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ANALYSIS OF GROWTH OF TWO MAJOR BREEDS OF DOMESTIC CAMEL IN PAKISTAN: IMPLICATIONS FOR BREED IMPROVEMENT

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SUMMARY

The camel is an important domestic animal for producing valuable food and is well adapted to extremely harsh environments. The camel is gaining importance as a source of meat in Pakistan. However, the information on camel is very limited. We obtained blood samples and growth records of 136 animals of native Pakistani camel breeds, viz. Marecha camels from Punjab and Lassi camels from Baluchistan. In this study, we will present results on weight traits and growth modelling for these animals. This is part of a larger study investigating genetic diversity and genome-wide associations in these two important breeds of camel in Pakistan. We discuss the potential of the camel as a meat producer in Pakistan.

INTRODUCTION

Traditionally, the livestock sector is an important component of social structure in rural areas of Pakistan, in addition to its role in farming and commercial operations. In Pakistan, agriculture is the biggest sector of the economy, and in particular, the livestock sector has a great impact in Pakistan because 35-40 million people in rural populations depend on livestock and obtain about 30-40% of their earnings from livestock (Government of Pakistan 2017).

The camel is an important species well adapted to hot and dry environments and contributes appreciably to the food security of the nomadic rural households in Pakistan. Due to its unique adaptability, this species is well suited for management in arid and semi-arid environment. The camel remained a neglected species among livestock for scientific research. One of the main reasons for its neglect is that the camel is mainly found in areas of poor nutrition and dry environments of Asia and Africa rather than developed countries with stronger agricultural research programs (Sohail 1983).

The camel is also known as the "ship of the desert" because of its adaptability and suitability to thrive in the hot, dry and semi-arid region of the world. This animal has a distinctive ability to change the scarce vegetation of the desert into milk, fibre and meat. The camel has limited competition with other animals for feed, eats relatively less comparative to it body size (Khan *et al*. 2003).

The camel offers an opportunity to address food insecurity in Pakistan and other arid and semi-arid developing countries because of its biological and production characteristics. With climate change, this is becoming an imperative. To date, few systematic breed improvements have been made to breed superior camels for improved meat, milk, or other production characteristics. However, developments in genetic technologies in recent years have made it worthwhile to investigate the feasibility of applying these methods to breed camels for improved meat production, or improved milk production. Applications of these methods have been well developed in other livestock species to optimally select animals for breeding, using marker-assisted selection, and more recently with the availability of high-density genotyping arrays, using genomic selection. Much could be learnt from experiences in those other livestock sectors and applying them, to camel breeding.

This paper investigates the growth of the camel, *Camelus dromedarius*, as the first stage in providing

phenotypic information for a quantitative genetic analysis of growth. The output from the growth analysis will allow a genetic evaluation at various ages of the camel, towards a genetic improvement program of the camel in Pakistan.

MATERIALS AND METHODS

Weight records at birth, weaning and monthly records for the most recent four years were obtained from farm records of Marecha camels (n = 83 female, n = 26 male) from the Camel Breeding and Research Station (CBRS) at Rakhmahni, Bhakkar Pakistan. Up to 48 monthly records were available. These were obtained using walk-over scales. Concurrently, blood samples were also collected from these animals for subsequent genomic analysis (not reported here). In addition, weight records and blood samples were obtained from Lassi camels (n = 27 females) on privately-owned farms in Lasbela, Baluchistan Pakistan.

Comparisons of birth weights and of weaning weights between the three groups of camels (Lassi females, Marecha females, and Marecha males) were made using linear models. For the growth records, linear mixed models were fitted to the data, with fixed effects for breed-sex group and age (as a covariate). To allow for the nonlinear growth curve, a spline function of age was included in the random effects model. Individual variability of growth curves was accommodated by inclusion of random intercepts, random slopes, as well as random splines for each camel. The analysis was conducted using the ASReml-R package (Butler *et al*. 2009) in R.

RESULTS AND DISCUSSION

Figure 1 shows the birth weights and weaning weights for female Lassi, female Marecha and male Marecha camels. There are significant differences in birth weight across the three groups ($P <$ 0.0001), with Marecha males being significantly heavier (45.42 ± 0.92 kg, mean ± SE) than females of either breed at birth (Lassi: 40.96 ± 0.91 kg; Marecha: 38.95 ± 0.52 kg). The difference in mean birth weights for females of the two breeds was marginally non-significant (P = 0.057). Similarly, for weaning weight, there were significant differences amongst the three groups of camels (P = 0.006), again with male Marecha camels (112.38 ± 3.01 kg) having significantly heavier weaning weights than females of either breed (Lassi: 99.70 ± 2.95 kg; Marecha: 102.66 ± 1.69 kg). There was no significant difference between the mean weaning weights of females of the two breeds (P = 0.39). However, caution need to be applied in making between-breed comparison of both birth weights and weaning weights, due to the different management and environment: the Marecha camels were managed in a research farm, while Lassi camels were managed by private farmers with close cultural ties to their animals. The relatively reduced significance of differences in mean weaning weights compared to between mean birth weights could be due to variation in ages of weaning of individual animals.

Figure 2 shows a sample of fitted growth curves for individual camels, representing each of the three groups. Table 1 shows selected model-based means weights at different ages, again for each of the three groups. What is immediately apparent is that many camels go through periods of losing weight. This is seen in the individual growth curves as well as the overall average of male Marecha camels. This decline may reflect decline in food availability, particularly over winter, but for Marecha males, another possibility of weight loss is when they are provided for breeder services. Also evident in Table 1 is the lack of substantial difference in mean growth profiles of the three groups of camels: divergence starts after two years, with male Marecha camels having a substantially higher growth rate than female Marecha camels. It is also seen that Lassi female had a higher growth rate than female Marecha camels. Again, the different management and environments of the two breeds need to be considered when interpreting between-breed differences.

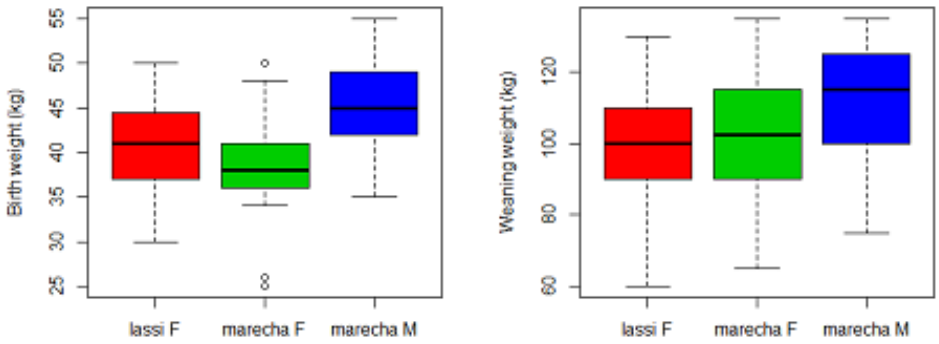

Figure 1. Distributiosn of birth weights (LHS) and weaning weights (RHS) for female Lassi, female Marecha and male Marecha camels

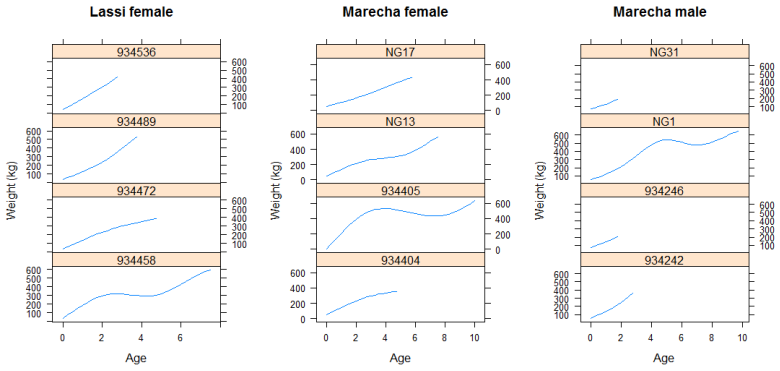

Figure 2. Fitted growth curves of a selection of female Lassi, female Marecha and male Marecha camels

As the body weight data were not collected at consistent ages across all animals, it would be difficult to use these raw data as phenotypic input into a GWAS for example. However, using model-based predictions for individual animals, it is possible to obtain values for all animals at specific ages. This allows an age specific GWAS to be conducted, and to track effects of genes over different times. These results will be reported in a subsequent study.

Table 1. Model-base mean body weight at selected ages of female Lassi, female Marecha and male Marecha camel

	Mean body weight ± SE (kg)		
Age (yr)	Lassi Female	Marecha Female	Marecha Male
0	40.66 ± 26.10	49.00 ± 17.03	48.61 ± 29.89
2	233.78 ± 16.61	227.32 ± 7.88	236.85 ± 13.68
4	429.56 ± 33.54	346.93 ± 16.25	508.58 ± 32.21
6	643.49 ± 44.06	434.87 ± 19.64	669.61 ± 45.81
8	791.27 ± 60.60	536.20 ± 17.35	592.11 ± 56.38

The camel in Pakistan represents an opportunity to 'future proof' the country against the risk of climate change and to add to increasing food security for the nation. The tools to develop a livestock industry have been well developed in other industries, particularly in developed counties. But with reductions in costs of genetic technologies and considering that not much in the way of breed improvement in the camel has been conducted, it would be expected a well-developed breeding program would have great financial and social benefits. It is also important to conserve the range of camel breeds that exist in Pakistan, as this genetic diversity represents another form of 'future proofing' production. This diversity should be considered in relation to the range of functions of the camel, i.e. meat, milk, skin, and even tourism. Genomic tools provide an efficient way to assess this genetic diversity and to plan how this can be managed in an optimal way.

CONCLUSIONS

This study provides information on growth traits in two major breeds of camel in Pakistan. A spline-based method is used to model growth and develop predictive models for individual animals and these predictions can be used as phenotypic input for a GWAS of camel growth. Little systematic breed improvement had been conducted on dromedary camels in Pakistan, but improvements in productivity have the potential to improve the economic situation for farmers in (semi-)arid regions but also to 'future proof' the nation in terms of its food security.

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