



CENTRAL LUZON STATE UNIVERSITY



**POST-MORTEM GOAT TESTICLE COOLED HANDLING CONDITION AND
ITS INFLUENCE ON THE QUALITY OF EPIDIDYMAL SPERM**

JOHN EVANDER VALDEZ FRANCISCO

An Undergraduate Thesis Submitted to the Faculty of the Department of
Biological Sciences, College of Arts and Sciences, Central Luzon
State University, Science City of Munoz, Nueva Ecija,
Philippines in Partial Fulfillment of the
Requirements for the Degree

BACHELOR OF SCIENCE IN BIOLOGY

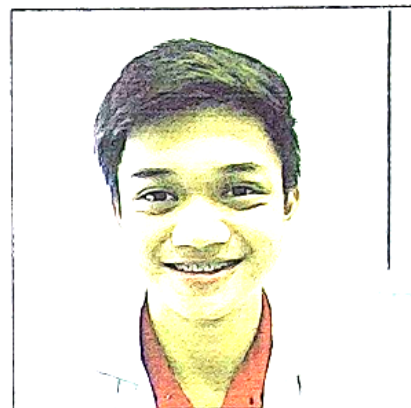
JUNE 2017



BIOGRAPHICAL SKETCH

PERSONAL INFORMATION

Name : JOHN EVANDER FRANCISCO
Date of Birth : January 4, 1997
Place of Birth : Cabanatuan City, Nueva Ecija
Address : Vega Grande, Bongabon, Nueva Ecija
Religion : Roman Catholic
Civil Status : Single
Parents : Mr. Rommel Francisco
 : Mrs. Shirley Valdez – Francisco
Sibling : Allyssa Marie V. Francisco



EDUCATIONAL BACKGROUND

TERTIARY : Central Luzon State University
(A.Y. 2013-2017) Science City of Muñoz, Nueva Ecija
Bachelor of Science in Biology

SECONDARY : Bongabon National High School, *Valedictorian*
(A.Y. 2009-2013) Bongabon, Nueva Ecija

ELEMENTARY : Saint Francis of Assisi Diocesan School, *Salutatorian*
(A.Y. 2003-2009) Bongabon Nueva Ecija

ON THE JOB TRAINING

Philippine Carabao Center National Headquarter and Gene Pool,
Maharlika Hi-way, Science City of Muñoz, 3119 Nueva Ecija, Philippines
June -July 2016

SEMINARS ATTENDED

Animal Genetic Resources in Japan and an International Collaboration
(A SATREPS PROJECT)
Philippine Carabao Center National Headquarters and Gene Pool,
Science City of Munoz, Nueva Ecija
February 15, 2017



Philippine Carabao Center In-house Review 2016
Philippine Carabao Center National Headquarters and Gene Pool,
Science City of Munoz, Nueva Ecija
June 2016

Symposium on Philippine Biodiversity and the National Museum
University Auditorium, CLSU, Science City of Muñoz, Nueva Ecija
March 22, 2016

Symposium on HIV: AIDS “Survival of the fittest. The Human Culture Media”
University Auditorium, CLSU, Science City of Muñoz, Nueva Ecija
November 21, 2015

Symposium on Current Trends in Food Safety and quality Assurance
University Gymnatorium, CLSU, Science City of Munoz, Nueva Ecija
August 30, 2014

Symposium on Rice Technology
University Auditorium, CLSU, Science City of Munoz, Nueva Ecija
September 7, 2013



ACKNOWLEDGEMENT

The author would like to thank all who in one way or another contributed to the completion of this undergraduate thesis. This could not have been completed without the great support that the author has received. The author wishes to offer his most heartfelt thanks to the following people:

First and foremost, to the Almighty God for giving the author the ability, knowledge, and strength to undertake this study and to persevere and complete this satisfactorily. Without His blessings, this achievement would not have been possible.

To the author's adviser, Dr. Cynthia C. Divina of Department of Biological Sciences, for her consideration, warm encouragement, kindness and for sharing her insights and knowledge for the improvement of the study. It is a great privilege for the author to work under her guidance.

To the author's co-adviser, Dr. Lerma C. Ocampo of Philippine Carabao Center, for her guidance and provisions as well as for sharing her expertise and ideas in the field of research during and after the conduct of the study. The author would like to extend his gratitude for providing him with the opportunities to work in the PCC laboratory and to do research as part of a project.

To the author's other members of the panel, Mr. Cornelio Francis M. Cruz, M.Sc. and Mr. Rich Milton R. Dulay, M.Sc., for their valuable critics and suggestions for the improvement of the study.

To Ms. Khristina Judan – Cruz, M.Sc. for her words of encouragement, parent-like support and for sharing positive outlook during the author's tough times on the



conduct of the study. Her pieces of advice would never be forgotten and were deeply appreciated.

To Ms. Angelica Bumanlag and Ms. Maureen Gajeton for their assistance and patience throughout the conduct of the study in the laboratory. The author's apology for the mistakes and headaches that he brought.

To the author's exceptional friends, Alexandra Agpaoa, Anna Boleyn Evangelista, Jean Lianne Felimon, Hannah Lei Harada, Angelli Llorando, Carlo Miguel, Paulyn Crystal Robina, Maorin Mari Santos, Alfred Sayson, Cristy Singh, Julius Tomas, Ruth Yambot and in the Department of Biological Sciences, whom he have shared the adventures, joys, and struggles of being a biology student; for the support, uplifting vibes and for pushing on the author to still continue whatever happens and problems to come; and for the unforgettable experiences throughout biology student life.

Lastly, to the author's family for the inspiration and motivation to succeed in his chosen track. To his parents, Rommel and Shirley Francisco, and his sibling, Allyssa Marie Francisco, the author would like to extend his gratitude for their unfathomable and unflinching support throughout the author's college life and for the years to come.

JOHN EVANDER VALDEZ FRANCISCO



TABLE OF CONTENTS

| | PAGE |
|---|------|
| TITLE PAGE | i |
| APPROVAL SHEET | ii |
| BIOGRAPHICAL SKETCH | iii |
| ACKNOWLEDGEMENT | v |
| TABLE OF CONTENTS | vii |
| LIST OF TABLES | x |
| LIST OF FIGURES | xi |
| LIST OF APPENDICES | xii |
| LIST OF APPENDIX TABLES | xiii |
| LIST OF APPENDIX FIGURES | xiv |
| ABSTRACT | xvi |
| INTRODUCTION | 1 |
| Background of the Study | 1 |
| Objectives of the Study | 4 |
| Significance of the Study | 5 |
| Scope and Limitation of the Study | 5 |
| Time and Place of the Study | 6 |
| REVIEW OF RELATED LITERATURE | 7 |
| Goats | 7 |
| Age Estimation | 7 |
| Diet | 8 |
| Goat Production and Industry in the Philippines | 9 |
| The Epididymis and Epididymal Sperm | 10 |
| Maturation of Sperm | 11 |
| Semen Evaluation | 12 |



| | |
|--|----|
| Animal Genetic Resources (AnGRs) | 12 |
| Conservation Programs | 13 |
| Cryopreservation | 15 |
| Cryoprotectant | 15 |
| Penetrating Cryoprotectant | 16 |
| Non-penetrating Cryoprotectant | 17 |
| Cryopreservation of Sperm | 21 |
| Post-mortem Collection | 22 |
| Storage Condition | 23 |
| MATERIALS AND METHODS | 25 |
| Experimental Procedure | 25 |
| Testicle Collection and Transport | 26 |
| Epididymal Sperm Collection | 26 |
| Visual Evaluation of Epididymal Sperm | 26 |
| Microscopic Evaluation of the Epididymal Sperm | 27 |
| Sperm Motility (conventional method) | 27 |
| Sperm Concentration | 28 |
| Evaluation of Live Sperm | 29 |
| Sperm Morphology | 30 |
| Dilution of Epididymal Sperm | 30 |
| Sperm Cooling | 32 |
| Pre-freeze Evaluation of Sperm | 32 |
| Preparation of Semen Straw and Sealing | 32 |
| Cryopreservation | 33 |
| Vapor Freezing and Storage in Liquid Nitrogen Tanks | 33 |
| Thawing of Semen Straws | 33 |
| Post-thaw Evaluation of Sperm | 33 |
| Data Gathered | 34 |
| Statistical Analysis | 34 |
| RESULTS AND DISCUSSION | 35 |
| Age of the Goats and Testicular Parameters | 35 |
| Volume and Sperm Concentration of the Recovered Epididymal Sperm | 37 |
| Motility Assessment of Recovered Epididymal Sperm | 40 |
| Livability Assessment of Recovered Epididymal Sperm | 45 |
| Abnormality Assessment of Recovered Epididymal Sperm | 49 |
| SUMMARY, CONCLUSION AND RECOMMENDATION | 53 |
| Summary | 53 |
| Conclusion | 53 |
| | 54 |



| | |
|--------------------------|----|
| Recommendation | 55 |
| LITERATURES CITED | 56 |
| APPENDICES | 74 |



LIST OF TABLES

| TABLE | | PAGE |
|-------|--|------|
| 1 | Scoring system for the motility of sperm cells (Mamuad et al., 2005) | 28 |
| 2 | Mean (\pm SE) age, testicular weight, and cauda epididymal weight of the goats per treatment | 35 |
| 3 | Mean (\pm SE) volume of the sperm and sperm concentration of the epididymal sperm recovered after 4 and 24 hours post-mortem | 38 |
| 4 | Mean percentage motility (\pm SE) of the epididymal sperm recovered after 4 and 24 hours post-mortem during the stages in cryopreservation | 41 |
| 5 | Mean percentage livability (\pm SE) of the epididymal sperm recovered after 4 and 24 hours post-mortem during the stages in cryopreservation | 46 |
| 6 | Mean percentage abnormality (\pm SE) of the epididymal sperm recovered after 4 and 24 hours post-mortem during the stages in cryopreservation | 50 |



LIST OF FIGURES

| FIGURE | | PAGE |
|--------|---|------|
| 1 | Flowchart of Methods | 25 |
| 2 | Abnormal morphology of spermatozoa (Barth and Oko, 1989) | 31 |
| 3 | Epididymal sperm stained with eosin-nigrosin in the study | 46 |
| 4 | Different sperm abnormalities observed in the study | 52 |



LIST OF APPENDICES

| APPENDIX | | PAGE |
|----------|--|------|
| A | Preparation of Tris-Citric Acid-Lactose-Raffinose-Egg Yolk (TCLREY) Extender | 75 |
| B | Statistical Analysis | 77 |
| C | Preparation of Eosin-Nigrosin Stain | 82 |
| D | Collection Sites | 83 |
| E | Animal Dentition for Age Estimation | 84 |
| F | Photo Documentation | 85 |
| G | Counting Area in Hemocytometer | 91 |



LIST OF APPENDIX TABLES

| APPENDIX TABLE | | PAGE |
|-------------------|--|------|
| 1 | Composition of Tris-Citric Acid-Lactose-Raffinose Buffer | 75 |
| 2 | Egg yolk concentration for the extender | 76 |
| 3 | Summary table of t-test results for significant difference between two time frames (4 hrs and 24 hrs) | 77 |
| 4 | Summary table of t-test results for significant difference between the fresh, pre-freeze and post-thaw quality of epididymal sperm of two time frames (4 hrs and 24 hrs) | 77 |
| 5 | T-test results for significant difference between testicular and epididymal sperm parameters of two time frames (4 hrs and 24 hrs) | 78 |
| 6 | T-test results for significant difference between the fresh, pre-freeze and post-thaw quality of epididymal sperm of two time frames (4 hrs and 24 hrs) | 79 |
| 7 | Results of Scheffe Post-hoc Analysis (p-value) for the comparison of parameter between fresh, pre-freeze and post-thaw quality of epididymal sperm within the two time frames (4 hrs and 24 hrs) | 81 |



LIST OF APPENDIX FIGURES

| APPENDIX FIGURE | | PAGE |
|--------------------|--|------|
| 1 | CJ's Kambingan Eatery, Bangad, Cabanatuan City | 83 |
| 2 | Angel's Kambingan Eatery, Bangad, Cabanatuan City | 83 |
| 3 | The oral dentition of goat for age estimation (Nolte, 2016) | 84 |
| 4 | Weighing of reagents for TCLREY buffer | 85 |
| 5 | Extraction of egg yolk | 85 |
| 6 | Collection of testicles from goat | 86 |
| 7 | Extraction of sperm from cauda epididymis | 86 |
| 8 | Centrifugation of the recovered epididymal sperm and determination of volume | 87 |
| 9 | Determination of sperm concentration using hemocytometer | 87 |
| 10 | Conventional motility assessment using phase contrast microscope | 87 |
| 11 | Staining of epididymal sperm for livability and abnormality assessment using eosin-nigrosin | 88 |
| 12 | Extended sperm cooling in refrigerator | 88 |
| 13 | Tooth comb, plastic bubbler dish, semen straw, and sealing powder | 88 |
| 14 | Loading of extended semen to semen straws and plunging to pre-cooled water | 89 |
| 15 | Vapor freezing of semen straws and plunging to liquid nitrogen | 89 |
| 16 | Thawing of frozen semen straw in water bath | 89 |
| 17 | Dilution of post-thawed epididymal sperm | 90 |



18

Area of hemocytometer for sperm counting

91



ABSTRACT

FRANCISCO, JOHN EVANDER VALDEZ, Bachelor of Science in Biology, Department of Biological Sciences, College of Arts and Sciences, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, June 2017. **POST-MORTEM GOAT TESTICLE COOLED HANDLING CONDITION AND ITS INFLUENCE ON THE QUALITY OF EPIDIDYMAL SPERM.**

Manuscript No.: BIO-M-2nd17-033

Adviser: Cynthia C. Divina, Ph.D.

Co-Adviser: Lerma C. Ocampo, Ph.D.

The general objective of this study was to evaluate and determine the influence of cooled temperature (17-22°C) storage of post-mortem goat testicle for the cryopreservation of epididymal sperm. Testicles with intact scrotal sac were collected immediately after the slaughter of matured local goats and stored in a styrofoam container with a pre-calibrated temperature of 17~22°C. Sperms were recovered from the incised epididymal tissue either after 4 hours (T1) and 24 hours (T2) post-mortem. The epididymal sperms were processed for cryopreservation using TCLR buffer solution supplemented with 20% (v/v) egg yolk and 7% (v/v) glycerol. Microscopic evaluations including determination of motility, livability, and morphology were done on the freshly recovered and processed epididymal sperm before (pre-freeze/extended sperm) and after cryopreservation (post-thaw sperm). In addition, sperm volume and concentration, as well as weights of testicles and cauda epididymal tissue, were determined.

The findings of the study revealed that there was a significant reduction in sperm concentration ($p < 0.05$) but not on sperm volume ($p > 0.05$) after 24 hours post-mortem. In



the freshly recovered epididymal sperm, the percentage motility was not significantly different ($p>0.05$) between treatments. However, there was a significant ($p<0.05$) decreased in the percentage livability and increased in the percentage abnormality overtime (after 24 hours). On the other hand, pre-freeze epididymal sperms between treatments showed no significant difference ($p>0.05$) in any parameter, except for motility ($p<0.05$). The cryopreserved epididymal sperm recovered after 4 hours obtained a mean post-thaw motility of 10.63%, livability of 40.38% and abnormality of 50.09%, whereas the pre-freeze quality of epididymal sperms recovered after 24 hours did not qualify for further freezing. No significant difference ($p>0.05$) was observed in the testicular parameters between treatments



LITERATURES CITED

- ABBA, Y. and I.O. IGBOKWE. (2015).** Testicular and related size evaluations in nigerian sahel goats with optimal cauda epididymal sperm reserve. *Veterinary Medicine International*, 2015: 1-5.
- ABBAS, A. and S.M.H. ANDRABI. (2002).** Effect of different glycerol concentrations on motility before and after freezing, recovery rate, longevity and plasma membrane integrity of Nili-Buffalo bull spermatozoa. *Pakistan Veterinary Journal*, 22: 1-4.
- ABEGAZ, S. and K. AWGICHEW. (2009).** Estimation of weight and age of sheep and goats. Retrieved on May 20, 2016 at <http://www.esgpip.org/pdf/Technical%20Bulletin%20No.23.pdf>
- ABOAGDALA, E.M.E. and T. TERADA. (2003).** Trehalose-enhanced fluidity of the goat sperm membrane and its protection during freezing. *Biology of Reproduction*, 69: 1245–1250.
- ABU, A.H., KISANI, A.I. and T. AHEMEN. (2016).** Evaluation of sperm recovered after slaughter from cauda epididymides of red Sokoto bucks. *Veterinary World*, 9 (12): 1440-1444.
- AGGA, G.E., UDALA, U., REGASSA, F. and A. WUDIE. (2011).** Body measurements of bucks of three goat breeds in Ethiopia and their correlation to breed, age and testicular measurements. *Small Ruminant Research*, 95 (2-3): 133-138.
- AISEN, E.G., MEDINA, V.H. and A. VENTURINO. (2002).** Cryopreservation and post- thawed fertility of ram semen frozen in different trehalose concentrations. *Theriogenology*, 57: 1801–1808.
- AKE-LOPEZ, J., CAVAZOS-ARIZPE, E., MAGANA-MONFORTE, J.G., CENTURION-CASTRO, F. and C. SILVA-MENA. (2010).** Effect of age and post-mortem time on some white-tailed deer (*Odocoileus virginianus texanus*) epididymal sperm characteristics and response of cryopreservation. *American Journal of Animal and Veterinary Sciences*, 5: 183-186.
- AKPA, G.N.M., AMBALI, A.L. and I.O SULEIMAN. (2013).** Body conformation, testicular and semen characteristics as influenced by age, hair type and body condition of red sokoto goat. *New York Science Journal*, 6(7): 44-58.



- ALVAREZ, J.G. and B.T. STOREY. (1993).** Evidence that membrane stress contributes more than lipid peroxydation to sublethal cryodamage in cryopreserved human sperm: glycerol and other polyols as sole cryoprotectant. *Journal of Andrology*, 14:199-209.
- AL-GHALBAN, A.M., TABBAA, M.A. and R.T. KRIDLI. (2004).** Factors affecting semen characteristics and scrotal circumference in Damascus bucks. *Small Ruminant Research*, 53 (1-2): 141-149.
- AMANN, R. P. and L. C. GRIEL, JR. (1974).** Fertility of bovine spermatozoa from rete testis, cauda epididymidis, and ejaculated semen. *Journal of Dairy Science* 57: 212-219.
- AMANN, R.P. and B.D. SCHANBACHER. (1983).** Physiology of male reproduction. *Journal of Animal Sciences*, 57: 380-403.
- AMANN, R.P. (1999).** Cryopreservation of sperm. *Encyclopedia of reproduction*. Academic Press, Burlington, MA.: 773-783.
- AMIRAT, L., TAINTURIER, D., JEANNEAU, L., THORIN, C., GÉRARD, O., COURTENS, J.L. and M. ANTON. (2004).** Bull semen *in vitro* fertility after cryopreservation using egg yolk LDL: a comparison with Optidyl®, a commercial egg yolk extender. *Theriogenology*, 61: 895-907.
- ANAKKUL, N., SUWIMONTEERABUTR, J., THARASANIT, T., PHUTIKANIT, N., SINGLOR, J. and M. TECHAKUMPHU. (2013).** Glycerol concentration effects on quality and longevity of post-thaw goat semen. *Thailand Journal of Veterinary Medicine*. 43(2): 179-186.
- ANAND, M., YADAV, S. and P. SHUKLA. (2014).** Cryoprotectant in semen extender: from egg yolk to low density lipoprotein (LDL). *Livestock Research International*, 2: 48-53.
- ANAND, M., YADAV, S. KUMAR, J. and S. YADAV. (2016).** Effect of Different Egg Yolk Concentration on Chilled Barbari Buck Semen During Short Term Storage. *Journal of Animal Research*, 6: 367-370.
- ANAND, M., BAGHEL, G. and S. YADAV. (2017).** Effect of egg yolk concentration and washing on sperm quality following cryopreservation in Barbari buck semen, *Journal of Applied Animal Research*, 45: 560-565.
- ANCHETA, J.C.G., AQUINO, F.P., LEOVERAS, M.E.DC., OCAMPO, L.C. and E. P. ATABAY. (2015).** Effect of duration of transport time and holding temperature in the Cryopreservation of boar semen. *European Journal of Biotechnology and Bioscience*, 3: 42-44.



- ANDERSON, S. (2003).** Animal genetic resources and sustainable livelihoods. *Ecological Economics*, 45: 331-339.
- ANDRABI, S.M.H and W.M.C. MAXWELL. (2007).** A review on reproductive biotechnologies for conservation of endangered mammalian species. *Animal Reproduction Science*, 99: 223-243.
- AQUINO, E.P. (1995).** Spectrophometric absorbance value of native goat (*Capra hircus*). College of Veterinary Science and Medicine, Central Luzon State University, Science City of Munoz, Nueva Ecija.
- AQUINO, F.P., VERGA, K.G., OCAMPO, L.C. and E.P. ATABAY. (2014).** Viability of extended goat semen stored at refrigerated condition. *Journal of Agricultural Science and Technology*, 4: 169-176.
- AX, R.L., DALLY, M., DIDION, B.A., LENZ, R.W., LOVE, C.C., VARNER, D.D., HAFEZ, B. and M.E. BELLIN. (2000).** Semen Evaluation. *In: Hafez B and Hafez ESE. Reproduction in Farm Animals. 7th Ed. Philadelphia: Lea and Febiger: 365-375.*
- AZIZ, M.A. (2010).** Present status of the world goat populations and their productivity. *Lohmann Information*, 45: 42-52.
- BAILEY, J.L., BILODEAU, J-F. and N. CORMIER. (2000).** Semen cryopreservation in domestic animals: a damaging and capacitating phenomenon. *Journal of Andrology*, 21(1): 1-7.
- BALBIN VILLAVERDE, A.I.S., FIORATTI, E.G., PENITENTI, M., IKOMA, M.R.V., TSUNEMI, M.H., PAPA, F.O. and M.D. LOPES. (2013).** Cryoprotective effect of different glycerol concentrations on domestic cat spermatozoa. *Theriogenology*, 80: 730-737.
- BARATI F., KHAKSARY, M.M. and G. MOHAMMADI. (2009).** Cryopreservation of in situ cool stored buffalo (*Bubalus bubalis*) epididymal sperm. *Iranian Journal of Veterinary Research, Shiraz University*, 10(4): 339-345.
- BARBAS, J.P. and R.D. MASCARENHAS. (2009).** Cryopreservation of domestic animal sperm cells. *Cell and Tissue Banking*, 10: 49-62.
- BARTH, A.D. and R.J. OKO. (1989).** Abnormal morphology of bovine spermatozoa. Iowa State University Press, Ames, Iowa.
- BARUN, S. (2015).** A review on applications & advantages of cryopreservation in different fields of science. *The Beats of Natural Sciences*, 2 (1): 1-6.



- BELTRAN, M.A.G. (2011).** Cryopreservation of goat semen for AI. Unpublished doctoral dissertation. Tarlac College of Agriculture. Knowledge Resource Management Center, Philippine Carabao Center.
- BELTRAN, M.A.G., ATABAY, E.P., ATABAY, E.C., CRUZ, E.M., AQUINO, F.P. and L.C. CRUZ. (2013).** Optimized extenders for cryopreservation of buck semen for artificial insemination. *Philippine Journal of Veterinary and Animal Sciences*, 39: 1-10.
- BERTOL, M.A.F., WEISS, R.R., SOCCOL, V.T., KOZICHI, L.E., FUJITA, A.S., DE ABREU, R.A. and K.T. GREEN. (2013).** Viability of bull spermatozoa collected from the epididymis stored at 18-20°C . *Brazilian Archives of Biology and Technology*, 56: 777-783.
- BEZERRA, F.S.B., CASTELO, T.S., ALVES, H.M., OLIVEIRA, I.R.S., LIMA, G.L., PEIXOTO, G.C.X., BEZERRA, A.C.S.D. and A.R. SILVA. (2011).** Objective assessment of the cryoprotective effects of dimethylformamide for freezing goat semen. *Cryobiology*, 63: 263–266.
- BISSETT, C. and R.T.F. BERNARD. (2005).** The effect of prolonged cold storage of eland (*Taurotragus oryx*) cauda epididymis on the spermatozoa: possible implications for the conservation of biodiversity. *Theriogenology*, 63: 1592-1604.
- BJORND AHL, L., SÖDERLUND, I. and U. KVIST. (2003).** Evaluation of the one-step eosin–nigrosin staining technique for human sperm vitality assessment. *Human Reproduction*, 4: 813–816.
- BLACKBURN, H.D. (2004).** Development of national animal genetic resource programs. *Reproduction, Fertility and Development*, 16: 27–32.
- BLASH, S., MELICAN, D. and W. GAVIN. (2000).** Cryopreservation of epididymal sperm obtained at necropsy from goats. *Theriogenology*. 54: 899-905.
- BONDOC, O.L. (1993).** Issues and implications of animal genetic conservation in the Philippines. *Animal Production Technology Journal*, 8 (1): 24-27.
- BONDOC, O.L. (2005).** The philippine goat breed registry in relation to genetic improvement and conservation. *The Philippine Agriculturist Scientist*, 88(2): 179-191.
- BROCKBANK, K.G.M., COVAULT, J.C. and M.J. TAYLOR. (2007).** Retrieved on July 15, 2016 at <http://iris.fishersci.ca/LitRepo.nsf>
- BROOKS, D.E. (1983).** Epididymal functions and their hormonal regulation. *Australian Journal of Biological Sciences*, 36: 205-221.



- BUCAK, M.N., ATESSAHIN, A. and A. YUCE. (2008).** Effect of antioxidant and oxidative stress parameters on ram semen after the freeze-thawing process. *Small Ruminant Research*, 75: 128-134.
- BUMANLAG, A.C. (2015).** Cryopreservation of native or non-descript goat epididymal sperm through liquid nitrogen vapor freezing. Unpublished undergraduate thesis. College of Arts and Sciences, Central Luzon State University, Science City of Munoz, Nueva Ecija.
- BUTSWAT, I.S.R. and D.T. ZAHARADDEEN. (1998).** Comparisms of some reproductive parameters in Red Sokoto and Kano brown breeds of goats, *Nigerian Journal of Animal Production*, 25: 1–5.
- COFFEY, L., HALE, M. and A. WELLS. (2004).** “Goats: Sustainable production overview”. Retrieved on June 1, 2016 at <http://www.attra.ncat.org>
- COLLINS, W. J., BRATTON, R.W. AND C.R. HENDERSON. (1951).** The relationship of semen production to sexual excitement of dairy bulls. *Journal of Dairy Sciences*, 34: 224-227.
- COMIZZOLI, P., MERMILLOD, P. and R. MAUGET. (2000).** Reproductive biotechnologies for endangered mammalian species. *Reproduction Nutrition Development*, 40: 493–504.
- COOPER, T.G. (1995).** The epididymal influence on sperm maturation. *Reproductive Medicine Review*: 4: 141– 161.
- COSADIO, A.L. HEBRON, I.U. and R. ELLACER. (2011).** Assessment of backyard raising in Claveria, Misamis, Oriental, Philippines. *Mindanao Journal of Science and Technology*, 9: 73-86.
- COSENTINO, M. J. and A. T. COCKETT. (1986).** Structure and function of the epididymis. *Urology and Research*. 14: 229-240.
- DACHEUX, J-L. and F. DACHEUX. (2014).** New insights into epididymal function in relation to sperm maturation. *Reproduction*, 147: 27-42.
- DARAMOLA, J.O. and E.O. ADEKUNLE. (2014).** Cryosurvival of goat spermatozoa in Tris-egg yolk extender supplemented with vitamin C. *Archivos de Zootecnia*, 64: 261-268.
- DAUDU C.S. (1984).** Spermatozoa output, testicular sperm reserve and epididymal storage capacity of the Red Sokoto goats indigenous to northern Nigeria. *Theriogenology*, 21(2): 317–324.



DHANDA, J.S., TAYLOR, D.G., MURRAY, P.J., PEGG, R.B. and P. J. SHAND. (2003). Goat meat production: present status and future possibilities. *Asian-Australian Journal of Animal Science*, 16: 1842-1852.

DHURVEY, M., GUPTA, V.K., NEMA, S.P., PATIDAR, A., SHIVHARE, M., SINGH, N. and V. SHAKYA. (2012). Modern semen evaluation techniques in domestic animals: a review. *DHR International Journal of Biomedical and Life Sciences*: 3, 62-83.

DA-BAR. (2011). Philippine Goat Industry. Retrieved on July 20, 2016 at <http://da.gov.ph>

DONG, Q., RODENBURG, S.E. HUANG, C. and C.A. VANDEVOORT. (2008). Cryopreservation of rhesus monkey (*Macaca mulatta*) epididymal spermatozoa before and after refrigerated storage. *Journal of Andrology*, 29(3): 283-292.

DONG, Q. and C. VANDEVOORT. (2009). Effect of egg yolk on cryopreservation of rhesus monkey ejaculated and epididymal sperm. *Journal of Andrology*, 30: 309-316.

DONG, Q.X., RODENBURG, S.E., HILL, D. and C.A. VANDEVOORT. (2011). The role of low-density lipoprotein (LDL) and high-density lipoprotein (HDL) in comparison with whole egg yolk for sperm cryopreservation in rhesus monkeys. *Asian Journal of Andrology*, 13: 459-464.

DUBEUF, J.-P., MORAND-FEHR, P. and R. RUBINO. (2003). Situation, changes and future of goat industry around the world. *Small Ruminant Research*, 51: 165-173.

DULLOO, M.E., HUNTER, D. and T. BORELLI. (2010). Ex situ and in situ conservation of agricultural biodiversity: major advances and research needs. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 38 (2): 123-135.

EL-BAWAB., I.E., METWELLY, K.K. and S.M. EL-RHEEM. (2015). Effect of different concentrations of chicken low density lipoprotein on quality of frozen buck semen. *Alexandria Journal of Veterinary Sciences*, 44: 93-102.

FOOD AND AGRICULTURE ORGANIZATION (FAO). (2012). Cryoconservation of animal genetic resources. *Animal Production and Health Guidelines*. Retrieved on June 6, 2016 at <http://www.fao.org>

FOOD AND AGRICULTURE ORGANIZATION (FAO). (2016). Implementing the Global Plan of Action for Animal Genetic Resources. Retrieved on June 6, 2016 at <http://www.fao.org>



- FARSHAD, A., KHALILI, B. and P. FAZELI. (2009).** The effect of different concentrations of glycerol and DMSO on the viability of Markhoz Goat spermatozoa during different freezing temperatures steps. *Pakistan Journal of Biological Science* 12: 239-245.
- FARSHAD, A. and S. AKHONDZADEH. (2008).** Effects of sucrose and glycerol during the freezing step of cryopreservation on the viability of goat spermatozoa. *Asian-Australian Journal of Animal Science*, 21: 1721-1727.
- FERNÁNDEZ-SANTOS, M.R., ESTESO, M.C., MONTORO, V., SOLER, A.J., and J.J. GARDE. (2006).** Influence of various permeating cryoprotectants on freezability of Iberian red deer (*Cervus elaphus hispanicus*) epididymal spermatozoa: effects of concentration and temperature of addition. *Journal of Andrology*, 27: 734-745.
- FERNÁNDEZ-SANTOS M.R, SOLER A.J., RAMÓN, M., ROS-SANTAELLA, J.L., MAROTO-MORALES, A., GARCÍA-ÁLVAREZ, O., BISBAL, A., GARDE, J.J, COLOMA, M.A. and J. SANTIAGO MORENO (2011).** Effect of post-mortem time on post-thaw characteristics of Spanish ibex (*Capra pyrenaica*) spermatozoa. *Animal Reproduction Science*, 129: 56-66.
- FOOTE, R. (2000).** Fertilizing ability of epididymal sperm from dead animals. *Journal of Andrology*, 21: 355.
- FREITAS, J.F., RONDINA, D., LOPES, E.S., JUNIOR, TEIXEIRAA, D.I.A. and N.R.O. PAULA. (2004).** Hormonal treatments for the synchronization of oestrus in dairy goats raised in the tropics. *Reproduction, Fertility and Development*, 16: 415-420.
- FULLER, B.J. (2004).** Cryoprotectants: the essential antifreezes to protect life in the frozen state. *Cryo Letters*: 25, 375-388.
- GAO, D. and J.K. CRITSER. (2000).** Mechanisms of cryoinjury in living cells. *Institute of Laboratory Animal Research*, 41: 187-196.
- GARDE, J., ORTIZ, N., GARCIA, A., GALLEGO, L., LANDETE, C.T. and A. LOPEZ. (1998).** post-mortem assessment of sperm characteristics of the red deer during the breeding season. *Archives of Andrology*, 41: 195-202.
- GARNER, D.L. and E.S.E. HAFEZ. (2000).** Sperms and Seminal Cytoplasmic. In: Hafez B, Hafez E.S.E. (ed). *Reproduction in farm animals*. 7th Ed. Philadelphia: Lea and Febiger, 96- 109.



- GAUTANE, J.J., BALAGAN, E.J.Y., MANAOIS, F.V. II, OCAMPO, M.B. and L.C. OCAMPO. (2016).** Characteristics of epididymal sperm recovered from slaughterhouse derived testes of nondescript/native goats in the Philippines. *Journal of Agricultural Technology* 12(2):215-228.
- GEMEDA, A.E. and K. WORKALEMAHU. (2017).** Body weight and scrotal-testicular biometry in three indigenous breeds of bucks in arid and semiarid agroecologies, ethiopia. *Journal of Veterinary Medicine*, 2017: 1-9.
- GOYAL, H.O. and C.S. WILLIAMS. (1991).** Regional differences in the morphology of the goat epididymis: A light microscopic and ultrastructural study. *American Journal of Anatomy*, 190: 349–369.
- HAENLEIN, G. (1992).** "All About Goats". National Dairy Database. Retrieved on February 03, 2017 at http://www.inform.umd.edu/EdRes/Topic/AgrEnv/ndd/goat/ALL_ABOUT_GOATS.html
- HENSON, E.L. (1992).** In situ conservation of livestock and poultry. *FAO Anim. Health Prod.* Retrieved on July 16, 2016 at <http://www.fao.org/docrep/004/T0559E/T0559E00.htm>
- HIEMSTRA, S.J., VAN DER LENDE, T. and H. WOELDERS. (2005).** The potential of cryopreservation and reproductive technologies for animal genetic resources conservation strategies. Retrieved on July 15, 2016 at www.fao.org/biotech/docs/hiemstra.pdf
- HOLT, W., WATSON, P., CURRY, M. and T. HOLT. (1994).** Reproducibility of computer-aided semen analysis: comparison of five different systems used in a practical workshop. *Fertility and Sterility*, 62: 1277–1282.
- HOLT, W.V. and A.R. PICKARD. (1999).** Role of reproductive technologies and genetic resource banks in animal conservation. *Reviews of Reproduction*, 4: 143–150.
- HOLT, W.V. (2000).** Fundamental aspects of sperm cryobiology: The importance of species and individual differences. *Theriogenology* 53: 47- 58.
- INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE (ILRI). (2008).** "Goats - Undervalued Assets In Asia". Animal Production and Health Commission for Asia and the Pacific. Retrieved on March 25, 2016 at <http://www.aphca.org>
- IRITANI, A. and Y. NISHIKAWA. (1963).** Studies on the egg-yolk coagulating factor in goat semen. Purification of the egg-yolk coagulating enzyme. *Japan Journal of Animal Reproduction*, 8: 118–121.



- JAMES, A.N., GREEN, H., HOFFMAN, S., LANDRY, A.M., PACCAMONTI, D. and R.A. GODKE. (2002).** Preservation of equine sperm stored in the epididymis at 4°C for 24, 48, 72 and 96 hours. *Theriogenology*, 58: 401–404.
- JAMES, A.N. (2004).** Preservation of sperm harvested from the rat, caprine, equine and bovine epididymis. Unpublished doctoral dissertation. Louisiana State University and Agricultural and Mechanical College.
- JOSEPH, A., YAO, H. and B.T. HINTON. (2009).** Development and morphogenesis of the Wolffian/Epididymal duct, more twists and turns. *Developmental Biology*, 325: 6-14.
- KAABI, M., PAZ, P., ALVAREZ, M., ANEL, E., BOIXO, J.C., ROUISSI, H., HERRAEZ, P. and L. ANEL. (2003).** Effect of epididymis handling conditions on the quality of ram spermatozoa recovered post-mortem. *Theriogenology*, 60: 1249–1259.
- KALYANI R., GOJEN, S.L. and S. BIDHAN. (2015).** Cryopreservation of Black Bengal buck semen by Tris-based extenders containing different levels of egg-yolk. *Annals of Veterinary and Animal Science*, 2: 47-54.
- KANN, M. L. and C. SERRES. (1981).** Development and initiation of sperm motility in the hamster epididymis. *Reproduction and Nutrition Development*. 20:1739-1749.
- KASSO, M. and M. BALAKRISHNAN. (2013).** Ex situ conservation of biodiversity with particular emphasis to Ethiopia. *International Scholarly Research Notices Biodiversity*, 2013: 1-11.
- KAYA, A., BILMER, S., ENWALL, L. and E. MEMILI. (2014).** Determinants of sperm morphology. *Animal Andrology Theories. In: Chenoweth, P.J. and S.P. Lorton. Animal Andrology: theories and application. Pondicherry, India*, 34-56.
- KIKUCHI K., NAGAI T., KASHIWAZAKI N., IKEDA H., NOGUCHI J., SHIMADA A., SOLOY E. and H. KANEKO. (1998).** Cryopreservation and ensuing in vitro fertilization ability of boar spermatozoa from epididymides stored at 4°C. *Theriogenology*, 50: 615-623.
- KIM, S., LEE, Y.J., JI, D.B. and Y.J. KIM. (2011).** Evaluation of different cryoprotectants (CPAs) in boar semen cryopreservation. *Journal of Veterinary Medical Science*, 73: 961–963.



- KORDAN, W., FRASER, LL., WYSOCKI, P., STRZEZEK, R., LECEWICZ, M., MOGIELNICKA-BRZOZOWSKA, M., DZIEKONSKA, A., SOLIWODA, D. and M. KOZIOROWSKA-GILUN. (2013).** Semen quality assessments and their significance in reproductive technology. *Polish Journal of Veterinary Sciences*: 16, 823-833.
- KOSHIMOTO, C., GAMLIEL, E. and P. MAZUR. (2000).** Effect of osmolality and oxygen tension on the survival of mouse sperm frozen to various temperatures in various concentrations of glycerol and raffinose. *Cryobiology*, 41:204 –231.
- KULAKSIZ, R., ARI, U.C., DASKINI, A. and A.G. UNER. (2013).** The effect of different glycerol concentrations on freezability of semen from Angora, Kilis and Saanen goats. *Slovakian Journal of Animal Science*, 46: 39-44.
- LEBOEUF, B., RESTALL, B. and S.B. SALAMON.(2000).** Production and storage of goat semen for artificial insemination. *Animal Reproduction Science*, 62:113–141.
- LEMMA, A. (2011).** Effect of cryopreservation on sperm quality and fertility. *Artificial Insemination in Farm Animals*. Retrieved on August 17, 2016 at <http://www.intechopen.com/books/artificial-insemination-in-farm-animals/>
- LEÓN-QUINTO, T., SIMÓN, M.A., CADENAS, R., JONES, J., MARTÍNEZ-HERNÁNDEZ, F., MORENO, J.M., VARGAS, A., MARTÍNEZ, F. and B. SORIA. (2009).** Developing biological resource banks as a supporting tool for wildlife reproduction and conservation. *Animal Reproduction Science*, 112: 347-361.
- LEROY, G., BESBES, B., BOETTCHER, P., HOFFMANN, I., PILING, D., BAUMUNG, R. and B. SCHERF. (2016).** Factors and determinants of animal genetic resources management activities across the world. *Livestock Science*, 189: 70-77.
- LI, Y.H., CAI, K.J., KOVACS, A. and W.Z. JI. (2013).** Effects of various extenders and permeating cryoprotectants on cryopreservation of cynomolgus monkey (*Macaca fascicularis*) Spermatozoa. *Journal of Andrology*, 26: 387-395.
- LIVESTOCK RESEARCH DIVISION-DEPARTMENT OF SCIENCE AND TECHNOLOGY (LRD-DOST). (2016).** Goats' meat: sure bet in building rural assets. Retrieved on August 12, 2016 at <http://www.pcaarrd.dost.gov.ph/home/portal/index.php/quick-information-dispatch/2685-goats-meat-sure-bet-in-building-rural-assets>



- LONE, F.A., ISLAM, R., KHAN, M.Z. And K.A. SAFI. (2011).** Effect of transportation temperature on the quality of cauda epididymal spermatozoa of ram. *Animal Reproduction Science*, 123: 54-59.
- LOPES, G., SOARES, L., FERREIRA, P. and A. ROCHA. (2015).** Tris-egg-yolk (TEY) extender developed fro freezing dog semen is a good option to cropreserve bovine epididymal sperm cell. *Reproduction of Domestic Animals*, 50: 97-103.
- MAPEKA, M.H., LEHLOENYA, K.C., NEDAMBALEL, T.L. and B. SUTHERLAND. (2009).** Effect of cryoprotectant on the cryopreservation of South African Kolbroek pig semen. *South African Journal of Animal Science*, 39: 198-201.
- MARA, L., CASU, S., CARTA, A. and M. DATTENA. (2013).** Cryobanking of farm animal gametes and embryos as a means of conserving livestock genetics. *Animal Reproduction Science*, 138: 25-38.
- MARTINEZ-PASTOR, F., GEURRA, C., KAABI, M., DIAZ, A.R., ANEL, E., HERRAEZ, P., DE PAZ, P. and L. ANEL. (2005).** Decay of sperm obtained from epididymes of wild ruminants depending on post-mortem time. *Theriogenology*, 63: 24-40.
- MARTINS, C.F., DRIESSEN, K., MELO COSTA, P., CARVALHO-NETO, J.O., DE SOUSA R.V., RUMPF R. and M.N. DODE. (2009).** Recovery, cryopreservation and fertilization potential of bovine spermatozoa obtained from epididymides stored at 5 °C by different periods of time. *Animal Reproduction Science*, 116: 50–57.
- MAMUAD SR. H.V., E.V. VENTURINA, R.T. MORUSO, E.C. ATABAY and K. KUDO. (2005).** Artificial Insemination Manual for Water Buffaloes. Water Buffaloes and Beef Cattle Improvement Project (WBBCIP). A Joint-JICA Assisted Project of the Philippine Carabao Center and the Bureau of Animal Industry Philippines.
- MAMUAD, F.V., VENTURINA, E.V. and H. SAITO. (2004).** Collection, Processing and Handling Buffalo Semen. Water Buffaloes and Beef Cattle Improvement Project (WBBCIP). A Joint-JICA Assisted Project of the Philippine Carabao Center and the Bureau of Animal Industry Philippines.
- MEDRANO, A., TERRAZAS, A. and R. SOTO. (2010).** Principles and perspectives for the conservation of goat buck spermatozoa. *Small Ruminant Research*, 89: 140–143.



- MEMON, A.A., WAHID, H., ROSNINA, Y., GOH, Y.M. and M. EBRAHIMI. (2013).** Effect of buffers and egg yolk concentrations on chilled and frozen-thawed boer goat spermatozoa. *Research Opinions in Animal and Veterinary Science*: 3(10), 374-379.
- MILESKI, A. (2004).** "*Capra hircus* domestic goat". Animal Diversity Web. Retrieved on July 24, 2016 at http://animaldiversity.org/accounts/Capra_hircus
- MIR, S.S., LONE, F.A., KHAN, M.Z., MALIK, A.A., ISLAM, R. and K.A. SOFI. (2011).** Effect of cold storage period on the quality of ram cauda epididymal spermatozoa recovered postmortem. *Turkish Journal of Veterinary and Animal Science*, 36(6): 683-687.
- MITCHELL, T. (1982).** How to tell the age of goats. Retrieved on June 26, 2016 at www.agric.nsw.gov.au
- MONTEIRO, G.A., GUASTI, P.N., ROCHA, A.S., MARTIN, I., SANCLER-SILVA, Y.F.R., FREITAS DELL'AQUA, C.P., DELL'AQUA J.A. JR. and F.O. PAPA. (2013).** Effect of storage time and temperature of equine epididymis on the viability, motion parameters, and freezability of epididymal sperm. *Journal of Equine Veterinary Science*, 33: 169-173.
- MOREL DAVIES, M.C.G. (2015).** Equine reproductive physiology, breeding and stud management, 4. Retrieved on June 20, 2016 at <https://books.google.com.ph>
- NAING, S.W., WAHID, H., MOHD AZAM, K., ROSNINA, Y., ZUKI, A.B., KAZHAL, S., THEIN, M., KYAW, T. and M.M. SAN. (2010).** Effect of sugars on characteristics of Boer goat semen after cryopreservation. *Animal Reproduction Science*, 122: 23-26.
- NEILD, D., MIRAGAYA, M., CHAVES, G., PINTO, M., ALONSO, A., GAMBAROTTA, M., LOSINNO, L. A and A. AG" UERO. (2006).** Cryopreservation of cauda epididymis spermatozoa from slaughterhouse testicles 24 h after ground transportation. *Animal Reproduction Science*: 94, 92-95.
- NISHIZONO, H., SHIODA, M., TAKEO, T., IRIE, T. and N. NAKAGATA. (2004).** Decrease of fertilizing ability of mouse spermatozoa after freezing and thawing is related to cellular injury. *Biological Reproduction*: 71: 973-978
- NOILES, E.E., BAILEY, J. and B.T. STOREY. (1995).** Temperature dependence of the water permeability, L_p , of murine sperm shows a discontinuity between 48 and 08C. *Cryobiology*, 32:220-238.



- NOLTE, M. (2016).** Teeth, Life Expectancy & How to estimate a goat's age. Retrieved on June 2, 2016 at <https://fiascofarm.com/goats/age.htm>
- NORMAN, G. A. (1991).** The potential of meat from goat. In: *Developments in Meat Science* (Ed. R. A. Lawrie). Elsevier Applied Science, London: 57-87.
- NUTI, L.C. (no date).** Goat semen collection and processing. Retrieved on May 10, 2017 at <http://goatdocs.ansci.cornell.edu/Resources/GoatArticles/GoatGeneticsRepro/GoatSemenNut.pdf>
- O'CONNELL, M., MCCLURE, N. and S.E.M. LEWIS. (2002).** The effect of cryopreservation on sperm morphology, motility and mitochondrial function. *Human Reproduction*, 17(3): 704-709.
- OLIVEIRA, L.Z., MONTEIRO, F.M., ARRUDA, R.P. and E.C.C. CELEGHINI. (2013).** The importance of semen quality in ai programs and advances in laboratory analyses for semen characteristics assessment. Retrieved on February 13, 2017 at <https://www.intechopen.com/books/success-in-artificial-insemination-quality-of-semen-and-diagnostics-employed/the-importance-of-semenquality-in-ai-programs-and-advances-in-laboratory-analyses-for-semen-charact>
- OTTO, R.S. and M.A. MEMON. (1980).** Breeding soundness examinations of rams and bucks, a review. *Theriogenology* :13, 155-164.
- OZKAVUKCU, S., ERDEMLI, E., ISIK, A., OZTUNA, D. and S. KARAHUSEYINOGLU. (2008).** Effect of cryopreservation on sperm parameters and ultrastructural morphology of human spermatozoa. *Journal of Assisted Reproduction and Genetics*, 25: 403-411.
- PAIVA, S.R., MCMANU, C.M. and H. BLACKBURN. (2010).** Conservation of animal genetic resources – a new tact. *Livestock Science*, 193: 32-38.
- PAPA, F.O., MELO, C.M., FIORATTI, E.G., DELL'AQUA, J.A. JR., ZAHN, F.S. and M.A. ALVARENGA. (2008).** Freezing of stallion epididymal sperm. *Animal Reproductive Science*, 107: 293-301.
- PACE M.M. and E.F. GRAHAM. (1974).** Components in egg yolk which protect bovine spermatozoa during freezing. *Journal of Animal Science*, 39: 1144-1149.
- PARKS, J.E. and J.K. GRAHAM. (1992).** Effects of cryopreservation procedures on sperm membranes. *Theriogenology*, 38: 209-222.
- PATHAK, A., KATIYAR, R. S., SHARMA, D. N. and M.M. FAROOQUI. (2014).** Postnatal developmental anatomy of testes and epididymis of gaddi goats. *International Journal of Morphology*, 32: 1391-1398.



- PEGG, D.E. (2007).** Principles of cryopreservation. *Methods Molecular Biology*, 368:39-57.
- PERERA, K.U.E. and H.B.S. ARIYATNE. (2013).** Cryopreservation of Goat Sperms Collected From Different Regions of the Epididymis. *International Journal of Science and Research*, 2: 36-38.
- PEREZ-SANCHEZ, F., TABLADO, L., YEUNG, C.H., COOPER, T.G. and C. SOLER. (1996).** Changes in the motility patterns of spermatozoa from the rabbit epididymis as assessed by computer-aided sperm motion analysis. *Molecular Reproduction and Development*, 45: 364-371.
- PHETUDOMSINSUK, K., SIRINARUMITR, K., CHOOTHEA, A., SUTHANMAPINUNT, P., KORNKAEWRAT, K., LAIKUL, A., AMORNSAK, S. and A. PINYOPUMMIN. (2009).** Freezability of Thai native crossbred horse semen in different extenders. *Thai Journal of Veterinary Medicine*, 39: 105-114.
- PHILIPPINE COUNCIL FOR AGRICULTURE, AQUATIC AND NATURAL RESOURCES RESEARCH AND DEVELOPMENT (PCAARRD). (2012).** Goat industry. Retrieved on June 3, 2016 from <http://www.pcaarrd.dost.gov.ph>
- PHILIPPINE STATISTICS AUTHORITY (PSA). (2016a).** Livestock and Poultry: Value of Production by Type of Valuation, by Subsector and by Region (Revised/Rebased), 1998-2014 (B61PNCLP). Retrieved on June 3, 2016 from <http://www.psa.gov.ph>
- PHILIPPINE STATISTICS AUTHORITY (PSA). (2016b).** Livestock: Inventory by Animal Type, Farm Type, by Region, by Province, 1994-2016 (C00PNLPI). Retrieved on June 3, 2016 from <http://www.psa.gov.ph>
- PILING, D. (2010).** Threats to animal genetic resources for food and agriculture – approaches to recording, description, classification and analysis. *Animal Genetic Resources*, 47:11-22.
- PURDY, P.H. (2006).** A review on goat cryopreservation. *Small Ruminant Research*, 63: 215-225.
- RAJI, A.O., IGWEBUIKE, J.U. and J. ALIYU. (2008).** Testicular biometry and its relationship with body weight of indigenous goats in semi-arid region Nigeria. *ARPN Journal of Agricultural and Biological Sciences*, 3: 6–9.
- RAUCH, A. (2012).** Cryopreservation of bovine semen in egg yolk based extender. Unpublished master's thesis. Department of Large Animal Clinical Sciences, University of Saskatchewan, Saskatoon.



- REGE, J.E.O. and J.P. GIBSON. (2003).** Animal genetic resources and economic development: issues in relation to economic valuation. *Ecological Economics*, 45: 319-330.
- ROY, A. (1957).** Egg yolk coagulating enzyme in the semen and cowper's gland of the goat. *Nature*, 179: 318-319.
- SAENZ, J.R. (2007).** Cryopreservation of white tailed deer epididymal sperm cell for artificial insemination. Unpublished master's thesis. Louisiana State University and Agricultural and Mechanical College.
- SAITO, H., MATEO, R. and U. AMAGAN. (2004).** Semen processing guide on beef cattle. WBCIP. JICA. Philippine Carabao Center & Bureau of Animal Industry.
- SALAMON, S. and A.J. RITAR. (1982).** Deep freezing of Angora goat semen: effects of diluent composition and method and rate of dilution on survival of spermatozoa. *Australian Journal of Biological Science*: 35, 295–303.
- SALMANI, H., NABI, M.M., VASEGHI-DODARAN, H., RAHMAN, M.B., MOHAMMADO-SANGCHESHMEH, A., SHAKERI, M., TOWHIDI, A., SHAHNEH, A.Z. and M. ZHANDI. (2013).** Effect of glutathione in soybean lecithin-based semen extender on goat semen quality after freeze-thawing. *Small Ruminant Research*, 112: 123-127.
- SANTIAGO-MORENO, J., TOLEDANO-DIAZ, A., PULIDO- PASTOR, A., DORADO, J., GÓMEZ-BRUNET, A. and A. LÓPEZ-SEBASTIÁN. (2006).** Effect of egg yolk concentration on cryopreserving Spanish ibex (*Capra pyrenaica*) epididymal spermatozoa. *Theriogenology*. 66: 1219- 1226.
- SETHURAMAN, G. and S. NAIDU. (2008).** International Encyclopedia of Agricultural Science and Technology: Organic farming. Retrieved on July 2, 2016 at https://books.google.com.ph/books/about/International_encyclopaedia_of_agricultu.html
- SEVILLA, C.C. (2015).** Development of dairy goat farming in the Philippines. Retrieved on June 3, 2016 at <http://www.searca.org>
- SHAKERI, M., ROSHANFKR, H., MAMOEI, M. and K.H. MIRZADEH. (2008).** Effect of epididymis handling conditions on the quality of ram spermatozoa recovered post-mortem. *Asian Journal of Animal and Veterinary Advances*, 3: 400-408.
- SINGH, A., TEOTIA, U.V. and S. SINGH. (2012).** Semen evaluation in farm animals. *DHR International Journal of Biomedical and Life Sciences*, 2(1): 35-42.



- SOLTANPOUR, F. and G. MOGHADDAM. (2013).** Effects of frozen diluents on storage of ram sperm. *International Journal of Advanced Biological and Biomedical Research*, 1 (12): 1698-1704.
- SONGSASEN, N., TONG, J. and S.P. LEIBO. (1998).** Birth of live mice derived by in vitro fertilization with spermatozoa retrieved up to twenty-four hours after death. *Journal of Experimental Zoology*, 280:189-196.
- STOUT, M.A. (2012).** Comparison of epididymal and ejaculated sperm collected from the same holstein bulls. Unpublished doctoral dissertation) Louisiana State University and Agricultural and Mechanical College.
- STRAND, J., RAGBORG, M.M., PEDERSEN, H.S., KRISTENSEN, T.N., PERTOLDI, C. and H. CALLESE. (2016).** Effects of post-mortem storage conditions of bovine epididymides on sperm characteristics: investigating a tool for preservation of sperm from endangered species. *Conservation Physiology*, 4(1): 1-8.
- SUNDARARAMAN, M.N. and M.J. EDWIN. (2008).** Changes in motility characteristics of goat spermatozoa during glycerol-equilibration and the relevance to cryopreservation. *Asian Journal of Cell Biology*, (1): 22-23.
- SULTANA, F., HUSAIN, S.S., KHATUN, A., APU, A.S. and M.A.M.Y. KHANDOKER. (2013).** Study on buck evaluation based on semen quality and fertility. *Bangladesh Journal of Animal Sciences*, 42(2): 101-108.
- TACIO, H. (2012).** Department of Agriculture. Retrieved on June 8, 2016 from <http://www.gaiadiscovery.com/agriculture-industry/goat-raising-offers-income-opportunity-for-farmers.html>
- TADA, N., SATO, M., YAMANOI, J., MIZOROGI, T., KASAI, K. and S. OGAWA. (1990).** Cryopreservation of mouse spermatozoa in the presence of raffinose and glycerol. *Journal of Reproduction and Fertility*, 89: 511-516.
- TAYLOR, R.E. and T.G. FIELD. (1999).** "Growth and Development" in *Scientific Farm Animal Production: An Introduction to Animal Science*. Prentice-Hall. Upper Saddle River, 321-324. Retrieved on July 18, 2016 at <https://en.wikipedia.org/wiki/Goat>
- TEGEGNE, A., DEMBARGA, Y. and T. KASSA. (1992).** Gonadal and extragonadal sperm reserves in Boran and Boran x Friesian bulls raised on two planes of nutrition in the highlands of Ethiopia. *Theriogenology*, 37: 953-961.



- TSAI, S. and C. LIN. (2012).** Advantages and Applications of Cryopreservation in Fisheries Science. *Brazilian Archives of Biology and Technology*, 55(3): 425-433.
- TUNCER, P.B., BUCAK, M.N., SARIOZKAN, S., SAKIN, F., YENI, D., CIGERCI, H., ATESSAHIN, A., AVDATEK, F., GUNDOGAN, M. and O. BYUKLEBLEBICI. (2010).** The effect of raffinose and methionine on frozen/thawed Angora buck (*Capra hircus ancryrensis*) semen quality, lipid peroxidation and antioxidant enzyme activities. *Cryobiology*, 61: 89-93.
- TURRI, F. (2012).** Developing the use of epididymal semen for farm animal cryobanks and some field applications. Unpublished doctoral dissertation. Facoltà di Medicina Veterinaria, Università degli Studi di Milano.
- TURRI, F., MADEDDU, M., GLIOZZI, T.M., GANDINI, G. and F. PIZZI. (2014).** Effect of testicle post-mortem storage on goat frozen-thawed epididymal sperm quality as a tool to improve genbanking in local breeds. *Animal*, 8: 440-447.
- UGWU, S.O.C. (2009).** Relationship between scrotal circumference, in situ testicular measurements and sperm reserves in the West African Dwarf Goats. *African Journal of Biotechnology*, 8(7): 1354-1357.
- VALE, W. (2004).** Semen production for artificial insemination. In Pre-Congress training on the use of Reproductive Biotechniques in Water Buffaloes. Science City of Munoz Nueva Ecija, Philippines: FAO, PCC and JICA.
- VALETE, E.J.P., MAYLEM, E.R.S., OCAMPO, M.B., ABELLA, E.A. and L.C. OCAMPO. (2015).** Post-mortem viability of epididymal sperm from native water buffalo (*Bubalus bubalis*). *Journal of Agricultural Technology*, 11 (8): 2283-2294.
- VALETE, E.J.P., OCAMPO, L.C., AQUINO, F.P., CRUZ, K.J. and M.B. OCAMPO. (2016).** Sperm concentration influences the post-thaw livability of frozen goat semen. *Research Opinions in Animals and Veterinary Sciences*, 6(5): 158-164.
- VALLECILLO, A., TRIGO, P.I., DELGADO, J.V. CABELLO, A., SANTOS E. and T. TENORIO. (2004).** Effect of cryopreservation on sperm motility in Blanca Serrana Andaluza goat. *South African Journal of Animal Science*, 34: 116-118.
- VARESI, S., VERNOCCHI, V., FAUSTINI, M. and G.C. LUVONI. (2013).** Morphological and acrosomal changes of canine spermatozoa during epididymal transit. *Acta Veterinaria Scandinavica*, 55: 1-6.



- WAHJUNUNGSIH, S., NURYADI, H., BUDIARTO, A. and P. BHINTORO. (2012).** Effect of sperm concentration and length of storage at 5c on motility of goat spermatozoa. *International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering*, 6(6): 392-394.
- WATSON, P.F. (1979).** The preservation of semen in mammals. In: Finn CA (ed.), *Oxford Reviews of Reproductive Biology*, 1: 283– 350.
- WATSON, P.F. (1995).** Cooling of spermatozoa and fertilizing capacity. *Reproduction in Domestic Animals*, 31: 135–140
- WOELDERS, H., WINDIG, J. and S. HIEMSTRA. (2012).** How Developments in Cryobiology, Reproductive Technologies and Conservation Genomics Could Shape Gene Banking Strategies for (Farm) Animals. *Reproduction in Domestic Animals*, 47:264–273.
- WOOLLIAMS, J.A., MATIKA, O. and J. PATTISON. (2008).** Conservation of animal genetic resources: approaches and technologies for in situ and ex situ conservation. *Agriculture*, 42: 71-89
- YOUNG, L.G., HINTON, B.T. and K.G. GOULD. (1985).** Surface changes in chimpanzee sperm during epididymal transit. *Biology of Reproduction*, 32: 399-412.
- YULNAWATI, H., MAHESHWARI, H., HERDIS and M. RIZAL. (2009).** Viability and plasma membrane integrity of the spotted buffalo epididymal spermatozoa after thawing with the addition of dextrose into the extender. *Biotropia*, 16(1): 21-27.
- ZEDER, M. and B. HESSE. (2000).** The initial domestication of goats (*Capra hircus*) in the Zagros mountains 10,000 years ago. *Science*, 287: 2254-2257.