UNIVERSITI PUTRA MALAYSIA

OVULATION RESPONSES ON THREE OESTRUS SYNCHRONISATION PROTOCOL AND ASSOCIATION BETWEEN PROGESTERONE CONCENTRATION IN LATE PREGNANCY AND LITTER SIZE OF BOER GOATS

ABDUL MU'IN BIN HASSAN BASRI

FP 2016 87

OVULATION RESPONSES ON THREE OESTRUS SYNCHRONISATION PROTOCOL AND ASSOCIATION BETWEEN PROGESTERONE CONCENTRATION IN LATE PREGNANCY AND LITTER SIZE OF BOER GOATS

By

ABDUL MU'IN BIN HASSAN BASRI

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

June 2016

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

OVULATION RESPONSES ON THREE OESTRUS SYNCHRONISATION PROTOCOL AND ASSOCIATION BETWEEN PROGESTERONE CONCENTRATION IN LATE PREGNANCY AND LITTER SIZE OF BOER GOATS

By

ABDUL MU'IN BIN HASSAN BASRI

June 2016

Chairman : Halimatun Bt. Yaakub, PhD
Faculty : Agriculture

Assessment of goat reproductive systems and application of advanced reproductive technologies (ART), help to improve the goat industry in Malaysia. Oestrus synchronisation (OS) protocols and equipment like real-time ultrasonography (RTU) machine are important component of advance reproductive technologies. The objectives of the current study were to determine the ovulation responses on three oestrus synchronisation protocols and association between progesterone levels with litter size in Boer goats. In Experiment 1, twenty-two (24) fertile and healthy Boer does were divided equally into three groups and each group was treated with one of the three treatments:- T1: CIDR for 14 days and 200 IU of pregnant mare serum gonadotrophin (PMSG) and 0.5 ml prostaglandin (PG) prior to CIDR removal; T2: CIDR for 14 days and 0.5 ml PG prior to CIDR removal; T3: CIDR for 9 days and 200 IU of PMSG and 0.5 ml PG prior to CIDR removal. The oestrus sign was observed from 24 hours after CIDR removal to first sign of oestrus. Both ovaries for all does were examined with a RTU machines for 72 hours at six-hours interval beginning at 24 hours after CIDR removal. Blood samples were collected at four points which were:- 24 hours after CIDR removal, at first time of oestrus sign, at first ovulation and at 72 hours after CIDR removal for progesterone hormonal profile assessment. All does demonstrated (100%) oestrus signs but 25%, 12% and 12% in T1, T2 and T3 respectively did not ovulated. Ovulation responses in terms of mean number of follicles observed before first ovulation, mean size of follicles before first ovulation and mean number of follicle ovulated did not show any significant difference ($p > 0.05$) among the T1, T2 and T3. The percentage of does with single and multiple ovulations were not significantly different among the three treatments. However, high percentages of multiple ovulations (83%, 86% and 71%, respectively) were recorded for each T1, T2 and T3 as compared to single ovulation. Mean number of follicles ovulated from right and left ovaries were significantly different ($p < 0.05$) in T3 (2.1 ± 1.0, 0.6 ± 0.5). The mean time of ovulation were recorded between 44.0 ± 2.85 to 47.4 ± 2.78 hours ($p > 0.05$) among the three treatments

calculated from 24 hours after CIDR removal. All treatments showed no significant difference ($p > 0.05$) for duration of ovulation with 18.0 ± 5.37, 21.0 ± 5.95, 19.2 ± 3.98 hours calculated from 24 hour after CIDR removal for T1, T2 and T3 respectively. Assessment of progesterone hormonal profiles at four points did not show any significant difference ($p > 0.05$) among the three treatments. In Experiment 2, 5 ml of blood sample from 48 pregnant does were taken approximately two weeks before expected kidding date. The blood samples were analyzed to determine progesterone hormonal profile. After parturation, the number of litter size for each doe were recorded either single, twins or triplets. The mean progesterone concentration showed no significant difference ($p > 0.05$) that are 17.7 ± 2.9 ng/ml for doe with single kid and 21.4 ± 2.8 ng/ml for does with two or more kids. In conclusion, in Experiment 1, the result of ovulation responses showed no significant differences between Treatment 1 (T1) which was insertion of CIDR for 14 days with the injection of 200 IU of PMSG and 0.5 ml PG prior to CIDR removal ; Treatment 2 (T2), insertion of CIDR for 14 days with the injection of 0.5 ml PG prior to CIDR removal and; Treatment 3 (T3), insertion of CIDR for 9 days with the injection of 200 IU of PMSG and 0.5 ml PG prior to CIDR removal. Meanwhile, in Experiment 2, the high number of litter size did not increase the level of progesterone concentration two weeks before kidding.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

TINDAK BALAS OVULASI TERHADAP TIGA PROTOKOL PENYELARASAN ESTRUS DAN HUBUNGAN ANTARA KEPEKATAN PROGESTERON PADA AKHIR KEBUNTINGAN DAN BILANGAN ANAK KAMBING BOER

Oleh

ABDUL MU'IN BIN HASSAN BASRI

Jun 2016

Pengerusi: **Halimatun Bt. Yaakub, PhD**
Fakulti : Pertanian

Penilaian sistem pembiakan kambing dan aplikasi teknologi pembiakan maju (ART) membantu dalam meningkatkan industri kambing di Malaysia. Protokol penyelarasan oestrus (OS) dan peralatan berteknologi tinggi seperti mesin ultrasonografi (RTU) adalah komponen penting dalam teknologi pembiakan maju. Objektif kajian semasa adalah untuk menentukan tindak balas ovulasi terhadap tiga protokol penyelarasan oestrus hubung kait antara tahap progesteron dengan bilangan anak terhadap kambing Boer. Dalam Eksperimen 1, sebanyak dua puluh empat (24) ekor kambing Boer yang subur dan sihat dibahagikan sama banyak kepada tiga kumpulan dan setiap kumpulan dirawat dengan salah satu daripada tiga rawatan: - T1: CIDR selama 14 hari dan 200 IU *pregnant mare serum gonadotrophin* (PMSG) dan 0.5 ml prostaglandin (PG) sebelum pengeluaran CIDR; T2: CIDR selama 14 hari dan 0.5 ml PG sebelum pengeluaran CIDR; T3: CIDR selama 9 hari dan 200 IU PMSG dan 0.5 ml PG sebelum pengeluaran CIDR. Tanda-tanda oestrus dipantau bermula 24 jam selepas pengeluaran CIDR sehingga tanda pertama oestrus. Kedua-dua belah ovari diperiksa dengan mesin RTU selama 48 jam pada selang enam jam bermula pada 24 jam selepas pengeluaran CIDR. Sampel darah diambil di empat titik iaitu: - 24 jam selepas pengeluaran CIDR, pada masa tanda pertama galak, pada ovulasi pertama dan 72 jam selepas pengeluaran CIDR untuk penilaian profil hormon progesteron. Semua kambing menunjukkan (100%) tanda galak tetapi 25%, 12% dan 12% ini tidak berovulasi untuk T1, T2 dan T3 masing-masing. Tindak balas ovulasi seperti bilangan folikel sebelum ovulasi pertama, saiz folikel sebelum ovulasi pertama dan bilangan folikel terovulasi tidak menunjukkan perbezaan yang ketara ($p > 0.05$) di antara T1, T2 dan T3. Peratusan kambing dengan ovulasi tunggal dan berganda tidak menunjukkan perbezaan ketara antara tiga rawatan. Walau bagaimanapun, peratusan yang tinggi ovulasi berganda (83%, 86% dan 71%) dicatatkan bagi setiap T1, T2 dan T3 berbanding ovulasi tunggal. Bilangan folikel yang mengalami ovulasi pada ovari kanan dan kiri telah menunjukkan perbezaan

yang ketara ($p < 0.05$) pada T3 (2.1 ± 1.0, 0.6 ± 0.5). Masa ovulasi telah direkodkan di antara 44.0 ± 2,85 - 47,4 ± 2.78 jam ($p > 0.05$) antara tiga rawatan dikira daripada 24 jam selepas pengeluaran CIDR. Semua rawatan tidak menunjukkan perbezaan yang ketara ($p > 0.05$) bagi tempoh ovulasi dengan 18.0 ± 5.37, 21.0 ± 5.95, 19.2 ± 3.98 jam dikira dari 24 jam selepas pengeluaran CIDR untuk T1, T2 dan T3. Penilaian untuk profil hormon progesteron di empat titik masa tidak menunjukkan sebarang perbezaan yang ketara ($p > 0.05$) antara tiga rawatan. Dalam Eksperimen 2, 5 ml sampel darah 48 ekor kambing hamil diambil kira-kira dua minggu sebelum tarikh jangkaan kelahiran. Sampel darah dianalisis untuk penentuan profil hormon progesteron. Selepas kelahiran, bilangan anak bagi setiap kambing telah direkodkan sama ada satu, kembar atau triplet. Kepekatan progesteron menunjukkan perbezaan yang ketara ($p > 0.05$) iaitu 17.75 ± 2.9 ng / ml untuk betina dengan anak tunggal dan 21.48 ± 2.8 ng / ml untuk betina dengan dua atau lebih anak. Kesimpulannya, dalam Eksperimen 1, hasil daripada tindak balas ovulasi tidak menunjukkan perbezaan yang signifikan antara Rawatan 1 (T1) yang memasukkan CIDR selama 14 hari dengan suntikan sebanyak 200 IU PMSG dan 0.5 ml PG sebelum pengeluaran CIDR; Rawatan 2 (T2), memasukkan CIDR selama 14 hari dengan suntikan sebanyak 0.5 ml PG sebelum pengeluaran CIDR dan; Rawatan 3 (T3), memasukkan CIDR selama 9 hari dengan suntikan sebanyak 200 IU PMSG dan 0.5 ml PG sebelum pengeluaran CIDR. Sementara itu, dalam Eksperimen 2, peningkatan bilangan anak tidak meningkatkan tahap progesteron dalam dua minggu sebelum kelahiran.

ACKNOWLEDGEMENTS

Firstly, I would like to thank my supervisor Associate Professor Dr. Halimatun Binti Yaakub and Professor Dr. Jothi Malar Panandam whose always helping and steered me in the right direction to finish this study. I also like to acknowledge the laboratory staffs of the Faculty of Agriculture at Universiti Putra Malaysia who always assist and guide me during laboratory analysis.

I would also like to thank the experts and staffs at Advanced Reproductive Biotechnology (ARB), Kluang, Johor who provided opportunities to run this research project. Without their passionate participation and input, this research could not have been finished successfully.

Finally, I must express my very profound gratitude to my parents Hassan Basri bin Mohd Kassim and Puziah binti Mohd Nawi, siblings and all friends for giving continuous support and encouragement throughout my study. Without them, it is impossible to finish this thesis. Thank you.

Abdul Mu'in Bin Hassan Basri.

I certify that a Thesis Examination Committee has met on 21 June 2016 to conduct the final examination of Abdul Mu'in bin Hassan Basri on his thesis entitled "Ovulation Responses on Three Oestrus Synchronisation Protocol and Association between Progesterone Concentration in Late Pregnancy and Litter Size of Boer Goats" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Dahlan bin Ismail, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Sabrina binti Sukardi, PhD
Associate Professor
Faculty of Medicine and Health Science
Universiti Putra Malaysia
(Internal Examiner)

Shanmugavelu a/l M. Sithambaram, PhD
Senior Lecturer
Malaysian Agriculture Research and Development Institute (MARDI)
Malaysia
(External Examiner)

NOR AINI AB. SHUKOR, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 3 November 2016

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Halimatun Yaakub, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Jothi Malar Panandam, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

BUJANG KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____ Date: _____

Name and Matric No.: Abdul Mu'in Bin Hassan Basri (GS32691)

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____
Name of
Chairman of
Supervisory
Committee: _____

Signature: _____
Name of
Supervisory
Committee: _____

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

AI	Artificial insemination
ANOVA	Analysis of variance
ART	Advance reproductive technologies
CIDR	Controlled internal drug release
D	Day
Ecg	Equine chorionic gonadotrophin
ELISA	Enzyme-linked immunosorbent assay
ET	Embryo transfer
FGA	Flurogestone acetate
FSH	Follicle stimulating hormone
GLM	General Linear Model
GnRH	Gonadotrophin-releasing hormone
i.m	Intra mascular
IU	International Unit
LH	Luteinizing hormone
LH-RH	Luteinizing hormone-releasing hormone
MAP	Methyl acetate progesterone
NS	Non significant
OS	Oestrus synchronisation
Pg	Picogram
PG/ $PGF_{2\alpha}$	Prostaglandin
PMSG	Pregnant mare serum gonadotrophin
RIA	Radioimmunoassay
Rpm	Round per minute
RTU	Real-time ultrasonograpy
SE	Standard error
TMB	Tetramethylbenzidine

CHAPTER 1

INTRODUCTION

Goat population in Malaysia has increased from 429,398 in 2014 to 439,667 in 2015 (DVS, 2016). As an alternative to beef as a source of red meat, the increase in goat production is very important to meet the market requirement in the future. The self-sufficiency level for mutton and chevon was estimated to be about 13% in 2014, and for beef, it was about 25%. The increase in goat population in Malaysia is mainly due to the establishment of many local breeding farms. These breeding farms usually import purebred goats and serve as multiplier farms, adopting various breeding strategies and advance reproductive technologies (ART) such as oestrus synchronisation (OS) and artificial insemination (AI).

1.1 Research problem

The government of Malaysia through DVS and Malaysian Agriculture Research and Development Institute (MARDI) has imported many breeding animals of good genetics as well as semen in the effort to improve goat population in Malaysia (Wan Zahari *et al.*, 2008). However, livestock farmers, especially owners of breeding farms, and goat industry workers should have knowledge on reproduction parameters to gain worthy outcomes from the imported breeders and semen. Assessment of reproduction parameters either in male or female goats will help to monitor performance and fertility of goats as well as boost goat production. Reproduction parameters in female goats include the length of oestrous cycle, time of oestrus onset, ovulation time, ovulation rate, conception and pregnancy rates, litter size and reproductive hormonal profiles. Farmers who possess good understanding and skills to assess these reproductive parameters will be able to conduct a good breeding program and save the cost, by successfully identifying good breeding animals and using various reproduction technologies and tools efficiently and effectively. Most of breeding farms in Malaysia used long duration of oestrus synchronisation protocols, and short duration was introduced recently to shorten the cycle. Both treatment were gave good result in term of oestrus response (Abdul Muin *et al.*, 2013). However, there still few works were conducted to assess ovulation response after synchronization in Malaysia to determine the most suitable OS protocol and help to facilitate AI.

In addition to the above, reproductive hormonal profiles can help to determine the number of fetus and to overcome the problem of fetus abortion during late pregnancy that was unofficially reported in some breeding farms. Thus, this study was conducted to determine the effect of oestrus synchronisation on ovulation responses, and to evaluate the association between progesterone concentrations and litter size at late pregnancy in Boer goats.

1.2 Justification

The outcome of this study will provide better information on oestrous cycle in Boer goats under Malaysian conditions. In addition, the information will provide the most suitable and efficient oestrus synchronisation protocol for reproductive logistics. This will facilitate goat breeding via natural or artificial insemination and reduce kidding interval. Farm management could also estimate suitable time to conduct artificial insemination to save the cost of breeding program and to get efficient result. Furthermore, the assessment of goat reproductive hormonal profile will be used as a mean to estimate the number of kid born and help to determine the problem of fetus abortion at late pregnancy.

1.3 Research hypothesis

1. The oestrus synchronisation protocol with a shorter duration of CIDR treatment together with PMSG and PG treatment will give similar or even better response of ovulation as compared to oestrus synchronisation protocol with a long duration of CIDR treatment. Similar or better response would is also expected with shorter duration of the combined hormone treatment compared to longer CIDR treatment with PG (without PMSG).

2. A high number of litter sizes will result in high progesterone (P4) concentrations two week prior to kidding.

1.4 Objectives

The general objective of this study was to determine the ovulation responses to different oestrus synchronisation protocols and the association between progesterone (P4) concentrations during late pregnancy and litter size in Boer goat in Malaysia.

The specific objectives were:

1. To evaluate the number of follicles ovulated from three oestrus synchronisation protocols using Controlled Internal Drugs Release (CIDR)

2. To determine the time and duration of ovulation.

3. To determine the P4 and oestrogen (E2) concentrations during oestrus.

4. To investigate the association of P4 concentration at late pregnancy and litter size.

REFERENCES

Abdul Muin, H.B., Hasbudie, H.B., Suraya, M.S., Panandam, J.M., Yaakub, H., Theivanai, J. and Quaza Nizamuddin, H.N. 2013. Effect of two CIDR-based oestrus synchronisation protocols on oestrus response in Boer goats. *Malaysian Journal of Animal Science*, 16(2): 29-35.

Abecia, J.A., Forcada, F. and González-Bulnes, A. 2011. Pharmaceutical control of reproduction in sheep and goats. *Journal of Veterinary Clinical North America Food Animal*, 27: 67–79.

Al-Azraqi, A.A. 2007. Effect of fasting on luteal function, leptin and steroids concentration during oestrous cycle of the goat in natural photo-status. *Animal Reproduction Science*, 98:343–349.

Al-Sobaiyl, K.A. 2010. Effect of breeding season and pregnancy status on serum progesterone, sodium, potassium, copper and iron of estrous synchronisation Aradi goat does. *Saudi Journal of Biological Sciences*, 17: 259–263

Alvarez, L., Arvizu, R.R., Luna, J.A. and Zarco, L.A. 2010. Social ranking and plasma progesterone levels in goats. *Small Ruminant Research,* 90: 161–164.

Arashiro, E.K.N., Viana, J.H.M., Fonseca, J.F., Camargo, L.S.A., Fernandes, C.A.C., and Brandão, F.Z. 2010. Luteal dynamics in goats: morphological and endocrine features. *Revista Brasileira de Zootecnia*, 39 (9): 1937-1942.

Azizah, A., 2013. Follicular wave development, oestrus interval and ovulation rate in timed-artificial inseminated Kedah-Kelantan, Brakmas, Charoke and crossbred cows. Phd thesis. Universiti Putra Malaysia.

Baldassarre H. and Karatzas C.N., 2004. Advanced assisted reproduction technologies (ART) in goats. *Animal Reproduction Science*, 82-83: 255-266.

Błaszczyk, B., Udała, J., and Gaczarzewicz, D. 2004. Changes in estradiol, progesterone, melatonin, prolactin and thyroxine concentrations in blood plasma of goats following induced oestrus in and outside the natural breeding season. *Small Ruminant Research*, 51: 209–219

Boscos, C.M., Samartzi, F.C., Lymberopoulos, A.G., Stefanakis A., and Belibasaki S. 2003. Assessment of progesterone concentration using enzyme immunoassay, for early pregnancy diagnosis in sheep and goats. *Reproduction in Domestic Animals*, 38: 170–174.

Bukar, M.M., Ariff, O.M., Rosnina, Y., Wahid, H., Dhaliwal, G.K., Naing S.W., and Khan, M.A. 2011. The effect of $PGF_{2\alpha}$ and CIDR on ovarian antral follicular development and plasma IGF-1 concentration in goats. *Journal of Animal and Veterinary Advances*, 10 (22): 3013-3020.

Bukar, M.M., Ariff, O.M., Rosnina, Y., Wahid, H., Dhaliwal, G.K., Naing S.W., and Khan, M.A. 2012b. Comparison of the patterns of antral follicular

development between hormonally synchronized and natural estrous cycles of non-seasonal, polyestrous goats in the tropics. *Reproductive Biology*, 12: 325 – 328.

Bukar, M.M., Rosnina, Y., Ariff, O.M., Wahid, H., Khan, G. K.M A., Yimer N., and Dhaliwal, G.K. 2012a. Corpora lutea diameter, plasma progesterone concentration and follicular development in PGF2 αand CIDR oestrus synchronised goats. *Pakistan Veterinary Journal*, 32(2): 216-220.

Capezzuto, A., Chelini, M.O.M., Felippe, E.C.G., and Oliveira, C.A. 2008. Correlation between serum and fecal concentrations of reproductive steroids throughout gestation in goats. *Animal Reproduction Science*, 103: 78–86.

Chemineau, P., 1987. Possibilities for using bucks to stimulate ovarian and oestrus cycles in anovulatory goats a review. *Livestock Production Science*, 17: 135147.

Chentouf, M., Bister, J.L., and Boulanouar, B. 2011. Reproduction characteristics of North Moroccan indigenous goats. *Small Ruminant Research*, 98: 185–188

Cox, J. F., Allende, R., Lara, E., Leiva, A., Diaz, T., Dorado, J., and Saravia, F. 2012. Follicular dynamics, interval to ovulation and fertility after AI in short-term progesterone and PGF2α oestrous synchronisation protocol in sheep. Reproduction Domestic Animal 47: 946–951.

Department of Veterinary Services, 2016. Livestock Population, http:// http://www.dvs.gov.my/index.php/pages/view/1498. Retrieved 21 August 2016.

Eveline, S.Z., Polegato, B.F., and Duarte, J.M.B. 2010. Comparison of two methods of synchronisation of oestrus in brown brocket deer (*Mazama gouazoubira*). *Animal Reproduction Science* 117: 266–274.

Fatet, A., Rubio, M.T.P., and Leboeuf, B. 2011. Reproductive cycle of goats. *Animal Reproduction Science*, 124: 211–219.

Filho, F.T.F., Santosa, M.H.B., Carrazzonia, P.G., Paula-Lopes, F.F., Neves, J.P., Bartolomeu, C.C. Lima, P.F., and Oliveira, M.A.L. 2007. Follicular dynamics in Anglo-Nubian goats using transrectal and transvaginal ultrasound. *Small Ruminant Research*, 72 (1): 51–56.

Fradson, R.D., Lee Wilke, W., and Anna Dee Fails. 2003. *Anatomy and physiology of farm animals*. Sixth edition. pp 395-404.

Freitas, V.J.F, Baril, G., and Saumande, J., 1997. Oestrus synchronisation in dairy goats: use of fluorogestone acetate vaginal sponges or norgestomet ear implants. *Animal Reproduction Science*, 46: 237-244.

Gaafar, K.M., Gabr, M.K., and Teleb, D.F. 2005. The hormonal profile during estrous cycle and gestation in Damascus goats. *Small Ruminant Research*, 57: 85-93.

Gillespie J.R., 2004. *Modern livestock and poultry production*. 7th Edition, pp 210-223.

Ginther, O.J. and Kot, K. 1994. Follicular dynamics during the ovulatory season in goats. *Theriogenology*, 42: 987-l001.

Goel, A.K., and Agrawal, K.P., 2003. Ovulation in Jakhrana goats native to tropical climates. *Small Ruminant Research*, 50: 209-212.

Gonzalez-Bulnes, A., Carrizosa, J.A., Urrutia, B. and Lopez-Sebastian, A. 2006.Oestrous behaviour and development of preovulatory follicles in goats induced to ovulate using the male effect with and without progesterone priming. *Reproduction, Fertility and Development*, 18: 745–750.

Greyling, J.P.C., and Van Niekerk, C.H., 1990. Ovulation in Boer goat doe. *Small Ruminant Research*, 3: 457-464.

Greyling, J.P.C. 2000. Reproduction traits in the Boer goat doe. *Small Ruminant Research*, 36, 171-177.

Hafez E.S.E., and Hafez B., 2000. Reproductive Cycle. In: *Reproduction in Farm Animal Science*. Seventh edition. pp 55-67.

Hashemi, M., Safdarian, M., and Kafi, M. 2006. Estrous response to synchronisation of oestrus using different progesterone treatments outside the natural breeding season on ewes. *Small Ruminant Research*, 65: 279-283.

Holtz W., 2005. Recent development in assisted reproduction in goats. *Small Ruminant Research*, 60: 95-110.

Holtz, W., Sohnrey, B., Gerland, M., and Driancourt, M.A. 2008. Ovysynch synchronization and fixed-time insemination in goats. *Theriogenology*, 69: 785-792.

Jack, A.M.M., Chang, C.C., Peh, H.C., and Chan, J.P.W. 2012. Fecal progesterone analysis for monitoring reproductive status in dairy goats. *Turkish Journal of Veterinary and Animal Science*, 36(5): 566-572.

Jarrell, V.L. and Dziuk, P.J., 1991. Effect of number of corpora lutea and fetuses on concentrations of progesterone in blood of goats. *Journal of Animal Science*, 69 : 770-773.

Kajaysri, J. and Thammakarn, C., 2012. Oestrus Synchronisation Using Intravaginal Medroxyprogesterone Acetate (MAP), MAP Plus Prostaglandin F 2 α , Controlled Internal Drug Release (CIDR) or CIDR Plus Prostaglandin F 2 α

in Saanen Dairy Goats in Thailand. *Kasetsart Journal (Natural Science),* 46: 71–79.

Karen, A., Kovács, P., Beckers, J.F., and Szenci, O. 2001. Review article pregnancy diagnosis in sheep: review of the most practical methods. *Acta Veterinaria Brno,* 70: 115–126.

Khanthusaeng, V., Navanukraw, C., Moonmanee T., Thammasiri J., and Boonkong S. 2012. Effect of short-term and long-term synthetic progesterone on estrous synchronisation and conception rate in Thai-native goat. *CMU.J.Nat.Sci.Special Issue on Agricultural & Natural Resources,* 11 (1): 449-454.

Khanum, S.A., Hussain, M., and Kausar, R. 2007. Assessment of reproductive parameters in female Dwarf goat (*Capra hircus*) on the basis of progesterone profiles. *Journal of Animal Science,* 102: 267-275.

Kumar, R., Phogat, J.B., Mann, J.S., Singh, U., and Sharma, A.K., 2011. Oestrus induction and fertility response in anoestrus mares with exogenous progesterone releasing device (CIDR-B) during late breeding season. *Biology and Medicine,* 3 (2). Special Issue: 359-364.

Lehloenya, K.C., Greyling, J.P.C. and Schwalbach, L.M.J., 2005. Reproductive performance of South African indigenous goats following oestrous synchronisation and AI. *Small Ruminant Research,* 57(2-3): 115–120.

Lopez-Sebastian, A., Gonzalez-Bulnes, A., Carrizosa, J.A., Urrutia, B., Diaz-Delfa, C., Santiago-Moreno, J., and Gomez-Brunet, A., 2007. New oestrus synchronisation and artificial insemination protocol for goats based on male ezposure, progesterone and cloprostenol during the non-breeding season. *Theriogenology,* 68: 1081-1087.

Manalu, W., and Sumaryadi, M.Y. 1998. Maternal serum progesterone concentration during gestation and mammary gland growth and development at parturition in Javanese thin-tail ewes carrying a single or multiple fetuses. *Small Ruminant Research,* 27: 131-136.

Manalu, W., Sumaryadi, M.Y., and Kusumorini, N. 1996. Effect of fetal number on the concentrations of circulating maternal serum progesterone and estradiol of does during late pregnancy. *Small Ruminant Research,* 23: 117-124.

Martemucci G., and D'Alessandro A.G., 2011. Induction/ synchronisation of oestrus and ovulation in dairy goats with different short term treatments and fixed time intrauterine or exocervical insemination system. *Animal Reproduction Science,* 126: 187-194.

Martínez, M.F., Kastelic, J.P., Colazo, M.G., and Mapletoft, R.J. 2007. Effects of estradiol on gonadotrophin release, oestrus and ovulation in CIDR-treated beef cattle. *Domestic Animal Endocrinology,* 33 (1): 77–90.

Martínez-Álvarez, L.E., Hern´andez-Cer´on, J., Gonz´alez-Padilla, E., Perera-Mar´ın, G., and Valencia, J. 2007. Serum LH peak and ovulation following synchronised oestrus in goats. *Small Ruminant Research*, 69 (1-3):124–128.

McCorkell, R.B., Woodbury, M R., and Adam, G.P. 2007. Evaluation of an ovarian synchronisation scheme for fixed-time artificial insemination in wapity. *Theriogenology*, 67: 1217-1223.

Menchaca, A., Miller V, Salveraglio V, and Rubianes E. 2007. Endocrine, luteal and follicular responses after the use of the Short-Term Protocol to synchronise ovulation in goats. *Animal Reproduction Science*, 102: 76 – 87

Menchaca, A. and Rubianes, E., 2004. New treatments associated with timed artificial insemination in small ruminants. *Reproduction, Fertility, And Development*, 16 (4): 403–13.

Moakhar, H.K., Kohram, H., Shahneh, A.Z., and Saberifar, T. 2012. Ovarian response and pregnancy rate following different doses of eCG treatment in Chall ewes. *Small Ruminant Research*, 102: 63–67.

Moakhar, H.K., Kohram, H., Salehi, R. and Shahneh, A.Z. 2010. Follicular and ovulatory responses of the right versus left ovaries to eCG treatment in Shall Iranian ewes. *African Journal of Biotechnology*, 9 (10): 1523-1527.

Mori, Y. and Kano, Y., 1982. Plasma concentrations of LH, progesterone and oestradiol in relation to the occurrence of luteolysis, oestrus and time of ovulation in the Shiba goat changes (*Capra hircus*). *Journal of Reproduction and Fertility*, 72 (1): 223-230.

Motlomelo, K., Greyling, J.P., and Schwalbach, L.M.., 2002. Synchronisation of oestrus in goats: the use of different progestogen treatments. *Small Ruminant Research*, 45 (1): 45–49.

Nascimento, P.M.P., Brandão, F.Z., Pereira, P.F.V., Oliveria, A.P., Viana, J.H.M., and Fonseca, J.F. 2009. Preovulatory follicle dynamics in Toggenburg goats after treatment with intravaginal implants of progesterone for 6, 9 or 12 days. *Animal Reproduction*, 6 (1): 226 226.

Oliveira, M.A.L., Guido, S.I., and Lima, P.F. 2001. Comparison of different protocols used to induce and synchronise oestrus cycle of Saanen goats. *Small Ruminant Research*, 40: 149-153.

Omontese, B.O., Rekwot, P.I., Ate, I.U., Rwuaan, J.S., and Makun, H.J. 2013. Comparative oestrus induction in indigenous Sahel goats using two progestogens (CIDR and FGA) and eCG. *Livestock Research for Rural Development*, 25 (4): 25066

Orita, J., Tanaka, T., Kamomae H., and Kaneda Y. 2000. Ultrasonographic Observation of Follicular and Luteal Dynamics during the Estrous Cycle in Shiba Goats. *Journal of Reproduction and Development*, 46 (1): 31–37.

Papachristoforou, C., Koumas, and Photiou, C., 2000. Seasonal effects on puberty and reproductive characteristics of female Chios sheep and Damascus goats born in autumn or in February. *Small Ruminant Research : The Journal Of The International Goat Association*, 38(1): 9–15.

Patterson D.J., Kojima F.N., and Smith F. M., 2003. A review of methods to synchronise oestrus in replacement beef heifers and postpartum cows. *Journal Animal Science*, 81 (E. Suppl. 2): E166-E177.

Pietroski, A.C.C.A., Brandão, F.Z., Souza, J.M.G., and Fonseca, J.F. 2013. Short, medium or long-term hormonal treatments for induction of synchronised oestrus and ovulation in Saanen goats during the nonbreeding season. *Revista Brasileira de Zootecnia-Brazilian*, 42(3): 168-173.

Rahman A.N.M.A., Abdullah R.B., and Wan Khadijah W.E., 2008. Oestrus synchronisation and superovulation in goats: A review. *Journal of Biological Science*, 8 (7): 1129-1137.

Ramukhithi, F.V., Nedambale, T.L., Sutherland, B., Greyling, J.P.C. and Lehloenya K.C. 2012. Oestrous synchronisation and pregnancy rate following artificial insemination (AI) in South African indigenous goats. *Journal of Applied Animal Research*, 40 (4): 292296.

Ranilla, M.J., Sulon, J., Mantechon, A.R., Beckers, J.F., and Carro, M.D. 1997. Plasma pregnancy-associated glycoprotein and progesterone concentrations in pregnant Assaf ewes carrying single and twin lambs. *Small Ruminant Research*, 24: 125-131

Rao, V.H. and Bhattacharyya, N.K., 1980. Ovulation in Black Bengal nanny goats. *Journal of Reproduction and Fertility*, 58: 67-69.

Rawlings, N.C., Jeffcoate, I.A., Savage, N. C., Steuart, D.M.K., and Steuart, L.H.M. 1983. Pregnancy diagnosis and assessment of fetal numbers in the ewe in a commercial setting. *Theriogenology*, 19 (5): 655-663.

Restall, B.J., Restall, H., and Walken-Brown, S.W. 1995. The induction of ovulation in anovulatory goats by oestrous females. *Animal Reproduction Science*, 40: 299-303.

Ritar, A.J., Salamon, S., Ball, P.D., and O'May, P.D. 1989. Ovulation and fertility in foats after intravaginal device-PMSG treatment. *Small Ruminant Research*, 2: 323-331.

Romano, J.E., 2004. Synchronisation of oestrus using CIDR, FGA or MAP intravaginal pessaries during the breeding season in Nubian goats. *Small Ruminant Research*, 55(1-3): 15–19.

Scaramuzzi, R.J., and Downing, J.A. 1997. The distribution of ovulations from the ovaries of Merino and Border Leicester × Merino ewes and its effect on the survival of their embryos. *Animal Reproduction Science,* 47: 32736.

Schrick, F.N., Surface R.A., Pritchard, J.Y., Dailey, R.A., Townsend, E.C., and Inskeep, E.K. 1993. Ovarian Structures during the Estrous Cycle and Early Pregnancy in Ewes. *Biology of Reproduction,* 49: 1133–1140.

Simões, J., Baril, G., Almeida, J.C., Azevedo, J., Fontes, P., and Mascarenhas, R. 2008. Time of ovulation in nulliparous and multiparous goats. *Animal : An International Journal of Animal Bioscience*, 2 (5): 761–8.

Sousa, N.M., Garbayo, J.M., Figueiredo, J.R., Sulon, J., Goncalves, P.B.D., and Beckers, J.F. 1999. Pregnancy-associated glycoprotein and progesterone profiles during pregnancy and postpartum in native goats from the north-east of Brazil. *Small Ruminant Research,* 32: 137-147.

Taft Rob, Nasim Ahmad, and Inskeep, E. K., 1996. Exogenous pulses of luteinizing hormone cause persistence of the largest bovine ovarian follicle. *Journal of Animal Science*, 74: 2985-2991.

Tanaka, T., Fujiwara, K. I., Kim, S., Kamomae, H., and Kaneda, Y. 2004. Ovarian and hormonal responses to a progesterone-releasing controlled internal drug releasing treatment in dietary-restricted goats. Animal Reproduction Science, 84: 135–146.

Tanaka, T., Yamaguchi, T., Kamomae, H., and Kaneda, Y., 2003. Nutritionally induced body weight loss and ovarian quiescence in Shiba goats. *Journal of Reproduction and Development*, 49: 113–119.

Thammasiri, T., Navanukraw, C., Jaikan, W., Moonmanee, T., Khanthusaeng, V., Boonkong, S., and Uopasai, S. 2012. Corpora lutea growth and development in Thai-native goats throughout the estrous cycle. *CMU Journal of Natural Science, Special Issue on Agricultural & Natural Resources*, 11 (1): 455-459.

Vilariño, M., Rubianes, E., and Menchaca, A. 2011. Re-use of intravaginal progesterone devices associated with the Short-term Protocol for timed artificial insemination in goats. *Theriogenology,* 75: 1195–1200.

Vilariño, M., Rubianes, E., and Menchaca, A. 2013. Ovarian responses and pregnancy rate with previously used intravaginal progesterone releasing devices for fixed-time artificial insemination in sheep. *Theriogenology,* 79: 206–210.

Vilariño, M., Rubianes, E., van Lier E., and Menchaca, A. 2010. Serum progesterone concentrations, follicular development and time of ovulation using a new progesterone releasing device (DICO®) in sheep. *Small Ruminant Research,* 91(2-3): 219–224.

Wan Zahari Mohamed, Mohd. Najib Mohd. Amin and Azizi Ahmad Azman. Penternakan Boer Untuk Usahawan. Malaysian Agriculture Research and Development Institute, 2008.

Wheaton J.E., Kristin M. Carlson, Harvey F. Windels, Lee J. and Johnston, 1993. CIDR: A new progesterone-releasing intravaginal device for induction of oestrus and cycle control in sheep and goats. *Animal Reproduction Science*, 33: 121-142.

Whitley, N.C. and Jackson, D.J., 2004. An update on oestrus synchronisation in goats: A minor species. *Journal of Animal Science*, 82: 270-276.

Wildeus, S., 2000. Current concepts in synchronisation of oestrus : Sheep and goats. *Journal of Animal Science*, 77: 1–14.

Yotov, S., 2007. Determination of the number of fetuses in sheep by means of blood progesterone assay and ultrasonography. *Bulg. Journal of Veterinary Medicine*, 10 (3): 185 −193.

BIODATA OF STUDENT

Abdul Mu'in Bin Hassan Basri was born in Kuala Lipis, Pahang on 20 July 1988. As the third child in a family of six siblings, he starts his schooling at Sekolah Kebangsaan Benta, Pahang and continued his secondary school at Sekolah Menengah Sains Tengku Abdullah, Raub, Pahang.

His tertiary education began when he pursued his study in Pulau Pinang Matriculation before continued for his first degree in the Faculty of Agriculture, Universiti Putra Malaysia (UPM) in 2007. Consequently, he was conferred the Bachelor of Agriculture (Animal Science) in 2011. Then, on 14th February 2012, he enrolled in the Master of Science (MSc) in Animal Production in the Faculty of Agriculture, UPM.

His first manuscript entitled ". Effect of two CIDR-based oestrus synchronisation protocols on oestrus response in Boer goats" has been published in Malaysian Journal of Animal Science (MJAS) Vol 16 (2), 2013. He also presented the posters entitled "Effect of different oestrus synchronisation protocols in Boer goats (*Capra hircus*)" in The 33rd Malaysian Society Of Animal Producrion Annual Conference 2012 held in Langkawi, Kedah and "Ovulation response to different oestrus synchronisation protocols on Boer goats" in The 34th Malaysian Society of Animal Producrion Annual Conference held from 3rd to 5th June 2013, Kuantan, Pahang.

LIST OF PUBLICATIONS

Abdul Muin, H.B., Hasbudie, H.B., Suraya, M. S., Panandam, J. M., Yaakub, H., Theivanai, J., Quaza Nizamuddin, H. N. 2013. Effect of two CIDR-based oestrus synchronisation protocols on oestrus response in Boer goats. Mal. J. Anim. Sci. 16(2):29-35.

Abdul Mu'in, **H. B.,** Hasbudie, B., Theivanai, J., Ismawandi, M. N., Quaza Nizamuddin, H. N., and Yaakub, H. 2012. Effect of different oestrus synchronisation protocols in Boer goats (*Capra hircus*). The 33rd Malaysian Society of Animal Production Annual Conference, Langkawi, Kedah. 4-7 June 2012.

Abdul Mu'in, **H. B.,** Yaakub , H., Johari, J. A. and Panandam, J. M. 2013. Ovulation response to different oestrus synchronisation protocols on Boer goats. The 34th Malaysian Society of Animal Production Annual Conference, Kuantan, Pahang. 3-5 June 2013.

Hasbudie, B., **Abdul Mu'in**, **H.B.,** Yaakub, H., Theivanai, J., Ismawandi, M.N. and Quaza Nizamuddin, H.N. 2011. Artificial insemination at fixed time in Boer goats. The 32th Malaysian Society of Animal Production Annual Conference, Sabah.

UNIVERSITI PUTRA MALAYSIA

STATUS CONFIRMATION FOR THESIS / PROJECT REPORT AND COPYRIGHT

ACADEMIC SESSION : _____

TITLE OF THESIS / PROJECT REPORT :

OVULATION RESPONSES ON THREE OESTRUS SYNCHRONISATION PROTOCOLS AND ASSOCIATION BETWEEN PROGESTERONE CONCENTRATION IN LATE PREGNANCY AND LITTER SIZE OF BOER GOATS

NAME OF STUDENT: ABDUL MU'IN BIN HASSAN BASRI

I acknowledge that the copyright and other intellectual property in the thesis/project report belonged to Universiti Putra Malaysia and I agree to allow this thesis/project report to be placed at the library under the following terms:

1. This thesis/project report is the property of Universiti Putra Malaysia.
2. The library of Universiti Putra Malaysia has the right to make copies for educational purposes only.
3. The library of Universiti Putra Malaysia is allowed to make copies of this thesis for academic exchange.

I declare that this thesis is classified as :

*Please tick (√)

☐	**CONFIDENTIAL**	(Contain confidential information under Official Secret Act 1972).
☐	**RESTRICTED**	(Contains restricted information as specified by the organization/institution where research was done).
☐	**OPEN ACCESS**	I agree that my thesis/project report to be published as hard copy or online open access.

This thesis is submitted for :

☐ **PATENT** Embargo from _____ (date) until _____ (date)

Approved by:

_____
(Signature of Student)
New IC No/ Passport No.:

Date :

_____
(Signature of Chairman of Supervisory Committee)
Name:

Date :

[Note : If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization/institution with period and reasons for confidentially or restricted.]