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Crossbreeding Balouchi Sheep with Romanov: A Profitable Strategy to Improve Litter Size, Lamb Growth, and Carcass Characteristics

Research Article

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ABSTRACT

Crossbreeding in sheep is strategically used to improve production and reproduction, especially when pastures have low quality. The objective of this study was to compare growth performance, birth and weaning body weights, and survivability between purebred Balouchi (n=53) and crossbred Balouchi × Romanov (n=114) lambs. In addition, carcass characteristics (n=24) were determined. Balouchi ewes were inseminated with Romanov semen to produce crossbred lambs. All experimental lambs were weaned at 77 d of age and slaughtered at 10 months of age. Birth body weight of the purebred Balouchi lambs was significantly greater than that of the crossbred lambs (3.75 *vs.* 3.56 kg, P<0.01). However, weaning body weight (16.6 *vs.* 12.4 kg) and average daily gain from birth until weaning (152.2 *vs.* 126.0 g/d) and slaughter (125 *vs.* 95 g/d) were greater (P<0.05) for the crossbred lambs than for the purebred lambs. Slaughter body weight at 10-month age (36.9 *vs.* 36.1 kg) tended to be greater (P=0.08) for the crossbred lambs. Litter size was also increased by crossbreeding (1.13 *vs.* 1.00), but lamb survivability was not different between the two groups. The fat-tail-free carcass yield tended to increase with crossbreeding. Crossbreeding increased (P<0.05) the weights of testis (0.24 *vs.* 0.16 kg), liver (0.61 *vs.* 0.52 kg), heart (0.15 *vs.* 0.12, kg), and lung (0.47 *vs.* 0.40 kg), while it decreased the weights of skin (3.16 *vs.* 3.72 kg), fat-tail (0.30 *vs.* 1.29 kg), and total internal fats (1.08 *vs.* 2.06 kg). It is concluded that crossbreeding Balouchi ewes with Romanov's semen resulted in improved litter size, weaning and slaughter body weights, average daily gains from birth until weaning and slaughter, and carcass characteristics without affecting lamb survivability. Therefore, crossbreeding can be a profitable strategy to increase lamb (meat) production in Balouchi sheep.

KEY WORDS Balouchi, carcass, crossbreeding, growth, Romanov, sheep.

INTRODUCTION

Various breeds availability is a valuable asset in the modern sheep industry. Crossbreeding is a multi-benefit strategy to improve the performance and profitability of purebred sheep herds (Abdullah *et al.* 2010; Khaldari, 2014). Crossbreeding offers two major advantages including heterosis and breeds complementary capabilities (Petrovic *et al.* 2011). As a result, crossbreeding can be a valuable approach where sheep meat (lamb) production is a main strategic goal (Kyanzad, 2001; Khaldari and Ghiasi, 2018). Application of this strategy is of economic importance in countries such as Iran that are red meat importers (Safdarian *et al.* 2008; Khaldari, 2014). Crossbreeding in sheep is strategically used to improve production (growth and carcass characteristics) and reproduction (twinning and litter size, all-year fertility, and early maturity) (Shrestha, 2005; Abdullah *et al.* 2011; Boujenane, 2015; Talebi and

Gholamhosseini, 2018). The global main breeds selected for crossbreeding include Dorset, Suffolk, and Texel for meat production, Finnish Landrace and Romanov for twinning and increased litter size, Merino and Rambouillet for wool production, and Awassi and East Friesian for milk production (Shrestha, 2005).

Iran is categorized as a dry and semi-arid country in terms of annual precipitation (Kyanzad, 2001; Khaldari, 2014). The main goal of Balouchi sheep raising is lamb production. However, despite being capable on pasture, because of poor pastures, Balouchi sheep has a large energy storage or fat-tail, and thus, suboptimal feed efficiency (Khaldari, 2014). In addition, Balouchi sheep does not have high twinning rate. Moreover, poor pasture quality for most of the year keeps Balouchi sheep from reaching its highest growth potential. Improving growth rate and feed conversion ratio and reducing tail and carcass fats in Balouchi sheep would result in increased profitability. As such, hypothetically, to increase litter size and improve maternal traits and lamb growth rate as well as carcass characteristics in Balouchi sheep, Balouchi ewes were inseminated with Romanov semen. Therefore, the objective of this study was to compare lamb birth and weaning body weights, growth and average daily gain from birth until weaning and slaughter, carcass characteristics, and survivability of purebred Balouchi *vs.* crossbred Romanov × Balouchi lambs.

MATERIALS AND METHODS

In this study, data for birth body weight, weaning body weight, birth type (normal vs. twinning), survivability (until weaning), birth and weaning dates of 53 purebred Balouchi lambs and 114 crossbred Romanov × Balouchi lambs were used. All lambs were kept with their mothers from birth until 21 days of age. After that, the lambs were on pasture during day and with their mother overnight. After 21 days of age, all lambs were each fed daily with 100 g of whole barley grain. Meanwhile, they had free access to chopped alfalfa hay. All experimental lambs were weaned at 77 days of age. The lambs were reared until 10 months of age, when 24 male lambs (12 male lambs from each group) were slaughtered to determine carcass characteristics. All animals were cared for according to the guidelines of the Iranian Council on Animal Care (1995).

Carcass yields with and without fat-tail were determined (Khaldari *et al.* 2007; Ekiz *et al.* 2009; Khaldari and Ghiasi, 2018; Dos Santos *et al.* 2021). Average daily gain from birth until weaning and slaughter were obtained. Thickness of the fat covering the back (TFCOB), thickness of the fat covering the loin (TFCOL) and fat thickness through the rear hindquarter (TRQ) were also measured. The weights of different external and internal organs were measured at slaughter.

These included head, skin, hands and feet, testis, rumen, small intestine, kidney, heart, liver, diaphragm, spleen and lung. In addition, the weights of different fats including kidney fat, cardiac fat, omental fat, splanchnic fat, visceral fat (sum of omental and splanchnic fats) were separately measured.

Statistical analysis

The statistical analysis was conducted by using the SAS (2004) program. The Mixed procedure was used for growth performance data analysis, and the Genmod procedure was utilized for survivability and twinning rate data analysis (SAS, 2004). The final statistical model for growth and carcass data included breed, gender, birth type, and their interactions. Birth weight and weaning age were considered as covariate. The slaughter age was modeled as covariate for the analysis of slaughter live body weight. The statistical model for survivability included the fixed effect of breed with two levels, gender, and litter size. Logistic regression models were used to analyze the occurrence of health traits.

RESULTS AND DISCUSSION

The present study provides new practical data on how crossbreeding of Balouchi ewes with Romanov's semen can improve litter size and resulting lamb weaning and slaughter performance, growth rate and carcass characteristics.

The least square means for growth data are given in Table 1. The breed (i.e., crossbreeding) effect was significant for birth and weaning body weights and average daily gains from birth until weaning and slaughter ($P<0.01$). The slaughter live body weight tended to increase (36.9 *vs.* 36.1 kg, $P=0.08$) by crossbreeding. Litter size was improved by crossbreeding (1.13 *vs.* 1.0; $P<0.01$). As a result of the increased litter size by crossbreeding, birth body weight was greater for Balouchi lambs than for crossbred Romanov × Balouchi lambs. This was most probably a result of the increased litter size in the crossbred sheep. However, weaning body weight (16.6 *vs.* 12.4 kg) was significantly greater ($P<0.01$) for the crossbred lambs than for the purebred Balouchi lambs. The weaning body weight has been reported to be affected by breed, gender, birth body weight, and weaning age (Nawaz *et al.* 1999; Khaldari and Ghiasi, 2018). Genotype's significant effect on birth and weaning body weights has been reported previously (Šáda and Lukešová, 2010; Talebi and Gholamahosseini, 2018). As such, the average daily gains from birth until weaning (152.2 *vs.* 126.0 g/day) and from birth until slaughter (125 *vs.* 95 g/d) were significantly greater ($P<0.01$) for the crossbred lambs than for the purebred Balouchi lambs.

Table 1 Crossbreeding effects on lamb birth body weight, weaning body weight, average daily gain, and survivability from birth until weaning

Item	Romanov × Balouchi (n=114)	Balouchi × Balouchi (n=53)	SEM	P-value
Birth body weight, kg	3.56^{a}	3.75^{b}	0.04	< 0.0001
Weaning body weight, kg	16.64^{a}	12.41^{b}	0.62	< 0.0001
Average daily gain from birth to weaning, g/d	152.2^{a}	126.00^{b}	7.09	0.003
Average daily gain from birth to slaughter, g/d	125.0^{a}	95.00^{b}	9.0	0.05
Survivability (until weaning), %	96.5	98.11	-	0.59
Litter size	1.13^{a}	1.00^{b}	0.03	< 0.01

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 2 Effect of gender on growth and survivability (until weaning) of Baluchi and crossbred lambs

Trait	Male	Female	SEM	P-value
Birth body weight (kg)	3.72^{a}	3.59^{b}	0.04	<0.01
Weaning body weight (kg)	15.09	13.96	0.56	0.07
Average daily gain (g)	146.73	131.45	7.16	0.06
Survivability (%)	0.99	0.95	-	0.26

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 3 Selected carcass characteristics of the two genetic groups at 10 months of age

Traits[1]	Romanov × Balouchi genotype (n=12)	Balouchi × Balouchi genotype (n=12)	SEM	P-value
Live body weight at slaughter, kg	36.9^{a}	36.1^{b}	0.29	0.08
Carcass weight without fat-tail, kg	14.14	13.63	0.21	0.13
Carcass weight with fat-tail, kg	14.44	14.93	0.21	0.15
Carcass yield with fat-tail, %	39.52	41.09	0.006	0.09
Carcass yield without fat-tail, %	38.62	37.31	0.005	0.09
TFCOB, mm	2.40	2.80	0.05	0.52
TFCOL, mm	4.30^{b}	6.30^{a}	0.03	0.002
TRQ, mm	5.64^{b}	8.69^{a}	0.05	0.0003

TFCOB: thickness of the fat covering the back; TFCOL: thickness of the fat covering the loin and TRQ: fat thickness through the rear hindquarter
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 4 Weight of different external and internal organs in the two genetic groups at slaughter (10 months of age)

Traits	Romanov × Balouchi genotype (n=12)	Balouchi × Balouchi genotype (n=12)	SEM	P-value
Head (kg)	1.96	1.92	0.03	0.30
Hands and feet (kg)	0.77	0.75	0.01	0.25
Skin (kg)	3.16^{b}	3.72^{a}	0.10	0.001
Small intestine (kg)	0.56	0.56	0.02	0.82
Rumen (kg)	1.20	1.13	0.05	0.37
Testis (kg)	0.24^{a}	0.16^{b}	0.015	0.002
Kidney (kg)	0.102	0.098	0.002	0.224
Kidney fat (kg)	0.078	0.077	0.007	0.96
Cardiac fat (kg)	0.04^{a}	0.02^{b}	0.003	0.02
Liver (kg)	0.61^{a}	0.52^{b}	0.01	< 0.0001
Heart (kg)	0.15^{a}	0.12^{b}	0.003	0.0001
Diaphragm (kg)	0.088	0.077	0.11	0.15
Spleen (kg)	0.053	0.049	0.003	0.42
Lung (kg)	0.47^{a}	0.40^{b}	0.02	0.04
Pelvic fat (kg)	0.06	0.08	0.008	0.14
Omental fat (kg)	0.16	0.19	0.05	0.75
Splanchnic fat (kg)	0.44	0.40	0.03	0.44
Visceral fat (omental and splanchnic fat) (kg)	0.60	0.58	0.05	0.81
Fat tail (kg)	0.30^{b}	1.29^{a}	0.10	< 0.0001
Total fat (visceral, kidneys, cardiac, and pelvic fats), kg	1.08^{b}	2.06^{a}	0.10	< 0.0001

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

The male lambs had greater birth body weight (P<0.01) and tended (P<0.10) to have greater weaning body weight and average daily gain from birth until weaning than did the female lambs (Table 2). Survivability was not different between male and female lambs (P>0.10).

The carcass data are presented in Tables 3 and 4. The carcass yield (excluding fat-tail) tended to increase by crossbreeding (P<0.10; Table 3). Thickness of fat covering loin and rear hindquarter was decreased (P<0.05) by crossbreeding (Table 3).

These data agree with the findings of Khaldari and Ghiasi (2018) that crossbred Lori Bkhtiari ewes with Romanov. Moreover, crossbreeding increased (P<0.05) the weight of testis, liver, heart, and lung and decreased (P<0.05) the weight of skin, fat-tail, and internal fats (visceral, kidney, cardiac, and pelvic fats) (Table 4). Such increases in important organs weights highlight the marked productive, reproductive, and economic benefits of crossbreeding in Balouchi sheep.

These data demonstrated that crossbreeding Balouchi ewes with Romanov's semen can markedly benefit lamb growth until weaning and slaughter. Crossbreeding can offer an economic advantage to sheep producers in Iran to improve lamb production and growth and carcass characteristics despite the low quality of pastures (Khaldari and Ghiasi, 2018). Some previous research has shown that crossbreeding can improve lamb survivability in native American sheep (Thomas, 2010). Results of the present study suggest that lamb survivability was comparable between the two groups (Table 1). Thus, crossbreeding improved lamb growth until weaning and slaughter as well as carcass characteristics without affecting lamb survivability. It can, thus, be suggested that crossbreeding would be a profitable strategy to improve lamb (meat) production in Balouchi sheep.

CONCLUSION

Results from this study confirmed that crossbreeding Balouchi ewes with Romanov semen can increase litter size and improve lamb weaning and slaughter body weight as well as average daily gain from birth until weaning and slaughter without affecting survivability, when compared to purebred Balouchi lambs. Crossbreeding tended to increase carcass yield and did increase the weight of liver, heart, lung and testis. This outcome possesses strategic and economic importance. The weights of fat-tail and internal fats were markedly decreased by crossbreeding. Thus, crossbreeding Balouchi sheep with Romanov's semen can be a profitable strategy to increase lamb and red meat production in Iran.

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