Journal of Livestock Science and Technologies, 2018, 6 (2): 47-56 http://lst.uk.ac.ir
DOI: 10.22103/jlst.2018.10848.1208

Inbreeding effects on lamb pre-weaning growth traits and survival in three Iranian sheep breeds

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Abstract The present study was performed to study the effect of inbreeding on the pre-weaning growth traits including the birth weight (BW), weaning weight (WW), average daily gain (ADG), Kleiber ratio (KR) and lamb survival from birth to weaning (SUR) in Baluchi, Iran-Black and Zandi sheep. Significant positive inbreeding trends were found only for Baluchi and Iran-Black breeds as 0.038 and 0.278, respectively. Inbreeding depression was assessed by fitting individual inbreeding coefficient as a linear covariate for each trait applying the most suitable animal model detected via Akaike's Information Criterion (AIC) among the models containing different combinations of direct additive and maternal effects. Inbreeding had no significant effect on BW in these breeds (P>0.05) but WW decreased significantly through inbreeding as -29.35 g, -25.12 g and -42.20 g per 1% increasing in inbreeding for Baluchi, Iran-Black and Zandi breeds, respectively. The influence of inbreeding on ADG of Iran-Black and Zandi breeds was significant, the corresponding values of -0.30 g/day (P<0.05) and -4.00 g/day (P<0.01) were obtained, respectively. The ADG in Baluchi sheep was not influenced by inbreeding (P>0.05). Inbreeding significantly influenced KR in Baluchi (0.30) and Zandi (-0.13) breeds but not in Iran-Black breed (P>0.05). Inbreeding (P<0.01) decreased SUR in Baluchi and Iran-Black as -0.45% and -0.85%, respectively, but not in Zandi sheep (P>0.05). Inbreeding depression was observed for most of the pre-weaning studied growth traits (except for BW) and lamb survival from birth to weaning in these breeds. It was concluded that the mating policies designed to minimize the inbreeding effect in Baluchi and Iran-Black sheep have not been effective.

Keywords: inbreeding depression, inbreeding coefficient, lamb survival, sheep

Received: 16 Sep. 2017, *accepted:* 05 Aug. 2018, *published online:* 08 Dec. 2018

Introduction

In several developing countries native breeds of small ruminants including sheep and goats are mainly reared by local farmers under low-input production systems where the livelihood of the flock holders depends mainly on increased production efficiency. Thus, coordinated attempts in terms of managerial practices and genetic improvement programs are of great importance (Kosgey and Okeyo, 2007). Intensive selective practices within small populations using the breeding values predicted based on animal models lead to more emphasis on the records of the related animals. Therefore, genetic diversity may be reduced and inbreeding rate may be increased. Inbreeding is of great concern in animal breeding due to its adverse effect on the genetic variance and phenotypic traits resulting in impaired growth, reproduction and health in inbred animals (Falconer and Mackay, 1996; Vozzi et al., 2007). Maintaining genetic diversity at a high level and inbreeding at a low level is a primary goal in the management of animal populations (Fernandez et al., 2005). In the developing countries, under-recorded sheep populations are mainly kept as captive ones, with limited exchange of animals from outside the population. Such populations are kept often in the small-sized flocks and, consequently, the rate of inbreeding can be high with associated depression in the functional traits (Boakes et al., 2007). Adverse effects of inbreeding on some economical important traits in several sheep breeds have been well documented (Pedrosa et al., 2010; Dorostkar et al., 2012; Safari, 2014; Dorbik and Martynauk, 2016). In a previous study Mokhtari et al. (2014) studied inbreeding depression effects on birth and weaning weights of Iran-Black sheep considering individual increases in inbreeding coefficient as a linear covariate in the context of animal models and found significant individual and maternal inbreeding depressions, respectively.

Genetic diversity in Baluchi sheep was studied via pedigree analysis by Tahmoorespur and Sheikhloo (2011) and the excessive use of some individuals as parent were observed. Gholizadeh and Ghafouri-Kesbi (2016) found no significant unfavorable effects due to inbreeding on birth weight, weaning weight and pre-weaning daily gain in Baluchi sheep. Ghafouri-Kesbi et al. (2008) investigating the genetic diversity and inbreeding characteristics in Zandi sheep, found low additive genetic variations without any implications from inbreeding effects on economical traits.

There are more than 50 million heads of sheep in Iran constituting of 27 breeds (Khodabakhshzadeh et al., 2016) several of which are not very well defined as distinct breeds. Mutton is one of the important sources of protein for human consumption in Iran, which is considerably influenced by early growth traits and lamb survival. Therefore, the aim of this study was to estimate the inbreeding coefficient and determine its effects on pre-weaning growth traits in three Iranian fat-tailed Baluchi, Iran-Black and Zandi sheep breeds, determining the most appropriate animal model for each trait.

Material and methods

The breeds and region

Baluchi sheep are well adapted to unfavorable environmental conditions prevalent in the region (Tahmoorespur and Sheikhloo, 2011). The breed constitutes approximately 12% of the total sheep population in Iran and mainly distributed in eastern parts of the country especially in Khorasan Razavi province. Iran-Black is the first composite sheep breed in Iran, resulting from a cross of Chios rams with Iranian Baluchi ewes and developed for improved litter size, weaning performance and tolerance to the harsh environmental conditions (Rashidi, 2012). The flock has been kept closed since inception in Abbasabad Breeding Station, near Mashhad in north-eastern part of Iran. Zandi sheep is a small-sized breed, well adapted to the central semi-arid regions of Iran, constituting approximately 5% of the total sheep population (Ghafouri-Kesbi et al., 2011).

In the late 1980s, an experimental flock was established in Khojir National Park between Tehran and Abali, aimed at establishing a nucleus source for improving the pastoral flocks in the region (Ghafouri-Kesbi, 2010).

Flock management and mating system

Mating occurred from late August to late in October for both Baluchi and Iran-Black breeds. The ewes in heat were detected by teaser rams and maiden ewes were exposed to fertile rams at approximately 18 months of age. Annually, 20-25 ewes were allocated randomly per ram with sire identification recorded. Ewes were kept in the flock until 7 years of age, with some rams being kept for a 2 or 3 mating seasons. Annually, 20% ewes and 40% rams were replaced, respectively. Lambing occurred from late January to late March. Newborn lambs were ear-tagged and weighed within 24 h of birth and allowed to remain with their dams in individual boxes for three days. The lambs were creep-fed, grazed on natural range, mainly Festuca and Poa, and reared in groups until weaning at approximately three months of age. The lambs were weaned on the same day, but not necessarily at the same age. During summer and autumn, the herds grazed on wheat and barley stubble. Supplementary feeding was offered during winter and late pregnancy, consisting of a ration composed of wheat and barley straw, alfalfa hay, dry sugar beet pulp and concentrate. Baluchi and Iran-Black replacement lambs were selected based on the weaning weight, breed characteristics, visual body conformation, wool quality scores and birth type.

Mating period in Zandi sheep lasts from early in October to mid-November and consequently lambing occurs from mid-February to late-March. Maiden Zandi ewes were exposed to rams at about 18 months of age with at a mating ratio of 15 ewes per a fertile ram. Within 24 h of birth, new-born lambs were weighed and ear-tagged. Weaning weight was recorded at approximately three months of age. The flock grazed during the day on natural pasture during the day-time and housed at night. Supplemental feeding comprising of dried alfalfa and barely grain was offered during winter season and particularly prior to mating and in late pregnancy. Replacement lambs were selected based on weaning weight, conformation and health, and also on milk yield of their dams (Mohammadi et al., 2011).

Data and studied traits

Data and pedigree information used for Baluchi and Iran-Black sheep were obtained from 1984 to 2011, and for Zandi breed from 1991 to 2011 (Table 1). The traits of interest were birth weight (BW), weaning weight (WW), average daily gain (ADG), Kleiber ratio (KR) ($ADG/WW^{0.75}$) and lamb survival from birth to weaning (SUR). The structure of the pedigree used for each breed is given in Table 2.

Statistical analysis

Inbreeding coefficients of animals were calculated acc-

Table 1. Descriptive statistics for the studied traits across breeds

Breed	Item	Traits[a]				
		BW (kg)	WW (kg)	ADG (gr)	KR	SUR (%)
Baluchi	No. of records	14374	12630	12630	12630	14374
	Mean	4.18	21.75	189.56	19.46	87.90
	S.D.	0.69	4.78	45.19	2.45	32.66
	Min.	2.0	8.0	51.02	9.72	0
	Max.	6.8	36.0	348.21	28.99	1
Iran-Black	No. of records	7036	5910	5910	5910	7036
	Mean	3.86	21.07	183.65	18.72	83.99
	S.D.	0.87	4.85	44.95	2.45	36.68
	Min.	2.0	11.0	60.42	10.07	0
	Max.	7.0	37.0	382.05	30.28	1
Zandi	No. of records	6140	5077	4662	4662	6140
	Mean	4.15	20.67	177.08	18.27	87.37
	S.D.	0.74	4.28	44.66	2.47	33.22
	Min.	2.0	8.4	43.27	8.37	0
	Max.	7.0	39.0	381.25	31.45	1

[a]BW: birth weight, WW: weaning weight, ADG: average daily gain from birth to weaning, KR: Kleiber ratio ($KR=ADG/WW^{0.75}$) and SUR: lamb survival from birth to weaning.

Table 2. The pedigree structures of the studied breeds

Item	Baluchi	Iran-Black	Zandi
No. of animals	15326	7344	6638
No. of Founders	952	308	498
Sires with progeny	444	114	258
Dam with progeny	4371	1552	2100
No. of animals with both parents known	14030	5969	5533
No. of animals with both parents unknown	952	308	498
No. of animals with one parent unknown	344	1067	607

ording to the algorithm of Meuwissen and Luo (1992) using the CFC software (Sargolzaei et al., 2006). The effects of inbreeding coefficient on the studied traits were estimated by the restricted maximum likelihood method (REML) applying the ASReml 3.0 software (Gilmour et al., 2009) under 12 different animal models as shown below:

$y=Xb+Z_aa+e$		Model 1
$y=Xb+Z_aa+Z_cc+e$		Model 2
$y=Xb+Z_aa+Z_mm+e$	$Cov(a,m)=0$	Model 3
$y=Xb+Z_aa+Z_mm+e$	$Cov(a,m)=A\sigma_{am}$	Model 4
$y=Xb+Z_aa+Z_mm+Z_cc+e$	$Cov(a,m)=0$	Model 5
$y=Xb+Z_aa+Z_mm+Z_cc+e$	$Cov(a,m)=A\sigma_{am}$	Model 6
$y=Xb+Z_aa+Z_ll+e$		Model 7
$y=Xb+Z_aa+Z_cc+Z_ll+e$		Model 8
$y=Xb+Z_aa+Z_mm+Z_ll+e$	$Cov(a,m)=0$	Model 9
$y=Xb+Z_aa+Z_mm+Z_ll+e$	$Cov(a,m)=A\sigma_{am}$	Model10
$y=Xb+Z_aa+Z_mm+Z_cc+Z_ll+e$	$Cov(a,m)=0$	Model11
$y=Xb+Z_aa+Z_mm+Z_cc+Z_ll+e$	$Cov(a,m)=A\sigma_{am}$	Model12

where, ***y*** is a vector of records for the studied traits; ***b, a, m**, **c, l*** and ***e*** are vectors of fixed effects (herd only for Baluchi sheep at 2 levels, birth year at 28 levels for Baluchi and Iran-Black and 21 levels for Zandi sheep, sex at 2 levels including male and female, type of birth at 3 levels including single, twin and triplet, age of dam at 6 levels including 2-7 years old), direct additive genetic, maternal additive genetic, maternal permanent environmental, maternal temporary environmental (common litter effects) and the residual effects, respectively. Age of lamb at weaning was fitted as a linear covariate for WW. Also, $\boldsymbol{X}$, $\boldsymbol{Z_a}$, $\boldsymbol{Z_m}$, $\boldsymbol{Z_c}$ and $\boldsymbol{Z_l}$ are corresponding design matrices relating records to the corresponding effects, respectively. The matrix of ***A*** is the numerator relationship matrix and $\boldsymbol{\sigma_{am}}$ denotes covariance between direct and maternal genetic effects. Finally, the most appropriate model was chosen applying Akaike's information criterion test (AIC) as follow (Akaike, 1974):

$$AIC_i = -2 \log L_i + 2 p_i$$

where, $\log L_i$ is the maximized log likelihood of model i at convergence and p_i is the number of parameters which were fitted for each model. A model with the lowest AIC was chosen as the most appropriate model for the analysis of each trait. Inbreeding depression was estimated as the linear regression of performance on the individual inbreeding coefficient of lambs, fitting the most appropriate selected animal model. Also, analyses of regression coefficients were performed by the analysis of variance (SAS, 2009).

Results and discussion

Descriptive statistics for the studied traits in the three breeds are presented in Table 1. Means of BW in Baluchi (4.18±0.69 kg) and Zandi (4.15±0.74 kg) breeds were similar and higher than that obtained in Iran-Black (3.86±0.87 kg). Mean of WW in Baluchi sheep (21.75±4.78 kg) was higher than 21.07±4.85 kg in Iran-Black sheep and 20.67±4.28 kg in Zandi sheep; a similar trend was found for ADG and KR. Pre-weaning lamb survival in Baluchi (87.90%) and Zandi (87.37%) breeds were higher than that of Iran-Black breed (83.99%). Amiri Roudbar et al. (2017a) reported values of 3.65 kg and 20.82 kg for means of BW and WW in Iran-Black sheep, respectively, which are in general agreement with the corresponding values obtained in the present study. Values of 4.27 kg and 21.54 kg were reported by Amiri Roudbar et al. (2017b) for mean BW and WW in Zandi sheep, respectively; being generally in agreement with the corresponding values for Zandi lambs in the present study.

Trends in inbreeding

Frequency and means of inbreeding coefficients for male and female lambs in the inbred animals and whole population for the studied breeds are shown in Table 3. The frequency of inbred male lambs was higher than that of inbred female for Baluchi and Iran-Black breeds; however, it was lower in Zandi sheep. Inbred animals constituted some 17.98%, 51.47% and 33.59% of total animals in Baluchi, Iran-Black and Zandi breeds, respectively. The average inbreeding coefficients were 0.85%, 4.54% and 1.22% in the whole population and 3.96%, 7.85% and 3.61% in inbred Baluchi, Iran-Black and Zandi sheep, respectively. Barczak et al. (2009) pointed out that populations originated from small number of founders are expected to show a high level of inbreeding.

The average of inbreeding coefficients increased from 1986 to 2011 in Baluchi sheep (Figure 1) and correspondingly a positive inbreeding trend of 0.038±0.01 percent per year was obtained ($P<0.05$). The average inbreeding coefficients from 1984 to 1986 was zero and increased afterwards due to selection of related animals. The average inbreeding coefficients decreased sharply from 2004 to 2008 and increased again until the end of the studied period. It seems that preventing the mating among relative animals led to the reduction in average inbreeding coefficients in this period. As shown in Figure 2, the average inbreeding coefficients in Iran-Black sheep increased from 1985 to 2011 with a positive trend of 0.278±0.05 percent per year ($P<0.01$). A steady increase in the average inbreeding level was observed during the study period. Generally, the average inbreeding coefficients in Zandi sheep increased from 1992 to 2011 with some fluctuations (Figure 3). Huby et al. (2003) studied the inbreeding trends in six French sheep breeds and reported that it was no higher than inbreeding rate of 0.40% per generation in the studied breeds. Norberg and Sorensen (2007) reported an increase in inbreeding in three Danish sheep populations as 1% per generation.

Model comparisons

The results of model comparison for determining the most appropriate model for each of the studied traits by applying the AIC, and expressed as deviation from the best model, are shown in Table 4. In Baluchi sheep, the most appropriate model for BW was the model containing the direct additive genetic, maternal additive genetic and maternal permanent environmental effects, ignoring the covariance between direct additive and maternal additive genetic effects (Model 5). In Iran-Black and Zandi breeds, the most appropriate model included the direct additive genetic, maternal additive genetic, maternal permanent environmental and common litter eff-

Table 3. Relative frequency and mean of inbreeding coefficient for male and female lambs in the whole population and inbred animals of the studied breeds

Breed	Sex of lamb	Inbred animals			Whole population		
		Numbers	Frequency (%)	Mean F (%)	Numbers	Frequency (%)	Mean F (%)
Baluchi	Male	1390	50.44	3.99	7218	50.22	0.84
	Female	1366	49.56	3.92	7156	49.78	0.87
Iran-Black	Male	1901	50.29	7.82	3533	50.21	4.52
	Female	1879	49.71	7.89	3503	49.79	4.57
Zandi	Male	1106	49.60	3.79	2998	48.83	1.26
	Female	1124	50.40	3.44	3142	51.17	1.19

F: Inbreeding coefficient

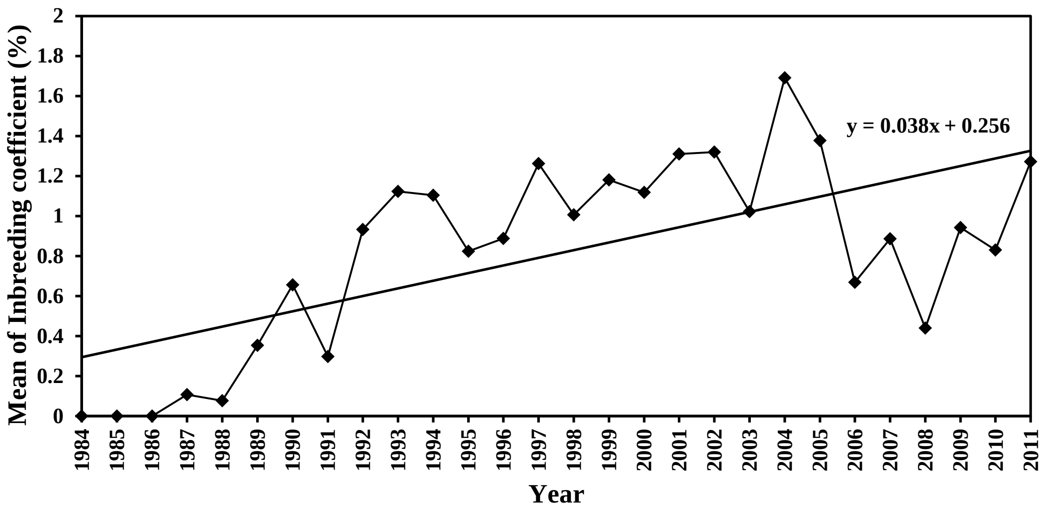

Figure 1. Mean inbreeding coefficient by year of birth for Baluchi sheep

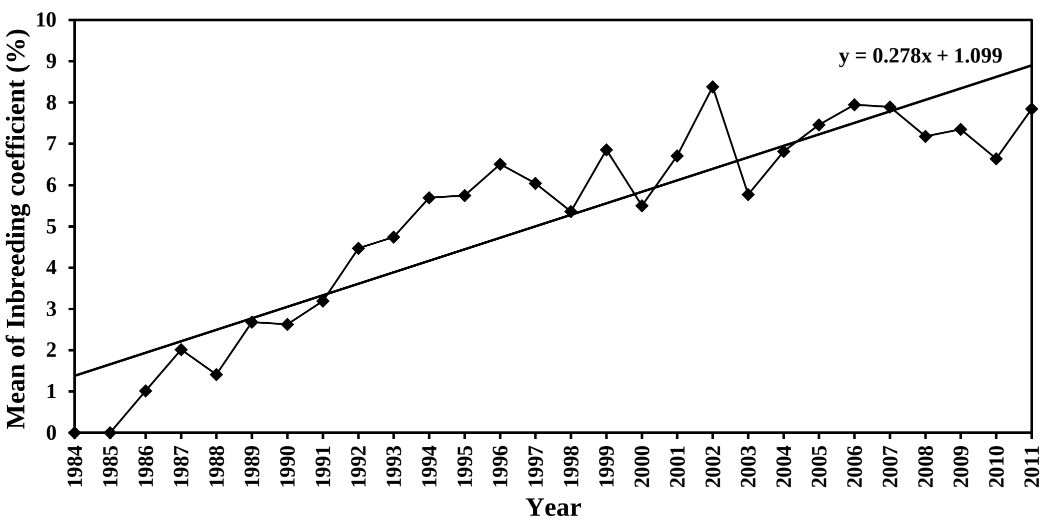

Figure 2. Mean inbreeding coefficient by year of birth for Iran-Black sheep

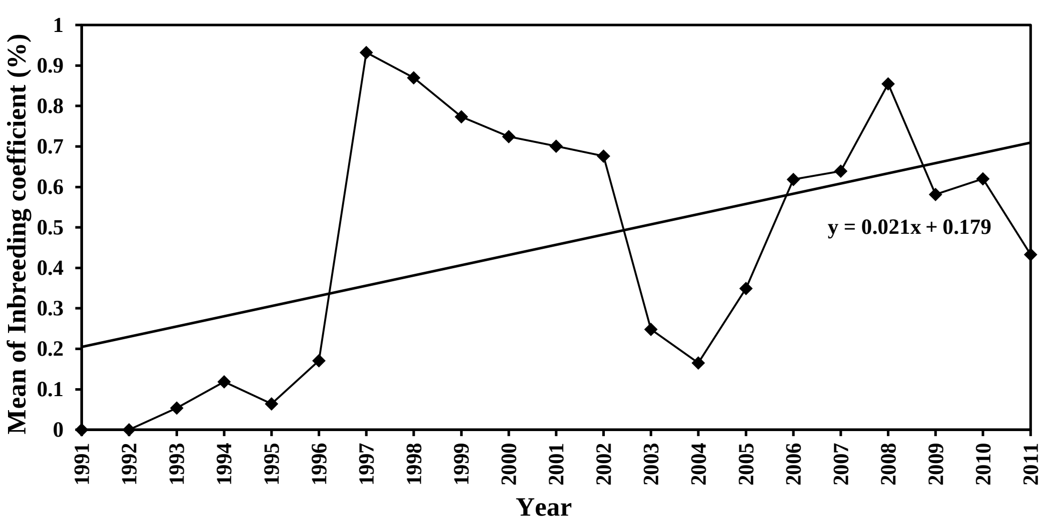

Figure 3. Mean inbreeding coefficient by year of birth for Zandi sheep

Table 4. Changes in the AIC values as deviation from the models with the lowest AIC value (best model) for traits in all breeds

Model	Baluchi					Iran-Black					Zandi				
	Traits[a]					Traits[a]					Traits[a]				
	BW	WW	ADG	KR	SUR	BW	WW	ADG	KR	SUR	BW	WW	ADG	KR	SUR
1	212.8	9.8	42.8	63.2	71.1	315.6	82.5	46.9	202.6	43.6	12.86	5.7	100.5	152.7	**0**
2	148.2	1.4	8	74.7	61.5	280.1	**0**	0.2	163	23.3	14.18	54.1	94.5	169.1	1.4
3	50.9	87	30.6	46.5	70.7	264.8	32.2	20.2	169.5	39.3	20.28	12.4	106.9	140.6	2.5
4	51.2	85	34.6	29.6	71.8	299.9	25.8	31.8	170.3	39.1	18.68	3.2	111.3	150.7	6
5	**0**	8.8	97.3	66.9	63.5	237.6	1.8	1.9	160.6	25.2	8.96	31	107.2	145.8	0.9
6	0.3	6.8	94.9	54.1	71.8	236.8	4.8	3.1	160.8	20.6	3.44	23	118.3	136.6	3.1
7	157.8	23.4	139.4	60	**0**	269.5	62.2	34	5.8	6.3	15.86	15.2	43.7	90.2	21.6
8	113.3	55.6	119.5	39.6	2	44.2	0.1	**0**	4.2	2.2	8.39	17.2	45.5	70.8	19.5
9	112.4	**0**	113.7	22	2	12.6	27.8	16.2	**0**	6.9	8.28	**0**	0.9	248.5	10.8
10	91.6	27	23.6	29.3	121.4	55.9	21.5	8.9	1.7	4.8	8.41	17.7	**0**	**0**	13.2
11	272.1	7.2	4.7	17	4	**0**	2	1.7	1.9	4.2	**0**	16.6	0.2	5	16.8
12	274.1	9.2	**0**	**0**	13.8	4.4	9	9.2	3.5	**0**	2	19.6	2.2	8.4	11.7

[a]BW: birth weight, WW: weaning weight, ADG: average daily gain from birth to weaning, KR: Kleiber ratio ($KR=ADG/WW^{0.75}$) and SUR: lamb survival from birth to weaning.

ects, ignoring the covariance between direct additive and maternal additive genetic effects (Model 11). In Baluchi and Zandi sheep, the best model (Model 9) for WW included direct additive genetic, maternal additive genetic and common litter effects, ignoring covariances between the direct additive and maternal additive genetic effects,. In Iran-Black sheep the model that included direct additive genetic and maternal permanent environmental effects was chosen as the best model for WW (Model 2).

The most complete model in the present study (Model 12) was determined as the best one for genetic analysis of ADG and KR in Baluchi sheep. While in Zandi sheep breed the model containing the direct additive genetic, maternal additive genetic and common litter effects, including the covariance between direct additive and maternal additive genetic effects, was determined as the best model for WW (Model 10). In Iran-Black sheep, the model that contained direct additive genetic, maternal permanent environmental and common litter effects (Model 8) and the model that included direct additive genetic, maternal additive genetic and common litter effects ignoring the covariance between direct additive and maternal additive genetic effects (Model 9) were determined as the most suitable models for ADG and KR, respectively.

Maternal effects had no influence on SUR in Zandi sheep. Therefore, the simplest model which did not include any types of maternal effects was considered as the best model. At the same time, the most complete model in the present study (Model 12) was the best model for genetic analysis of SUR in Iran-Black sheep. The model that included direct additive genetic and common litter effects as random parts of the model was determined as the most appropriate model for SUR in Baluchi sheep.

Effects of inbreeding on the studied traits

The Means of the studied traits for three breeds are shown in Table 5. Among the inbred animals, the highest frequency was related to animals with inbreeding coefficients of lower than or equal to 10% which constituted 16.45, 39.04 and 31.40 percent of all animals in Baluchi, Iran-Black and Zandi breeds, respectively.

The effects of inbreeding, considering the most suitable animal model for each trait, is presented in Table 6. The effect of inbreeding on BW was not significant, however, inbreeding effect on WW in Baluchi ($P< 0.01$), Iran-Black and Zandi ($P< 0.05$) sheep were significant, being adversely influenced by inbreeding as -29.35g, -25.12g and -42.20 g per 1% increase in inbreeding for Baluchi, Iran-Black and Zandi sheep, respectively. Such differences may be explained to some extent by the differences in mating systems and completeness of the considered pedigrees (Gholizadeh and Ghafouri-Kesbi, 2016).

Significant changes of -112, -82 and -88 g per 10% increase in lamb inbreeding for birth weight of Texel, Shropshire and Oxford Down sheep breeds were reported by Norberg and Sorensen (2007), respectively. Dorostkar et al. (2012) studied the effect of inbreeding on body weight in Iranian Moghani sheep, another Iranian native breed; significant inbreeding depression was found for body weight at 3 months of age as -291 g per 1% increase in inbreeding which is higher than the estimated values in the present study. Pedrosa et al. (2010) studied the effect of inbreeding depression on the birth weight, and body weight at 60 days and 180 days in Santa Ines sheep breed and reported a significant inbreeding depression for all the considered traits. van

Table 5. Mean of the studied traits in the inbreeding groups across the three breeds

Breed	Inbreeding groups (%)	No.	Frequency (%)	Traits [a]				
				BW (kg)	WW (kg)	ADG (g)	KR	SUR(%)
Baluchi	F=0	11618	80.82	4.18	21.78	189.52	19.25	88.06
	0<F≤10	2365	16.45	4.23	21.72	192.84	19.12	87.65
	10<F≤20	280	1.94	4.10	21.86	186.36	18.94	87.23
	20<F	111	0.77	4.20	21.19	183.95	18.50	80.58
Iran-Black	F=0	3256	46.28	3.98	21.36	184.92	19.25	85.52
	0<F≤10	2747	39.04	3.85	20.95	182.55	18.53	83.11
	10<F≤20	882	12.54	3.67	20.82	178.34	18.35	82.87
	20<F	151	2.15	3.58	20.12	180.89	18.34	82.35
Zandi	F=0	3910	63.68	4.20	20.92	178.49	18.38	88.05
	0<F≤10	1928	31.40	4.10	20.29	175.41	18.07	86.69
	10<F≤20	262	4.27	3.82	20.01	170.30	18.05	83.27
	20<F	40	0.67	3.75	20.09	165.13	18.04	80.05

[a]BW: birth weight, WW: weaning weight, ADG: average daily gain from birth to weaning, KR: Kleiber ratio ($KR=ADG/WW^{0.75}$) and SUR: lamb survival from birth to weaning.

Table 6. Estimates of the regressions of the studied traits on inbreeding ±S.E. across the breeds

Breed	Traits [a]	Regression coefficient
Baluchi	BW(Kg)	2.45^{ns}±1.51
	WW(Kg)	-29.35^{**}±9.24
	ADG(gr)	3.28^{ns}±2.42
	KR	0.30^{*}±0.12
	SUR (%)	-0.45^{**}±0.14%
Iran-Black	BW(Kg)	-1.27^{ns} ±1.88
	WW(Kg)	-25.12^{*} ±9.65
	ADG(gr)	-0.30^{*}±0.14
	KR	-0.02^{ns}±0.02
	SUR (%)	-0.85^{**}±0.24%
Zandi	BW(Kg)	-3.49^{ns} ±4.87
	WW(Kg)	-42.20^{*}±20.18
	ADG(gr)	-4.00^{**}±0.24
	KR	-0.13^{**}±0.01
	SUR (%)	-0.04^{ns} ±0.20%

[a]BW: birth weight, WW: weaning weight, ADG: average daily gain from birth to weaning, KR: Kleiber ratio ($KR=ADG/WW^{0.75}$), SUR: lamb survival from birth to weaning.
ns: (P>0.05)
*: (P<0.05)
**: (P<0.01)

Wyk et al. (2009) studied the effect of inbreeding on production and reproduction traits of Elsenburg Dormer sheep stud and reported reductions of -6.40 g and -92.60 g per 1% increase in inbreeding for BW and WW, respectively. Mandal et al. (2005) studied the effects of inbreeding on growth traits in Muzaffarnagri sheep and reported significant effects of inbreeding on birth weight and body weight of lambs at three months of age as -10 and -48 g per 1% increase in inbreeding, respectively.

The effect of inbreeding on ADG in Baluchi sheep was not significant but inbreeding significantly influenced the ADG in Iran-Black and Zandi sheep; the corresponding values for inbreeding depressions were -0.30 g and -4.00 g per 1 % of increase in inbreeding (Table 6). The KR in Iran-Black sheep was not significantly affected by inbreeding but the effects of inbreeding on KR of Baluchi and Zandi sheep breeds were significant. Significant effects of inbreeding on ADG in Moghani sheep (Ghavi Hossein-Zadeh, 2013) and KR in Makooei sheep (Safari, 2014) were also reported. In Elsenburg Dormer sheep , van Wyke et al. (1993) reported significant inbreeding depression of -8 g, -99 g, -0.9 g/d and -0.021 for BW, WW, ADG and KR, respectively.

Although inbreeding did not affect SUR in Zandi sheep, it resulted in a decrease in SUR by -0.45% and -0.85% per 1% increase in inbreeding in Baluchi and Iran-Black sheep, respectively. Dorbik and Martyniuk (2016) found significant inbreeding depression in lamb survival (up to 56 days) in Polish Olkuska sheep. They reported that each 1% increase in inbreeding decreased the survival of lambs by 2%. The negative effect of inbreeding on lamb survival was also reported by several investigators (Lamberson and Thomas, 1984; Ercanbrack and Knight, 1991), with values varying from 0.241% (Ercanbrack and Knight, 1991) to 7.2% (Lamberson and Thomas, 1984) per 1% increase in inbreeding. There are also reports of non-significant inbreeding depression effects on lamb survival (Ceyhan et al., 2011; Boujenane and Chami, 1997; Rzewuska et al., 2005). Leroy (2014) performed a meta-analysis of the inbreeding depression in livestock species and reported that the average inbreeding depression for offspring survival was equal to a significant value of 0.322 (scaled on mean). The extent of genetic variation in the base population, and differences among breeds in allele segregation and managerial practices, and the diversity of founders in the flocks are the main factors influencing the variation in inbreeding effects (MacKinnon, 2003). urthermore, remembered that some traits or populations are more influenced by inbreeding depression than others and such differences could be explained by the interaction between inbreeding and environment (Leroy, 2014).

Conclusions

A significant increase in inbreeding trend was observed for Baluchi and Iran-black breeds. It was concluded that the mating policies designed to minimize the inbreeding effect in Baluchi and Iran-Black sheep have not been effective. Inbreeding depression was observed for most of the pre-weaning growth traits (except for BW) and an important trait associated with fitness such as lamb survival from birth to weaning in these breeds. Due to increasing trend in inbreeding in these breeds, the selection of rams with the lowest kinship with ewes can be an effective strategy to control inbreeding in these populations.

Acknowledgments

The authors wish to thank the staff of the Animal Breeding Center of Iran for providing the pedigree and performance data, and University of Kurdistan for funding.

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Communicating editor: *Ali K. Esmailizadeh*

اثر همخونی بر صفات رشد پیش از شیرگیری و زنده مانی بره در سه نژاد گوسفندان ایرانی

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چکیده در پژوهش کنونی اثر همخونی بر صفات رشد پیش از شیرگیری در برگیرنده وزن تولد، وزن شیرگیری، افزایش وزن روزانه، نسبت کلیبر و نیز زنده مانی از تولد تا شیرگیری در گوسفندهای بلوچی، ایران بلک و زندی بررسی شد. برای روندهای همخونی در نژادهای بلوچی و ایران بلک به ترتیب مقادیر مثبت و معنی دار ۰/۰۳۸ و ۰/۲۷۸ به دست آمد. کاهش همخونی با برازش ضرایب همخونی انفرادی به عنوان متغیر کمکی خطی برای هر صفت، با مناسبترین مدل تشخیص داده شده بر اساس معیار اطلاعات آکائیک از میان مدل‌های دارنده ترکیبات مختلف اثرهای افزایشی مستقیم و مادری، ارزیابی شد. همخونی بر وزن تولد اثر معنی داری نداشت (P>۰/۰۵) ولی وزن شیرگیری در نژادهای بلوچی، ایران بلک و زندی به ترتیب ۲۹/۳۵ گرم، ۲۵/۱۲ و ۴۲/۲۰ گرم به ازای هر یک درصد افزایش همخونی به طور معنی داری کاهش یافت (P<۰/۰۱). اثر همخونی بر افزایش وزن روزانه در نژادهای ایران بلک و زندی به ترتیب مقادیر معنی دار ۰/۳۰- گرم در روز(P<۰/۰۵) و ۴/۰۰- گرم در روز (P<۰/۰۱) به دست آمد ولی در نژاد بلوچی معنی دار نبود. همخونی به طور معنی داری بر نسبت کلیبر در نژاد بلوچی (۰/۳۰) و زندی (۰/۱۳-) اثر گذاشت ولی اثر آن بر نسبت کلیبر در نژاد ایران بلک معنی دار نبود. همخونی زنده مانی پیش از شیرگیری را در نژادهای بلوچی و ایران بلک به ترتیب ۰/۴۵ درصد و ۰/۸۵ درصد کاهش داد(P<۰/۰۱) ولی اثر معنی داری بر زنده مانی پیش از شیرگیری در نژاد زندی نداشت. افت همخونی برای بیشتر صفات رشد پیش از شیرگیری (به جز وزن تولّد) و زنده مانی از تولّد تا شیرگیری این نژادها مشاهده شد. می‌توان نتیجه گرفت که سیاستهای جفت گیری طراحی شده برای کاهش اثر همخونی در گوسفندان بلوچی و ایران بلک موثر نبوده است.