



**UNIVERSITI PUTRA MALAYSIA**

**GENETIC CHARACTERIZATION OF SOUTH AFRICAN AND  
AUSTRALIAN PUREBRED BOER GOATS AND AUSTRALIAN  
CROSSES USING MICROSATELLITES**

**HAMIDAH BINTI ALI KAMARULZAMAN**

**ITA 2010 3**



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AUSTRALIAN PUREBRED BOER GOATS AND AUSTRALIAN CROSSES  
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By

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**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Degree of Master of Science**

**December 2010**



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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**Chairman: Prof Dr. Jothi Malar Panandam, PhD**

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The Boer goats which originate from South Africa are raised as meat goats across the American, Australia and Asia continent. They are being continuously imported into Malaysia from South Africa and Australia. However, lack of information is available on the breed's genetic characteristics or genetic variability. Comprehensive knowledge of the existing genetic variability of a species is a core element for conservation and exploitation of animal diversity for breeding purposes. When exotic breeds are imported into a country, unless proper breeding programs are implemented and adhered to, the unique characteristics of the breed might become diluted due to crossbreeding with other breeds, sub-structuring or genetic drift. This study was conducted to evaluate the genetic variability within and between the purebred of South African and Australian Boer goats and the Australian Boer crosses in Malaysia using microsatellite markers.

Blood samples were randomly sampled from 50 purebred Boer goats from South Africa (SA), and 50 purebred Boer goats (AUS) and 30 crossbred Boer goats (CRS)



from Australia. Thirty microsatellite loci suggested by FAO for genetic diversity studies in goats plus 20 microsatellite loci reported as polymorphic in other studies on goats were used. Optimization of polymerase chain reaction (PCR) protocols and preliminary screening to detect polymorphic loci were carried out using DNA pools. The status of the monomorphic loci was confirmed by screening seven individual samples from each population. The loci detected as polymorphic were then used in the analysis of individual sample.

Only 46 of the microsatellite loci were successfully amplified, of which 15 were monomorphic and 31 were polymorphic. Eighteen polymorphic loci were from the panel recommended by FAO. The mean number of observed alleles was 2.39 for all the populations and the allele sizes ranged from 31 to 330 bp. The observed heterozygosity values ( $H_o$ ) were higher than the expected heterozygosities. The CRS population had the highest  $H_o$  (0.52), followed by AUS (0.51) and SA (0.45) populations. The polymorphic information content values for the loci investigated ranged from 0.11 (INRABERN185) in the SA population to 0.64 (TGLA53) in the AUS population. No linkage disequilibrium was found among the loci used in the study. Significant heterozygosity excess on the basis of the Infinite Allele Model, Two Phase Model and Stepwise Mutation Model revealed by the Wilcoxon sign-rank test, along with the absence of L-shape distribution in the mode-shift test for allele frequency classes, indicated no inbreeding in the SA, AUS and CRS populations. The overall mean inbreeding coefficient ( $F_{IS}$ ) of 0.02 also supported this.

Wright's fixation index ( $F_{ST}$ ) was -0.09 indicating the absence of genetic differentiation among the three Boer breed types. The Nei's genetic similarity

between SA and AUS was 99%, and between CRS and SA and between CRS and AUS were 98%. Analysis of molecular variance (AMOVA) indicated that of the total genetic variation 99% was attributed to within population variation and only 1% was due to among population variation.

The present study shows that the AUS and CRS populations have moderate genetic diversity, while SA has a slightly lower genetic diversity. The purebred Boer goats from South Africa and Australia are very similar in their genetic makeup. The three Boer breed types are not genetically distinct.

However, further screening of the Boer goat types with more populations of each type and more microsatellite loci are needed before drawing any definite conclusions. Capillary electrophoresis of the microsatellite alleles and other more sensitive genetic marker systems, such as single nucleotide polymorphism (SNP), should also be considered. The information derived from the present study about the Boer goat populations from South Africa and Australia and the crossbred Boer goats using microsatellite analysis serves as preliminary results for planning breeding designs and for future studies.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENCIRIAN GENETIK KAMBING BOER BAKA TULEN YANG BERASAL DARI AFRIKA SELATAN DAN AUSTRALIA DAN KACUKAN AUSTRALIA DENGAN MENGGUNAKAN MIKROSATELIT**

Oleh

**HAMIDAH BINTI ALI KAMARULZAMAN**

**Disember 2010**

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Kambing Boer berasal Afrika Selatan adalah ditenak sebagai kambing pedaging merentasi benua Amerika, Australia dan Asia. Ia diimport ke Malaysia secara berterusan dari Afrika Selatan dan Australia. Bagaimanapun, terdapat kurang maklumat tentang pencirian genetik ataupun variasi genetik baka tersebut. Maklumat komprehensif tentang variasi genetik yang wujud pada sesuatu spesis merupakan elemen utama untuk pemuliharaan dan mengeksploitasi kepelbagaian genetik bagi tujuan pembiakbakaan. Apabila baka eksotik diimport ke dalam sesuatu negara, dan jika program pembiakbakaan yang sesuai tidak dilaksanakan, ciri unik baka tersebut mungkin hilang kerana pembakaan kacukan, sub-penstrukturasi ataupun kemerosotan genetik. Kajian ini dijalankan untuk menilai variasi genetik di dalam dan di antara kambing Boer baka tulen dari Afrika Selatan dan Australia dan kambing Boer kacukan dari Australia dengan menggunakan penanda mikrosatelit.

Sampel darah diambil secara rawak daripada 50 ekor kambing Boer baka tulen dari Afrika Selatan (SA) dan 50 ekor kambing Boer baka tulen dari Australia (AUS) dan 30 ekor baka kacukan kambing Boer (CRS) dari Australia. Tiga puluh lokus mikrosatelit yang dicadangkan oleh FAO untuk kajian kepelbagaian genetik pada kambing dan 20 lokus mikrosatelit yang dilaporkan sebagai polimorfik di kajian lain pada kambing telah digunakan. Pengoptimuman protokol tindakbalas berantai polimeras (PCR) dan pemeriksaan awalan untuk mengenalpasti lokus yang polimorfik telah dijalankan dengan menggunakan gabungan DNA. Status lokus yang monomorfik disahkan dengan pemeriksaan tujuh sampel individu dari setiap populasi. Lokus yang dikenalpasti sebagai polimorfik digunakan untuk analisis sampel individu.

Hanya 46 lokus mikrosatelit yang berjaya diamplifikasi dimana Daripada jumlah ini 15 lokus adalah monomorfik dan 31 lokus polimorfik untuk ketiga-tiga populasi. Lapan belas lokus polimorfik adalah daripada panel yang dicadangkan oleh FAO. Purata bilangan alel yang dicerap adalah 2.39 untuk semua populasi dan saiz alel berjulat daripada 31 bp kepada 330 bp. Nilai heterozigositi yang dicerap ( $H_o$ ) adalah lebih besar daripada nilai heterozigositi yang dijangka. Populasi CRS mempunyai  $H_o$  yang tertinggi (0.52) diikuti dengan populasi AUS (0.51) dan populasi SA (0.45). Nilai kandungan maklumat polimorfik untuk lokus yang dikaji berjulat daripada 0.11 (INRABERN185) di dalam populasi SA ke 0.64 (TGLA53) di dalam populasi AUS. Ketakseimbangan rangkaian tidak dijumpai antara lokus yang digunakan di dalam kajian ini. Lebihan heterozigositi yang signifikan berdasarkan *Infinite Allele Model*, *Two Phase Model* dan *Stepwise Mutation Model* didedahkan dengan *Wilcoxon sign-rank test*, bersama dengan ketiadaan taburan bentuk-L dalam *mode-shift test* untuk

kelas frekuensi alel, menunjukkan tiada pembiakbakaan dalam di dalam populasi SA, AUS and CRS. Nilai purata pekali pembiakbakaan dalam ( $F_{IS}$ ) 0.02 juga menyokong ini.

*Wright's fixation index* ( $F_{ST}$ ) adalah -0.09 menunjukkan tiada atau kurang pembezaan genetik antara ketiga-tiga jenis baka Boer. Kesamaan genetik Nei antara SA dan AUS adalah 99%, dan antara CRS dan SA dan antara CRS and AUS adalah 98%. *Analysis of molecular variance* (AMOVA) menunjukkan bahawa daripada jumlah variasi genetik 99% adalah terhasil daripada variasi di dalam populasi dan hanya 1% adalah disebabkan oleh variasi antara populasi.

Berdasarkan keputusan daripada kajian ini ia dapat disimpulkan bahawa populasi AUS dan CRS mempunyai kepelbagaian genetik yang sederhana, manakala populasi SA mempunyai kepelbagaian genetik yang sedikit lebih rendah. Kambing Boer baka tulen dari Afrika Selatan dan Australia mempunyai kandungan genetik yang serupa. Ketiga-tiga jenis baka Boer tidak menunjukkan pengkelasan dari segi genetik.

Walaupun bagaimanapun, lebih saringan kambing jenis Boer dengan menggunakan lebih populasi bagi setiap jenis dan lebih lokus mikrosatelit diperlukan sebelum membuat sebarang kesimpulan yang tepat. Penggunaan *Capillary electrophoresis* mungkin dapat mengesan variasi kecil pada saiz alel mikrosatelit yang mana tidak dapat dikesan dengan menggunakan *metaphor agarose electrophoresis*. Selain itu, sistem penanda genetik yang lebih sensitif seperti *single nucleotide polymorphism* (SNP) harus juga dipertimbangkan. Maklumat yang diperolehi daripada kajian ini mengenai populasi kambing Boer dari Afrika Selatan dan Australia dan kambing Boer kacukan



dari Australia dengan menggunakan analisis microsatelit merupakan maklumat untuk merancang rekabentuk pembiakbakaan dan kajian masa depan.

## ACKNOWLEDGEMENTS

First and foremost, I would like to express my sincere and deepest appreciation to my supervisor Prof. Dr. Jothi Malar Panandam for her continued advice, guidance, support, encouragement and for helping me learn new things throughout the period of the study.

I would like to gratefully acknowledge to my co-supervisor Assoc. Prof. Dr. Siti Khalijah Daud for her guidance and interest in my research, and support by allowing me to work in her laboratory when the thermal cycler in the Genetics Laboratory at the Department of Animal Science was not working. My research work could not have run smoothly without the support of my two supervisors.

I am grateful to thank all my friends at the Department of Animal Science, especially to Arash Javanmard, Haytham Hago, Yow Weng Kit, Kamariah Jamhari, Mamat Hamidi, Alireza Majidi, Reza Tohidi and Saeid Nikbin, for the motivation and advice, and for sharing their knowledge with me over the duration of this period of study. Not forgotten are my friends in the Biology Laboratory, Faculty of Science, Tee Meng Han, Azlina Zainab, Hasnita, Faezah, Nadiatul Hafiza, Fitri and Dania. Without them, life in the lab would have been boring.

My thanks to Siti Aishah Abdul Wahid, for her company and time during my practical lab work. I will always cherish her friendship.



I am grateful and thankful to my parents, Mr. Ali Kamarulzaman Othman and Ms. Habsah Hasan, and also to my brothers, Mohd Zaid, Abdul Hafiz, Mohd Hanif and Muhammad Haziq, and my sister, Siti Aishah, for their understanding and support

Special thanks go to the Ministry of Science, Technology and Innovation Malaysia for providing me the National Sciences Fellowship for my Masters of Science program.

Last but not least, I would like to acknowledge everyone who had help me in one way or another during the course of my study and conducting this project.



I certify that an Examination Committee has met on 6 December 2010 to conduct the final examination of Hamidah binti Ali Kamarulzaman on her Master of Science thesis entitled “Genetic Characterization Of South African And Australian Purebred Boer Goats And Australian Boer Crosses Using Microsatellites” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the Masters of Science.

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## **DECLARATION**

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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**HAMIDAH BINTI ALI KAMARULZAMAN**

Date:

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