based mainly on selection for body weight. Such breeding plan has to be evaluated from time to time to ensure its effectiveness in improving mutton production in Barki sheep. Estimation of inbreeding level in any closed population is essential to develop genetic improvement programs (Barczak et al., 2009; Eteqadi et al., 2014). The inbreeding process increases homozygosity for whatever genes are present, including the less desirable ones of the trait (Ercanbrack and Knight, 1991). It is shown that inbreeding is usually associated with the genetic defects and decreases both fitness and performance (Akhtar et al., 2000). The ratio of males to females, mating system and population size are important factors being reported to influence the inbreeding level (Norberg and Sørenson, 2007). The increase in inbreeding level might lead to inbreeding depression which is expressed as the change in performance per unit of inbreeding coefficient. Inbreeding depression had been recorded in many populations and being associated with decreased performance for a variety of economic traits (Van Wyk et al., 2009; Drobik and Martyniuk, 2016 and Yeganehpur et al., 2016). Thus, sheep breeder has to maintain inbreeding at an acceptable level to ensure higher genetic gain (Van Wyk et al., 2009; Eteqadi et al., 2014). Since the effect of inbreeding has not been evaluated in this flock, the present study was undertaken to assess its impact on some body weights to make effective adjustments on the breeding plan and hence improving mutton production in Barki sheep.

MATERIALS AND METHODS

1. Data and Pedigree Information

The data and pedigree information used in this study were obtained from the sheep flock of the Desert Research Centre reared at two research stations; Ras-Elhekma (from 1963 to 1972) and Maryout (from 1973 to 2004). Management of both flocks was almost the same, where the breeding season carried out once a year in June – July to start lambing in October – November. Ewes were often exposed to rams for the first time at approximately 16 months of age. Lambs were weighed at birth to assign birth weight, then body weight was recorded at biweekly interval till weaning followed by monthly interval till the animals were removed from the flock. After weaning, ewe lambs were separated from ram lambs till mating season. Shearing took place once a year during April- May. Feeding depends mainly on grazing at Ras-Elhekma station while rely on cut and carry at Maryout research station. Detailed flock management was described by El-Wakil et al. (2009). The included traits were body weights at birth, BW; weaning, W120; yearling, 360 days, W360 and at first mating, 480 days, W480. Birth weight was kept as recorded while weaning, yearling and first mating body weights were linearly adjusted to 120, 360 and 480 days for each lamb, respectively. Prior to analyses, those animals had missing identifications as well as few numbers of twinning were excluded from the dataset. After editing, the data included 3191 lamb records originated from 186 sires and 1640 dams. Records of BW (3191 offspring), W120 (2782 lambs), W360 (1719 animals) and W480 (1476 animals) were analyzed.

2. Statistical Analysis

The CFC software (Sargolzaei et al., 2006) was used to calculate statistics of the pedigree and coefficient of inbreeding for each individual in the pedigree. The GLM procedure of SAS program (version 9.1, 2003) was used to determine the fixed factors affecting the investigated traits according to the following model:

$$Y_{ijklm}=\mu+G_i+A_j+L_k+R_{l(k)}+e_{ijklm} \quad (1)$$

Where, Y_{ijklm} is the observation of the response variable (BW, W120, W360 or W480) of m^{th} animal of i^{th} gender, j^{th} age of dam, k^{th} location and l^{th} year within location; μ is the overall mean; G_i is the fixed effect of gender (1=female and 2=male); A_j is the fixed effect of age of dam (2, 3, 4 and ≥5 years old), L_k is the fixed effect of location (1= Ras-Elhekma and 2= Maryout), $R_{l(k)}$ is the fixed effect of year within location (Ras-Elhekma from 1963 to 1972 and Maryout from 1973 to 2004) and e_{ijklm} is the residual assuming to be NID $(0,\sigma^2_e)$.

All interactions of the first order were included in the model while the significant ones were only presented in Table (3). Also, trend of inbreeding coefficient over studied years was estimated using linear regression of animal inbreeding coefficient on the year of birth, using Reg. procedure of SAS program.

Inbreeding depression was expressed as a partial linear regression coefficient of body weights on inbreeding coefficients of the animal. It is interpreted as a change of body weight influenced by 1% increase of inbreeding coefficient. The single trait animal model program (MTDFREML) proposed by Boldman et al. (1995) was used to estimate the inbreeding effect on the studied traits according to the following model:

$$Y=X\beta+Z_a a+e, \quad (2)$$

Where, Y = a vector of observations of BW, W120, W360 and W480, X= the incidence matrix for fixed effects mentioned previously in model (1), β = the vector including the overall mean and the same fixed effects as those stated in model (1), Z_a= the incidence matrix for random effects, a = the vector of direct genetic effect of animal with zero mean and variance equal $\sigma^2_a A$ where A is the numerator relationship matrix and e = a vector of random residuals normally and independently distributed with zero mean and variance $\sigma^2_e I$.

RESULTS AND DISCUSSION

Results of pedigree analysis and inbreeding coefficients estimated in the present study are shown in Tables 1 and 2. Number of inbred animals was found to be 157 which contributed to 4.92% of the dataset. Average inbreeding coefficient of inbred animals was estimated as 3.57% and appeared to be ranged from 0.05% to 25.20%. The maximum inbreeding coefficient of 25.20% might indicate that some matings of close relatives occurred, however, these matings were few. The obtained low inbreeding coefficient of 3.57% might be due to the small number of inbred animals in this set of data. A similar explanation was reported by Barros et al. (2017). It should be mentioned that the current individual record included a sire and a dam for each record.

Table 1. Pedigree analysis and description of the present dataset

Parameter	Number
No. of individuals with known parents	3191
No. of sires	186
No. of dams	1640
No. of individuals with no progeny	2765
Full-sib groups	41

Table 2. Average inbreeding coefficients estimated in the present data

Parameter	Unit
No. of inbred animals	157
Inbred animals %	4.92
Non-inbred animals (F=0) %	95.08
Average inbreeding coefficient of studied animals (%)	0.18
Average inbreeding coefficient of inbred animals (%)	3.57
Range of inbreeding coefficient of inbred animals (%)	0.05-25.20

F= Inbreeding coefficient

Tables 3 and 4 show the analysis of variance for non-genetic factors affecting the studied traits as well as means and their standard deviations for these traits. Results indicated that females had significantly (P≤0.05) lighter body weights compared with males for all studied traits. As age of dam increased, BW and W120 tended to increase significantly (P<0.01) until the age of four years, then a slight decrease was detected for those dams aged 5 years and more. Ras-Elhekma research station recorded significantly (P<0.01) heavier W120 and lighter W480 compared with Maryout research station. These results were similar to those reported in this flock (El-Wakil and Elsayed, 2013). The interactions were found to be non-significant (P<005) except the interaction between sex and location (for W120 and W480) and that between age of dam and location for W480. While heavier W120 in both sexes occurred at Ras-Elhekma, the opposite trend was recorded for W480. At all levels of age of dam, W480 was heavier in Maryout compared with Ras-Elhekma research station; however, the difference was inconsistent. The studied body weights tended to be fluctuated significantly (P<0.01) over birth years within location with no definite trend. These results might reflect the variations in the level of feeding, management and environmental conditions under which the sheep flock was maintained over the studied years. Table 5 and Figure 1 showed the trend of inbreeding coefficient over the studied years from 1963 to 2004 in Ras-Elhekma and Maryout research stations. The trend of pooled inbreeding coefficient for inbred and non-inbred animals as well as that for inbred animals were found to be significantly negative (P<0.01). In Ras-Elhekma, while the trend of inbreeding coefficient was significantly (P<0.01) negative for inbred animals, while that trend was not significant in Maryout research station. Similar trends were reported in other breeds (Barczak et al., 2009; Rashedi Dehsahraei et al., 2013). Figure 1 shows that as birth year advanced, inbreeding coefficient tends to generally increase until 1984 then it dropped to be almost zero in 2004.

Table 3. Analysis of variance for body weight at birth, BW; weaning, W120; yearling, W360 and first mating, W480 in Egyptian Barki sheep

Sources of variation	BW		W120		W360		W480	
	Df	MS	df	MS	Df	MS	df	MS
Gender	1	8.17**	1	295.13**	1	551.87**	1	1275.79**
AoD	3	8.34**	3	159.76**	3	74.67	3	64.50
Location	1	0.18	1	610.17**	1	4.12	1	834.89**
Year/Location	26	4.17**	26	494.57**	26	1308.15**	26	978.17**
Sex*Location	1	0.26	1	72.57*	1	0.12	1	321.40**
AoD*Location	3	0.62	3	0.93	3	76.17	3	186.22**
Residual	3155	0.36	2746	12.61	1683	32.57	1440	36.55

AoD= Age of dam and *, ** significant at P<0.05 and P<0.01, respectively.

Table 4. Means and standard deviations (SD) for body weights at birth, BW; weaning, W120; yearling, W360and first mating, W480 according to gender, age of dam, locations and year of birth

	BW		W120		W360		W480	
	N	Mean(SD)	N	Mean(SD)	N	Mean(SD)	N	Mean(SD)
Overall	3191	3.54(0.63)	2782	17.51(4.20)	1719	31.55(7.24)	1476	36.63(7.56)
Gender								
Female	1572	3.49^a(0.62)	1378	17.26^a(4.03)	899	30.99^a(7.02)	785	35.79^a(7.43)
Male	1619	3.59^b (0.64)	1404	17.75^b(4.35)	820	32.17^b(7.43)	691	37.59^b(7.60)
Age of dam								
2	461	3.33^a(0.58)	402	16.63^a(4.12)	217	30.30^a(6.94)	175	34.11^a(7.41)
3	655	3.47^b(0.62)	566	17.46^b(4.18)	360	32.08^b(6.80)	315	37.08^b(6.95)
4	674	3.62^c(0.65)	578	18.21^c(4.11)	380	32.07^b(7.32)	339	37.53^b(7.87)
5 and more	1401	3.61^c(0.63)	1236	17.49^c(4.23)	762	31.40^b(7.45)	647	36.62^b(7.59)
Location								
Ras- Elhekma	765	3.56^a(0.55)	675	18.25^a(4.68)	519	31.23^a(7.34)	411	34.13^a(7.38)
Maryout	2426	3.54^a(0.66)	2107	17.27^b(4.01)	1200	31.69^a(7.20)	1065	37.60^b(7.41)
Year of birth								
Ras-Elhekma								
1963	54	3.60(0.44)	54	22.68(3.25)	53	33.74(5.49)	52	33.22(6.49)
1964	79	3.66(0.43)	79	22.40(3.81)	76	35.23(5.73)	75	36.69(7.45)
1965	81	3.70(0.62)	76	20.37(4.02)	47	34.47(7.60)	28	38.33(8.88)
1966	99	3.60(0.52)	80	16.32(3.23)	42	24.84(9.11)	10	37.57(7.31)
1967	109	3.48(0.60)	88	14.70(3.37)	50	30.78(5.56)	40	33.91(6.69)
1968	106	3.55(0.57)	98	17.84(4.64)	73	28.87(6.17)	53	31.25(5.81)
1969	78	3.37(0.57)	56	15.47(3.15)	43	28.04(7.69)	31	30.79(8.77)
1970	52	3.59(0.47)	47	16.22(3.69)	43	30.34(6.89)	41	34.20(7.67)
1971	48	3.45(0.61)	44	18.20(4.29)	43	30.14(5.83)	43	33.62(5.78)
1972	59	3.56(0.54)	53	18.85(4.69)	49	33.20(7.65)	38	33.83(7.31)
Maryout								
1973	56	3.62(0.52)	54	16.51(4.03)	49	28.25(6.62)	48	27.86(4.84)
1975	77	3.42(0.57)	73	17.86(5.27)	71	29.89(6.28)	70	34.25(7.81)
1976	70	3.52(0.64)	57	18.36(4.30)	46	26.65(5.10)	43	29.29(5.56)
1977	48	3.61(0.60)	42	16.59(4.23)	40	28.40(5.55)	11	37.36(4.76)
1984	81	3.77(0.59)	70	17.41(3.18)	64	37.23(4.27)	61	40.90(5.87)
1989	271	3.63(0.53)	229	13.99(2.77)	82	25.68(5.37)	59	31.86(4.20)
1990	75	3.40(0.52)	48	12.84(3.11)	35	21.81(3.82)	33	30.25(4.37)
1992	123	3.36(0.79)	91	17.89(4.28)	65	23.76(5.85)	38	33.75(6.30)
1994	118	3.69(0.47)	110	16.80(3.17)	64	25.95(4.74)	55	33.25(5.40)
1995	203	3.36(0.56)	145	14.65(3.91)	34	30.61(4.49)	28	36.03(5.58)
1997	276	3.75(0.61)	245	19.94(4.12)	190	35.17(5.43)	176	40.06(5.30)
1998	205	3.81(0.64)	180	18.66(3.38)	72	40.82(5.13)	72	43.22(4.86)
1999	132	3.09(0.73)	132	16.79(3.88)	66	29.86(5.36)	60	35.12(6.47)
2000	162	3.30(0.74)	154	18.92(2.36)	51	33.82(2.00)	51	39.97(2.71)
2001	168	3.28(0.64)	126	15.27(3.64)	41	29.98(4.01)	41	37.65(5.56)
2002	135	3.75(0.55)	130	18.25(2.76)	120	34.84(6.25)	120	42.57(7.21)
2003	116	3.72(0.74)	113	19.01(2.60)	50	33.79(4.98)	40	38.91(5.79)
2004	110	3.44(0.69)	108	18.36(2.61)	60	37.49(4.66)	59	44.48(5.28)

Means with different letters a, b and c are significantly different (P<0.05).

The trend of increasing inbreeding coefficient was observed mainly in Ras-Elhekma station while the decreasing trend existed in Maryout research station. During 1972 and 1976, inbreeding coefficients were high and tend to increase from 1972 (1.03%) to reach its maximum in 1976 (2.23%). The data showed that two sires have been used for mating in four successive years while one sire has been used for three successive years and five sires were used for two successive years. The intensive use of sires in mating seasons probably resulted in high inbreeding coefficients attained during 1972 to 1976. It was also observed from Figure 1 that inbreeding coefficients dropped to be almost zero from 1984 to 2004. The distribution of non-inbred animals of zero inbreeding coefficients shows that they have predominantly existed from 1984 to 2004 which explain the trend attained during this period.

Table 5. The trend of inbreeding coefficients over studied years for inbred and non-inbred animals in both locations

	Ras-Elhekma	Maryout	Pooled
Overall inbreeding coefficient	0.001**±0002	-0.001**±0.0001	-0.0002**±0.00003
Inbreeding coefficient for inbred animals	-0.015**±0.004	0.003^{ns}±0.003	-0.004**±0.002

**= significant at P<0.01 and ns = not significant (P ≥ 0.05).

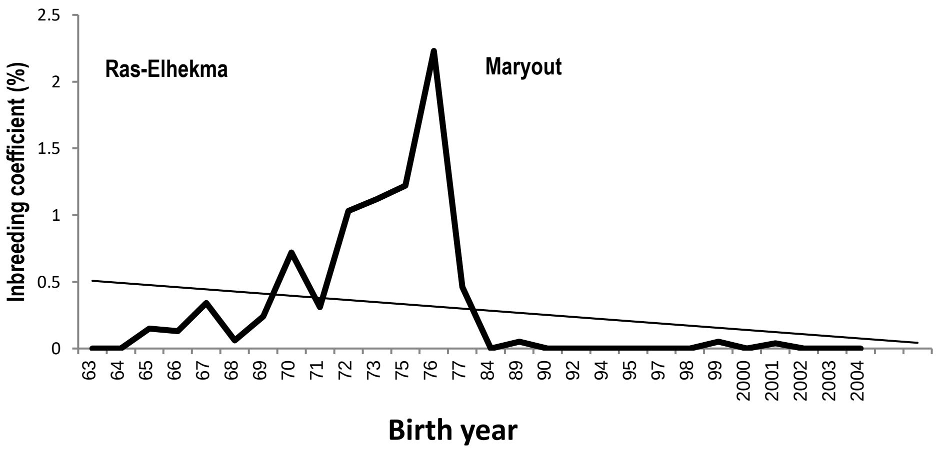

Figure 1. The trend of inbreeding coefficient over the studied years of birth in both locations.

Effect of inbreeding could be expressed as a linear regression coefficient for values of animal performance on inbreeding coefficients of the animal. Regression coefficients of studied body weights on inbreeding coefficients of the animals are presented in Table 6. Although not significant, results of pooled data from both flocks showed that each one percent increase in inbreeding coefficient resulted in a reduction in BW (-0.0156 kg), W120 (-0.0364 kg) and W360 (-0.0079 kg) together with an increase in W480 (0.0559). In Ras-Elhekma research station, each one percent increase in inbreeding coefficient resulted a reduction in W120 (-0.1456 kg), W360 (-0.2925 kg) and W480 (-0.2411 kg) with an increase in BW (0.0003 kg). On the contrary, each one percent increase in inbreeding coefficient in Maryout research station resulted in a reduction in BW (-0.0172 kg) and increase in W120 (0.0697 kg), W360 (0.2123 kg) and W480 (0.2760 kg). Similar trends were reported elsewhere (Akhtar et al., 2000; Dorostkar et al., 2012; Yeganehpur et al., 2016). The effect of inbreeding seems to be negligible for the studied body weights with no consistent trend in both locations. The non-significant effect (P≥0.05) of inbreeding on the studied traits could be due to the low percentage of inbred animals and the inbreeding coefficient (Barros *et al*., 2017).

Table 6. Regression coefficients with their standard errors of body weights (kg) on inbreeding coefficient of the animal

Trait	Ras-Elhekma	Maryout	Pooled
BW	0.0003±0.64	-0.0172±1.08	-0.0156±0.88
W120	-0.1456±2.85	0.0697±6.20	-0.0364±5.41
W360	-0.2925±7.65	0.2123±10.24	-0.0079±9.09
W480	-0.2411±9.04	0.2760±11.33	0.0559±9.89

Body weight at birth, BW; weaning, W120; yearling, W360 and first mating, W480.
All the regression coefficients were not significant (P≥0.05).

CONCLUSION

Number of inbred animals in the present study contributed to 4.92% of the dataset. Inbreeding coefficient of inbred animals ranged from 0.05% to 25.20% with an average of 3.57%. The trend of inbreeding coefficient appeared to be increasing in Ras-Elhekma station and decreasing in Maryout research station. The effect of inbreeding seemed to be negligible on the studied body weights with no consistent trend in both locations. The flock management in both locations might have a role in this context. However, the low percentage of inbred animals could be the main reason affecting the outcome of the present study. As usual, each record of this data contained the animal together with his sire and dam, and that might not be adequate to detect the real inbreeding of the animal. Despite the reasonable number of animals in this study, one has to go deeper in the ancestry of the animal to explore the effect of inbreeding, if any, on the economic traits. That could be the scope of further investigation.

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الملخص العربى

تأثير التربية الداخلية على بعض أوزان الجسم فى الأغنام البرقى المصرية

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استخدمت فى هذه الدراسة عدد 3191 سجل للحملان البرقى أبناء 186 كبش و 1640 أم ، تم تربيتهم فى قطيع الأغنام البرقى التابع لمركز بحوث الصحراء فى محطتين بحثيتين (محطة بحوث رأس الحكمة منذ عام 1963 حتى عام 1972 ومحطة بحوث مريوط منذ عام 1973 حتى عام 2004). إستهدفت الدراسة تقدير تأثير التربية الداخلية على أوزان الجسم عند الميلاد وعند الفطام عند عمر 120 يوم وعند عمر 360 يوم وعند عمر 480 يوم. تم دراسة العوامل غير الوراثية التي تؤثر على الصفات المدروسة. أوضحت النتائج أن عدد الحيوانات المرباه تربية داخلية يمثل نسبة 4.92٪ وقدر متوسط معامل التربية الداخلية لهذه الحيوانات بنسبة 3.57٪ وتراوحت هذه النسب بين 0.05٪ إلى 25.20٪. كما أوضحت النتائج أن معامل إنحدار التربية الداخلية على سنة الميلاد للحيوانات المرباة داخليا كان سالبا ومعنويا في محطة رأس الحكمة (-0.015) بينما كان غير معنويا في محطة مريوط (0.003). أظهرت النتائج المتحصل عليها من المحطتين معا أن كل زيادة بمقدار 1% في معامل التربية الداخلية أدت إلى انخفاض الوزن عند الميلاد (-0.0156 كجم) والوزن عند عمر 120 يوم (-0,0364كجم) والوزن عند عمر 360 يوم (-0,0079كجم) وكذلك زيادة في الوزن عند عمر 480 يوم (0,0559 كجم) . أوضحت الدراسة تأثير طفيف للتربية الداخلية على أوزان الجسم المدروسة مع عدم وجود اتجاه ثابت في كلا المحطتين.