Intercrossing and Improving Chinese Local Sheep in Gansu with Meat Sheep Breeds from New Zealand

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Abstract: The Borderdale and Poll Dorset rams were introduced from New Zealand to intercross and improve local sheep breeds in Gansu province in North-West China. The research showed that the F_1 lambs have quick speed of live-weight gain, high dressing percentage, high meat yield and with good economic efficiency; their carcasses contain plenty of essential and nonessential amino acids with fresh colour of red and clear fatting strip, ideal rib-eye area and thickness of fat. The results also indicate that Borderdale and Poll Dorset are perfect paternal breeds to improve local sheep breeds in North-West China and necessarily to be extended during lamb production; the Borderdale F_1 is better than the Poll Dorset F_1 in meat gaining ability, ratio of investment to output and economic efficiency. It is better to fat the male F_1 lambs without castration from 5 months old. The high quality of lamb meat that produced in the testing plot is up to the standard of soft food.

Key words: Sheep breeds, meat, local sheep, intercross, improve

INTRODUCTION

The trend in developing nations is also for increased meat consumption with increasing affluence (Myers and Kent, 2003). Myers and Kent (2003) estimated that between 1997 and 2020, developing countries as a whole will increase their demand for meat by 92% (Kitessa *et al.*, 2010). With the impact of market demand at home and abroad, now sheep meat production is increasing and it's the primary product of the Chinese sheep industry (Li *et al.*, 2011). However, for growth traits, local sheep breeds are inferior to imported mutton sheep breeds (such as Poll Dorset, Borderdale and so on). Therefore, crossbreeding between local sheep breeds and these imported breeds is an effective way to improve sheep comprehensive performance and increase economic benefit (Di *et al.*, 2012).

Gansu is one of the provinces which are proud of their developed sheep and goat industry in China. At the end of the year 2002, the inventory of sheep and goats in Gansu was about 12.091 million (the amount of sheep was 9.018 million) which accounted for 3.82% of the Chinese sheep and goats population. In order to improve sheep comprehensive performance and meet the increasing requirement of the market, researchers researched on the crossbreeding between local sheep breeds and these imported breeds and it was performed in Yongchang County and neighbor areas in Gansu province.

The Borderdale (Zhao *et al.*, 2002) and Poll Dorset (Du, 2011) breeds are used in many countries as paternal breeds in crossbreeding systems for meat production and in the development of composite breeds (Rasali *et al.*, 2006; Montaldo *et al.*, 2011). This research improved local sheep breeds through the crossbreeding between local sheep breeds and these imported breeds from New Zealand.

MATERIALS AND METHODS

Option of the testing towns and villages, variety technical staff and farmers training: The towns and villages which locating near to others and being easy to arrive at with plenty of feedstuff and agricultural byproducts, its villagers have enough education to receive new things and ideas were chosen as the testing plot. First of all, mayors with their colleagues and farmers who raising great amount of sheep and goats were called together to learn some basic terminology and several useful technology in order that they can be used in their research, they were trained carefully with the step of the

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training plan until they can do it by themselves in practice. In recent 6 years, there are about 20 thousand technical books such as techniques of raising sheep and goats in practice, techniques of raising meat sheep and goats with high economic efficiency, techniques of planting alfalfa and techniques of making corn fodder silage and about 3.1 thousand variety technical staff and about 20 thousand farmers had been trained successfully. Then, all experiences and successful methods were extended to areas with similar condition.

Setting up sheep intercrossing and improving system: At the end of the year 2008, a modern sheep breeding center was set up in Yongchang meat sheep breeding farm to market super quality rams and spermatozoa (including frozen spermatozoa), total 43 breeding stations with needed settings and equipments which were managed well and take a very important role for belonging to farmers who had enough education and had been trained before were set up in the ten testing towns and 127 super quality rams were bought from the sheep breeding center to offer to the stations where the rams being raised well for example except for with good health and breeding capacity, their average body-weight was >80 kg at the age of 18 months and came upto 100 kg at the age of 24 months.

RESULTS AND DISCUSSION

Result of intercrossing and improving: From the year 2003 to 2008 in Yongchang, there were about 104.6 thousand local ewes which mainly being mogoular, Xiaowei Han, Gansu Alpine Fine Wool sheep and the hybrid of them had been artificially inseminated with the spermatozoa of Borderdale and Poll Dorset and the amount of born and alive F_1 and F_2 was about 84.3 thousand. At the same time, there were about 99.7 thousand local ewes which had been artificially inseminated with Borderdale and Poll Dorset's spermatozoa in other counties of Gansu and a few counties of Qinhai, Ningxia and Henan provinces and the amount of born and alive hybrid was about 79.8 thousand.

The hybrid with typical meat-usage conformation, quick weight-gaining speed and good economic efficiency

can resist the poor condition of feeding and management and can reward the raisers well. Being compared with the same aged local sheep, the hybrid was bigger and muscling with wider chest width and plat back with good adaptation, feeding ability and live-weight gain, about 30% higher than that of same aged local sheep. The F_2 was more like its father in conformation and gaining ability and production performance. The weight of F_1 raised under better feeding and management conditions was recorded in Table 1.

Result of fattening test: Lambs were fatted with pellet fattening diet at the age of 3, 5 and 7 months which were weighted regularly until after 50 days or 65 days when the test was ended (Ustuner *et al.*, 2012). The results of fatting test among 5 months old lambs were recorded in Table 2-6. In order to get rid of the effect of feed, the composition of the feed formula kept stable (Mousa, 2011; Kioumarsi *et al.*, 2008).

It can be seen from Table 3 that the average daily gain of male F_1B was highest and the average daily gain of hybrid F_1 lambs was significantly higher than that of local sheep lambs (p<0.01). The differences of their average daily gain were caused by their genetic structure (Arora and Bhatia, 2004), environment (Ma *et al.*, 2006), hormone (Chen *et al.*, 2012) and some other factors.

It can be seen from Table 4 that the carcass weight of male F_1B and castrated F_1B were significantly higher than that of local castrated lambs (p<0.01), the carcass weight of castrated F_1D was higher than that of local castrated lambs (p<0.05); the dressing percentage of male F_1B was higher than that of male F_1D (p<0.05); the dressing percentage of male F_1B, castrated F_1B and castrated F_1D were almost same; the meat percentage of male F_1B was significantly higher than that of local sheep lambs (p<0.01) and was higher than that of male F_1D, castrated F_1D. These differences could represent specifically through their body size (Cam *et al.*, 2010).

It can be seen from Table 5 that the tender cutting force of the meat of male Poll Dorset F_1 was extremely significant smaller than that of Borderdale F_1 and the local breeds (p<0.01) that of Borderdale F_1 was significantly smaller than that of local sheep (p<0.05), it means that the meat of Poll Dorset F_1 was tender than that of Borderdale

Table 1: Weight gain ability of F_1 in Yongchang rural unit: kg

Paternal breed	Sex	Heads	Birth weight	4 months weight	6 months weight	1 year weight
Borderdale	Male	176	4.72±1.03	30.62±6.67	35.18±6.32	45.22±6.93
Borderdale	Female	263	4.26±1.21	27.58±5.63	32.17±5.13	41.34±5.76
Poll Dorset	Male	137	4.83±1.25	31.56±4.23	37.61±6.26	43.07±7.25
Poll Dorset	Female	216	4.35±1.18	28.23±6.01	34.34±7.71	39.37±5.68
Local Mogoluar	Female	189	3.15±0.78	22.75±4.33	24.58±3.83	29.23±4.38

F_1 which was tender than that of the local; the muscle fiber diameter of hybrid was extremely significant smaller than that of the local (p<0.01); the steamed meat percentage of Borderdale F_1 was 63%, extremely higher than that of others (p<0.01) so that the Borderdale hybrid was more productive; the water holding capacity of Poll Dorset F_1 was extremely significant higher than that of others (p<0.01); the colour score of Borderdale F_1 meat was extremely lower than that of poll Dorset and local sheep (p<0.01) and the colour of hybrid meat was normal but the colour of local sheep meat was darker than normal; compared with the criteria of meat fatty strew score table, the score of hybrid was significantly higher than that of local sheep, the meat of hybrid was fatted better than local sheep; the fat thickness of Borderdale F_1 was higher than that of Poll Dorset F_1 (p<0.05) and was extremely significant higher than that of local sheep (p<0.01); the rib-eye area of Borderdale hybrid meat was extremely larger than that of local sheep (p<0.01) and the rib-eye area of poll Dorset meat was larger than that of local sheep; the amount of the nine amino acids in Borderdale hybrid meat was the highest and that in local sheep meat was the lowest.

The meat yield level and meat quality of Poll Dorset F_1 and Borderdale F_1 were more satisfactory than that of the local. The results we got from Table 4 and 5 conformed to the forecast of heterosis. And these results were similar with the earlier traits study (Liu *et al.*, 2010; Ren *et al.*, 2008).

It can be seen from Table 6 that the hybrid had a much higher economic efficiency than the local sheep and should be extended in North-West China. It was better to fat the male F_1 lambs without castration from 5 months old. According to Table 6, different combination of hybridization also had an influence on economic efficiency (Farahvash *et al.*, 2011).

Table 2: Composition of the feed formula for 5 months old lambs

Composition	Age of lambs	5 months old
Composition of feed formula (%)	Corn	66.50
	Wheat bran	8.55
	Oil cake	5.70
	Bean	14.25
	Feed soil	3.00
	Salt	1.00
	Lamb feed additive premix	1.00
Nutritional level (dry meter amount per kg)	Dry matter	82.43
	ME (MJ/kg)	13.42
	CP (%)	12.75
	Ca (%)	0.43
	P (%)	0.20
Daily allowance	(kg/head)	0.78
Feeding cost	(yuan/day)	1.15

Table 3: Results of fattening test of 5 months old lambs

Sorts of lambs	Initial weight (kg)	Finishing weight (kg)	Live-weight gain (kg)	Average daily gain (g)
Male F_1B	21.50±3.20	38.80±4.760	17.30±1.99	288.33±33.12
Castrated F_1B	21.88±1.25	35.88±1.180	14.00±1.73	233.33±28.87
Male F_1D	20.13±1.93	37.25±3.700	17.13±2.72	285.42±45.33
Castrated F_1D	20.50±0.87	32.0±1.3800	13.67±1.53	227.78±25.46
Castrated local	20.83±5.39	32.0±8.6700	11.17±3.40	186.11±56.73

Table 4: Analysis of 5 months old lambs' meat yield level

Sorts of lambs	Live weight (kg)	Carcass weight (kg)	Dressing (%)	Meat (%)	Carcass meat (%)	Bone-meat ratio
Male F_1B	35.20±6.31	17.80±3.33	50.58±1.84	40.02±1.75	79.17±1.17	1:3.8
Castrated F_1B	33.20±0.82	17.00±0.63	51.21±0.73	39.70±0.43	78.28±0.71	1:3.6
Male F_1D	29.10±4.08	14.20±2.36	48.68±2.17	37.12±4.47	77.78±3.93	1:3.6
Castrated F_1D	30.50±3.94	15.30±1.52	51.21±0.73	40.22±0.82	77.51±1.35	1:3.5
Local	26.38±1.83	12.67±1.17	47.96±1.80	37.10±0.57	77.06±1.03	1:3.5

Table 5: Analysis of the quality of 5 months old lambs' meat

Sorts of lambs	Colour score	Fatty strip score	pH 1	pH 24	Percentage steamed (%)	Water holding (%)	Tender cutting force (%)	Demeter of muscle fiber (um)
Male F_1B	3.9±0.22	2.86±0.30	6.45±0.06	5.59±0.06	59.43±1.95	14.69±0.42	4.51±0.48	35.38±0.70
Castrated F_1B	3.4±0.55	2.98±0.59	6.28±0.09	5.59±0.11	63.46±1.41	12.31±2.08	4.28±0.46	33.32±3.72
Male F_1D	3.9±0.42	2.58±0.26	6.28±0.15	5.62±0.15	58.88±1.48	19.17±4.17	3.82±0.50	37.36±4.37
Castrated F_1D	5.0±0.23	2.66±0.68	6.49±0.10	5.58±0.05	59.40±1.96	20.64±2.43	3.67±0.40	34.18±2.35
The local	4.5±0.04	1.67±0.29	6.59±0.09	5.75±0.01	60.41±1.61	11.18±1.19	5.03±0.41	40.92±0.64

Table 6: Economic analysis of 5 months old lamb group

Sorts of lambs	Weight gain (kg/lamb)	Dressing (%)	Meat yield (kg/lamb)	Income (yuan/lamb)	Feedstuff fee (yuan/lamb)	Other cost (yuan/lamb)	Profit (yuan/lamb)
Male F_1B	17.30	50.58	8.75	175.0	100.05	8.0	66.95
Castrated F_1B	14.00	51.21	7.17	143.4	96.05	8.0	38.95
Male F_1D	17.13	48.68	8.34	166.8	98.50	8.0	60.30
Castrated F_1D	13.67	51.21	7.00	140.0	90.00	8.0	42.00
The local	11.17	47.96	5.34	106.8	90.00	8.0	8.60

Other costs including the fee of disinfecting, dipping, vaccinating, ear-tagging, disease prevention and cure and salary of workers

Table 7: Analysis of meat contaminant and pesticide residue

			Amount of contaminant	
Contaminant	Unit	Criteria	Male F_1B	Male F_1D
Pb	mg/kg	0.1	0.056	0.06
As	mg/kg	0.5	0.085	0.09
BHC	mg/kg	0.2	0.000	0.00
DDT	mg/kg	0.2	0.000	0.00

Heavy metal and pesticide residue analysis: The amount of some pollutant restocking in hybrid meat had been analysed (Table 7). The result showed that the meat of the hybrid was completely unpolluted. The high quality of lamb meat that produced in the testing plot was up to the standard of unpolluted food.

CONCLUSION

In recent years, many excellent mutton sheep breeds were imported to the North-West China to intercross and improve Chinese local sheep which had greatly increased the income of local farmers and herdsmen. According to the research, the Borderdale F_1 was better than the Poll Dorset F_1 in meat gaining ability, ratio of investment to output and economic efficiency. And the comprehensive performance of local sheep breeds had improved obviously. Taking advantage of mutton sheep breeds to intercross local sheep is a main method to improve the growth traits of local sheep.

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