GENETIC CHARACTERISATION OF MAFRIWAL DAIRY CATTLE OF MALAYSIA USING QUANTITATIVE AND MOLECULAR METHODS

By

KALAISELVI PALANI

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

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DEDICATION

TO MY PARENTS
Mr. A. PALANI and Mrs. PORKODI PALANI

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman: Jothi Malar Panandam, Ph.D.
Faculty: Agriculture

In Malaysia, there is an increasing demand for milk and other dairy products. The total milk consumption has almost doubled in the last decade, but self-sufficiency has decreased. Among the government's effort to stimulate the dairy industry was the development of the tropicalised synthetic breed named "Mafriwal" by crossbreeding of Sahiwal and Friesian breeds. The Mafriwal, being a new breed, is still subjected to selection and improvement. Therefore, it is essential that its performance and genetic structure be monitored. This study was carried out to characterise the Mafriwal dairy cattle of Malaysia, using quantitative methods and microsatellite markers, and to investigate possible association between microsatellite markers and quantitative trait loci for milk production and reproduction traits. This study focused on the Mafriwal herd at Institut Haiwan Kluang, Johor.

Evaluation of four breed groups, namely M50, M56, M63 and M75 with 50%, 56%, 63% and 75% Friesian gene, respectively, based on retrospective data 1058 cows born between 1982-1996, showed breed group effect to be non-significant for LTM, P305, DPM, LL, DM and DP but significant ($P<0.05$) for NSC, CFS and CBW. P305M, DPM

and DM was significantly ($P<0.05$) low in the first lactation. First parity had significantly ($P<0.01$) longer CFH, CFS and lower CBW than subsequent parities. The phenotypic correlations between the milk production traits were high (0.78 to 0.86), and that between reproduction traits ranged from 0.23 to 0.96. Repeatability estimates for the four breed groups were 0.14 - 0.68 for milk production traits and low for reproduction traits.

The modified gamma function used to fit lactation curves of 144 cows revealed initial milk yield was higher ($P<0.05$) in M56 and M63 compared to M50 and M75, but their rise to peak production and rate of decline were lower. The lactation curve parameters were higher for cows that calved after 1996 and were significantly ($P<0.01$) lower for first lactation.

Microsatellite analysis of a random sample of 40 cows using 55 established marker primers detected 90.9% polymorphism. The polymorphic loci showed 4 to 10 alleles, with 8 to 20 genotypes per locus. The allele frequencies ranged from 0.01 to 0.45 and genotypic frequencies ranged from 0.03 to 0.38. Observed heterozygosity was 0.20 - 0.75, with mean 0.52 ± 0.12. Significant ($P<0.05$) deviations from Hardy-Weinberg equilibrium were observed for all the polymorphic loci, except RM209.

The 30 high producers (HP) and 30 low producers (LP) in the herd, analysed for the 50 polymorphic microsatellite loci, could not be distinguished by any particular marker and were quite similar in terms of genetic variability. Among HP, three alleles showed

significant ($P<0.05$) association with milk production traits and nine alleles with reproduction traits. Among LP, absence of allele SPS115:D/150 showed significant ($P<0.05$) increase in LL and two alleles showed significant ($P<0.05$) association with reproduction traits. For the pooled data (HP, LP and random sample), presence of following alleles was significantly ($P<0.05$) associated with higher means for performance traits: AGLA29:E/146, BM143:A/100, BM4208:G/190, BM678:H/175, CSSM5:C/125 and TGLA170:C/95 with LTM, BM143:A/100 and RM372:G/170 with LL and BM143:A/100, BM4208:G/190, BM678:H/175, CSSM5:C/125 and HUJV174:E/150 with DM. Animals with alleles AGLA29:E/176, BMS678:H/175 and CSSM5:D/133 showed significantly ($P<0.05$) shorter CFH and CFS and with alleles BMS4028:F/120 and BMS678:H/175 had shorter CCo and CI.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENCIRIAN GENETIK LEMBU TENUSU MAFRIWAL MALAYSIA DENGAN KAEDAH KUANTITIF DAN MOLEKUL

Oleh

KALAISELVI PALANI

Ogos 2004

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Di Malaysia keperluan susu dan produk tenusu yang lain telah meningkat. Jumlah kegunaan telah bertambah lebih kurang dua kali ganda dalam dekad yang lepas, tetapi sara diri telah berkurangan. Antara usaha kerajaan untuk merangsang industri tenusu adalah pembentukan baka sintetik tropika yang digelar Mafriwal melalui kacukan baka Sahiwal dengan Friesian. Mafriwal adalah baka baru dan pemilihan dan pembaikbiakan masih diamalkan. Maka adalah penting bahawa prestasi dan stuktur genetiknya dipantau. Kajian ini dijalan kan untuk menciri lembu tenusu Mafriwal di Malaysia dengan menggunakan cara kuantitatif dan petanda mikrosatelit, dan menyiasat perhubungan yang mungkin antara penanda mikrosatelit dan lokus trait kuantitatif untuk trait penghasilan susu dan pembiakan. Kajian ini ternumpu kepada kelompok Mafriwal di Institiut Haiwan Kluang, Johor.

Penilaian empat kumpulan baka, iaitu M50, M56, M63 dan M75, dengan 50%, 56%, 63% dan 75% gen Friesian, masing-masing, berdasarkan data retrospektif daripada 1058 ekor lembu betina yang dilahirkan antara tahun 1982-1996, menunjukkan bahawa kesan

kumpulan baka adalah tidak signifikan untuk LTM, P305M, DPM, LL, DM dan DP, tetapi adalah signifikan ($P<0.05$) untuk NSC, CFS and CBW. Laktasi pertama mempunyai P305M, DPM dan DM yang rendah secara signifikan ($P<0.05$). Pariti pertama mempunyai CFH, CFS dan CBW yang kurang secara signifikan ($P<0.01$). Korelasi fenotipik antara trait penghasilan susu adalah tinggi (0.78 hingga 0.86) dan diantara trait pembiakan berjulat daripada 0.23 hingga 0.96. Anggaran keberulangan untuk empat kumpulan adalah 0.14 – 0.68 untuk trait penghasilan susu dan rendah bagi trait pembiakan.

Fungsi gamma terubahsuai yang digunakan untuk berpadanan dengan lengkuk laktasi 144 ekor lembu betina menunjukkan hasil pengeluaran susu awal adalah lebih tinggi ($P<0.05$) bagi M56 dan M63 berbanding dengan M50 dan M75, tetapi peningkatan ke penghasilan tertinggi dan kadar kemerosotan adalah lebih rendah. Parameter lengkuk laktasi adalah tinggi bagi lembu yang melahirkan anak selepas 1996 dan rendah secara signifikan ($P<0.01$) untuk laktasi pertama.

Analisis mikrosatelit sampel rawak untuk 40 ekor lembu dengan menggunakan 55 petanda primer yang terbukti mengesan 90.9% polimorfisme. Lokus polimorfik menunjukkan 4 hingga 10 alel dengan 8 hingga 20 genotip setiap lokus. Frekuensi alel adalah berjulat daripada 0.01 hingga 0.45 dan frekuensi genotip pula adalah 0.03 hingga 0.38. Heterozigositi yang dicerap adalah 0.20 - 0.75 dengan min 0.52 ± 0.12. Sisihan signifikan ($P<0.05$) daripada keseimbangan Hardy – Weinberg diperhatikan untuk kesemua lokus polimorfik, kecuali RM209.

Tiga puluh ekor lembu penghasil tertinggi (HP) dan 30 ekor penghasil terendah (LP) yang telah dianalisis dengan 50 lokus mikrosatelit polimorfik tidak boleh dibezakan oleh sebarang penanda, dan mempunyai persamaan dari segi variasi genetik. Antara HP, tiga alel menunjukkan perhubungan signifikan ($P<0.05$) dengan trait penghasilan susu dan sembilan alel dengan trait pembiakan. Dikalangan LP, ketiadaan alel SPS115:D/150 menunjukkan pertambahan signifikan ($P<0.05$) bagi LL dan dua alel menunjukkan perhubungan signifikan ($P<0.05$) dengan trait pembiakan. Untuk data terkumpul (HP, LP dan sampel rawak) kehadiran alel berikut menunjukkan perhubungan signifikan ($P<0.05$) dengan min yang lebih tinggi untuk trait prestasi: AGLA29:E/176, BM143:A/100, BM4208:G/190, BMS678:H/175, CSSM5:C/125 dan TGLA170:C/95 dengan LTM, BM143:A/100 dan RM372:G/170 dengan LL, BM143:A/100, BM4208:G/190, dan BM678:H/175, CSSM5:/125 dan HUJV174:E/150 dengan DM. Lembu yang mempunyai alel AGLA29:E/176, BMS678:H/175 dan CSSM5:D/133 menunjukkan CFH dan CFS yang lebih pendek secara signifikan ($P<0.05$) dan Lembu yang mempunyai alel BMS4028:F/120 dan BMS678:H/175 pula mempunyai CCo dan CI yang lebih pendek.

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I certify that an Examination Committee has met on **24-08-2004** to conduct the final examination of **P. Kalaiselvi** on her **Doctor of Philosophy** thesis entitled "Genetic Characterisation of Mafriwal Dairy Cattle of Malaysia using Quantitative and Molecular Methods" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the requirements for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

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DECLARATION

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

KALAISELVI PALANI

Date:

TABLE OF CONTENTS