International Conference on
Agriculture and Allied Sciences:
The Productivity, Food Security and Ecology
ISBN-978-93-85822-71-1

A Comparative Study on Semen Quality of Stud Bulls

Tripti Kumari[1], Subhransu Pan[2] and Rajeev Kumar Choudhary[3]

[1]Department of Livestock Production and Management, ICAR- ERS,
NDRI, Kalyani - 741237, West Bengal, INDIA
[2]Department of Livestock Production and Management,
WBUAFS, Kolkata- 700037 INDIA
[3]Department of Veterinary Pathology, WBUAFS, Kolkata- 700035, West Bengal, INDIA
E-mail: [1]triptilpm@gmail.com, [2]span@rediffmail.com, [3]rajeevchoudhary58@gmail.com

Abstract—*A study was conducted to evaluate the effect of genetic group, season, temperature, humidity and temperature - humidity index (THI) on the semen quality {semen volume (ml), sperm concentration (million/ml), initial motility (%), post-thaw motility (%) and crenellation pattern (noted in code)} of 25 stud bulls (five bulls from each genetic groups of Sahiwal, Gir, Jersey cross, H.F. cross and Murrah buffalo bulls) maintained at the Frozen Semen Bull Station, Nadia, Haringhata, West Bengal, India in two seasons (i.e. winter and summer). Meteorological data was obtained from Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia, West Bengal, India. Significant variation among genetic group and genetic group x season interaction was found on semen volume, sperm concentration, initial motility, post thaw motility and crenellation pattern of semen of stud bulls (P <0.01). The effect of season was found on semen volume and crenellation pattern (P<0.05), initial motility and post thaw motility (P<0.01). Only the, effect of air temperature was found significant (P<0.01) on semen volume whereas, the effect of THI was significant statistically (P<0.01) on semen volume and post- thaw motility of semen of stud bulls.*

Keywords*: semen quality, stud bulls, genetic group, season, temperature, humidity.*

1. INTRODUCTION

Stud bull plays a unique role in cattle breeding. It has large impact on both production and profitability of commercial dairy operation. The fertility and genetic potential of bulls significantly affect the overall productivity and production efficiency of dairy herds. The two main purposes of breeding bulls are to contribute high reproduction and genetic performance to the herd [1]. In addition to being such a resource, bulls have been treated as companions and viewed with affection by those whose job it is to care for them [2]. It is the animal which provides gainful employment as well as round the year income to millions of people in India because today India has largest breeding infrastructure in the world. Artificial insemination using frozen semen is now the most widespread tool employed nationwide for improving the genetic potential of livestock [3]. Therefore, semen quality is an important aspect of stud bull characteristics because breeding behaviour of male is closely related with its conventional semen profile (i.e., semen volume, sperm concentration, initial motility, post-thaw motility and crenellation pattern). Evaluation of semen quality and freezability of semen is the important aspect of successful breeding performance result [4]. Variation in quality of semen according to different genetic group, species and season has been found. Good management practices have positive impact on semen quality and quantity. Thus, present study has been carried out to evaluate the effect of genetic group, season, temperature, humidity and temperature - humidity index (THI) on the semen quality of bulls, so that better management practices could be adopted in the farm for exhibiting better performances by the bulls that have positive impact on its seminal quality.

2. MATERIALS AND METHOD

The study was conducted on twenty five stud bulls (five bulls of each five genetic groups viz., Sahiwal, Gir, Holstein cross, Jersey cross and Murrah Buffalo) at Frozen Semen Bull Station, Haringhata Farm under Paschim Banga Go Sampad Bikash Sangsthan, ARD Department, Government of West Bengal in two seasons, viz., winter and summer. All the animals were maintained as per routine management practices of farm under uniform environment and identical conditions. Meteorological data pertaining to both experimental seasons were collected from the Observatory managed by the Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia. Temperature humidity Index (THI) (morning and afternoon) was calculated as, **THI = 0.72 (Cdb + Cwb) + 40.6,** where, Cdb and Cwb = dry and wet bulb temperature in centigrade respectively [5].

Procedure of semen collection

Semen were collected twice weekly from the same bull in artificial vagina. The site and the personnel taking collection were kept the same for all the bulls during the period of study. Collections were taken in the morning between 7.30 to 9.00 A.M under all possible sterile conditions.. Generally two ejaculates were collected from most of the bulls in a day [6, 7] with a gap of 20-30 minutes. Semen samples soon after collection were diluted in Egg Yolk Citrate diluter [8] in the ratio of 1:1. One ml. of diluted semen from each bull in separate sterilized test tube was brought to the laboratory in a thermo flask filled up with ice up to ¾ capacity. The samples brought to the laboratory were kept in a beaker containing water at approximately 32 ^{0}c for 20 to 30 minutes and were subjected to different tests as:

Semen volume was noted directly from the graduated collecting conical test tubes just after collection [9]. Sperm concentration was determined by direct cell count method [10, 11]. Neubaur Haemocytometer is used to count the sperm concentration [8] . Initial motility of sperm was determined after an hour of collection. The initial motility of fresh semen and was expressed in terms of percentage as described by [12] . Freezability of semen includes thawed motility of semen [13] which gives relationship between the number of viable sperm and fertility after artificial insemination. It was used to calculate post thaw motility of semen and was expressed in percentage. Crenellation Pattern is a method used in assessment of semen quality. It is significantly correlated with other seminal characterstics [14]. One drop of semen was taken on dry glass slide just after collection. Then it showed a characteristic pattern, called as crenellation pattern. By visualizing the pattern, the quality of semen was noted as good, moderate and bad and scored as 1, 2 and 3 respectively.

The data were analyzed using mixed model least squares analysis for fitting constants [15]. The mathematical model used to study the effect of different factors was as follows -

$\mathbf{Y_{ijk} = \mu + B_i + S_j + (B\times S)_{ij} + b_1(X_{ijk} - \bar{X}) + b_2 (X_{ijk} - \bar{X}) + b_3 (X_{ijk} - \bar{X}) + e_{ijk}}$ Where, Y_{ijk} is the record for the k^{th} animal. μ is the overall mean. B_i is the random effect of the i^{th} genetic group. S_j is the effect of the j^{th} season of sampling. $(B\times S)_{ij}$ is the interaction effect of the genetic group of animal and season of sampling. b_1 is the linear regression coefficient for temperature during sampling. b_2 is the linear regression coefficient for humidity during sampling. b_3 is the linear regression coefficient for temperature humidity index (THI) during sampling. X_{ijk} is the temperature, humidity and THI, resp. corresponding to $Y_{ijk..}$ $\bar{X}$ is the arithmetic mean of temperature, humidity THI, resp. during sampling. e_{ijk} is the residual error element with standard assumptions. Other statistical analysis like correlation etc. was calculated as per standard statistical techniques [16].

3. RESULTS AND DISCUSSION

Mean ± S.E. of various seminal parameters are presented in Table 1.

Table 1: Mean ± S.E. of semen quality parameters in different groups of genetic groups

Genetic groups	Semen Volume (ml)	Sperm Concentration (million/ml)	Initial Motility (%)	Post -thaw Motility (%)	Crenellation Pattern (score)
Sahiwal	4.75± 0.14$^{AC\ DE}$	1630.4±0.02^{ACEG}	66.0±0.9$^{A\ BCE}$	68.92±1.5$^{A\ CEG}$	1.89±0.07$^{A\ BCD}$
Gir	5.04± 0.14$^{DIL\ N}$	1460.2±0.02 F^{JNQ}	61.6±0.9$^{D\ IMP}$	30.4±1.4$^{FL\ PS}$	2.03±0.07$^{C\ HJM}$
Jersey cross	4.89± 0.14$^{CG\ LM}$	1086.4± 0.02^{DIMO}	65.8±0.9$^{B\ GLN}$	49.8±0.7$^{DJ\ OQ}$	2.11±0.07$^{C\ FJK}$
H.F. cross	3.96± 0.14$^{BF\ HJ}$	1263.9± 0.02^{BHJK}	66.7±0.9$^{A\ GHJ}$	61.6±1.1$^{BI\ KM}$	1.77±0.07$^{A\ EGI}$
Murrah	4.15± 0.14$^{EK\ MO}$	1584.9± 0.02^{GLPR}	70.5±0.9$^{F\ KOQ}$	26.8±1.5$^{HN\ RS}$	1.65± 0.07^{DILN}

Semen Volume

It could be seen from the result that the overall semen volume irrespective of season were highest in Gir (5.04±0.14 ml.) followed by those in Jersey cross (4.89 ±0.14 ml.), Sahiwal (4.75±0.14 ml.), Murrah (4.35±0.14 ml.) and H.F cross (3.96±0.14 ml.) in that order (Table 1). The effect of genetic groups, season, and genetic group x season interaction, air temperature and THI were found to be statistically significant at 1, 5, 1, 1 and 1% level respectively. Seasonal variation were observed in Sahiwal, H.F cross, Jersey cross and Murrah buffalo bulls between winter and summer. Higher volume was recorded during winter than summer season (Fig. 1). These findings coincided with some researchers in Sahiwal bulls [17, 18] and in H.F. cross bulls [19, 20] but some were in contrast [21-23] with the present findings. Comparatively lower ejaculate volume were reported in crossbred bulls [24], Sahiwal bulls and Murrah bulls respectively [19, 20]. Comparatively higher value than the present result was found in H.F cross bulls [25]. Higher values in winter season were also reported in Murrah buffalo bulls [26, 3].

ISBN: 978-93-85822-71-1

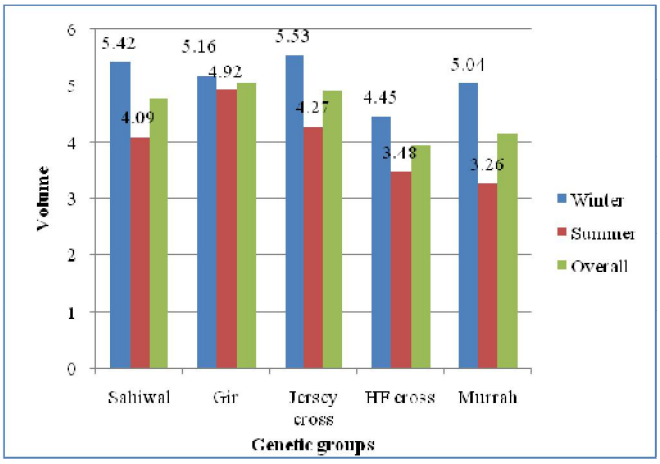

Figure 1: Semen volume of different genetic groups in different seasons

Sperm Concentration

Overall sperm concentration irrespective of season were found to be highest in Sahiwal (1630.4±0.02 million/ml.) followed by those in Murrah (1584.9±0.02 million/ml.), Gir (1460.2±0.02 million/ml.), H.F.cross (1263.9±0.02 million/ml.) and Jersey cross bulls (1086.4±0.02 million/ml.) in that order (Table 1). The effect of genetic group and genetic group x season were found significant statistically ($P < 0.01$). Only the differences in sperm concentration between H.F. cross and Jersey cross in winter and summer season were significant statistically ($P<0.05$). The present findings were higher than the present values in Sahiwal bulls [17, 22, 24, 27-29]. Similar value was reported in Jersey cross bull [25] and in H.F. cross bull [29], whereas lower value was found in H.F cross bull [25].

Initial motility

Overall initial motility of sperm irrespective of season were highest in Murrah **(**70.5±0.9%) followed by those in H.F. cross (66.7±0.9%), Sahiwal (66.0±0.9%), Jersey cross (65.8±0.9%) and Gir (61.6±0.9%) in that order (Table 1). The effect of genetic group, season and genetic group x season were found significant statistically ($P<0.01$). Initial motility was found to be lower in summer season in the present finding (Fig. 2). The differences in initial sperm motility between Sahiwal, Gir, Jersey cross, HF cross and Murrah buffalo bulls in winter and summer season were significant ($P<0.05$). The differences in initial sperm motility between Gir and Sahiwal, Murrah and Sahiwal, H.F. cross and Murrah, Jersey cross and Murrah and Gir and Murrah bulls were significant statistically ($P<0.05$). The present findings were in accordance with the observations of various researchers [22, 30, 27], but comparatively higher sperm motility in crossbred cattle and Murrah buffalo bulls than the present values were reported [31, 32, 24, 19, 20]. Significant seasonal variation in initial motility found in this study was in agreement with the reports of some research workers [33, 34]. This variation might be due to genetic differences, management and type of animal and adaptability of animal towards environment.

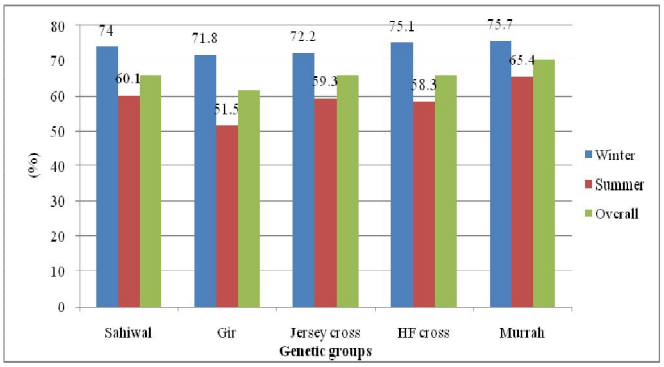

Figure 2: Initial motility of different genetic groups in different seasons

Post - thaw motility

Overall post-thaw motility of sperm irrespective of season were highest in Sahiwal (68.92±1.5%) followed by those in H.F. cross (61.6±1.1%), Jersey cross (49.8±0.7%), Gir (30.4±1.4%) and Murrah (26.8±1.5%) in that order (Table 1). Only the effects of genetic group, season, genetic group x season and THI were found significant statistically ($P<0.01$). Post-thaw motility was less in summer season (Fig.3). The differences between post-thaw motility of sperm between H.F.cross and Jersey cross. in winter and summer season was found significant statistically ($P<0.05$). Similar values were found in Friesian cross bulls [28]. Lower values in comparison to present findings were reported in Kundhi buffalo and crossbred bulls respectively [35, 20], whereas higher value was reported in Murrah buffalo bulls [20] . This variation might be due to the variation in climatic conditions of these two seasons and the uniformity in managerial practices under which these bulls had been kept.

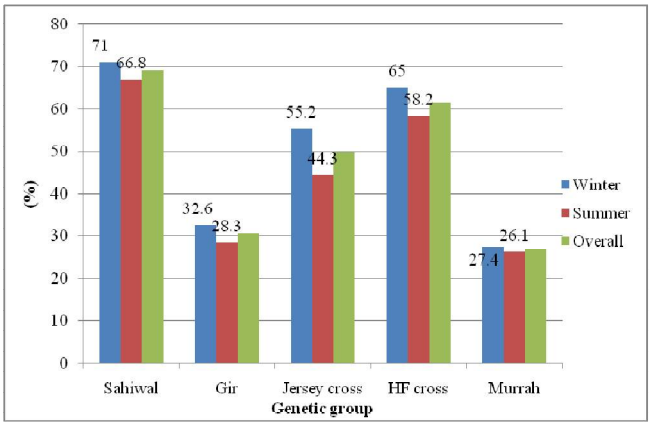

Figure 3: Post - thaw motility of different genetic groups in different seasons

ISBN: 978-93-85822-71-1

Crenellation Pattern

Overall crenellation pattern of semen irrespective of season were lowest in Murrah (1.65±0.07) followed by those in H.F.cross (1.77±0.07), Sahiwal (1.89±0.07), Gir (2.03±0.07) and Jersey cross (2.11±0.07) in that order (Table 1). The effect of genetic groups, season and genetic group x season interaction were found statistically significant at 1, 5 and 1% level respectively. Good crenellation pattern of semen was found during winter in comparison to that in summer season (Fig.4). The differences in crenellation pattern of semen between Sahiwal, Gir, H.F. cross and Jersey cross in winter and summer season were found to be significant ($P < 0.01$). Similar variation was observed in Karan Fries bulls [36] and in Murrah and crossbred bulls [37]. All these variations found might be due to differences in genetic constitution of bulls, variation in management and adaptability of the animal to particular situation.

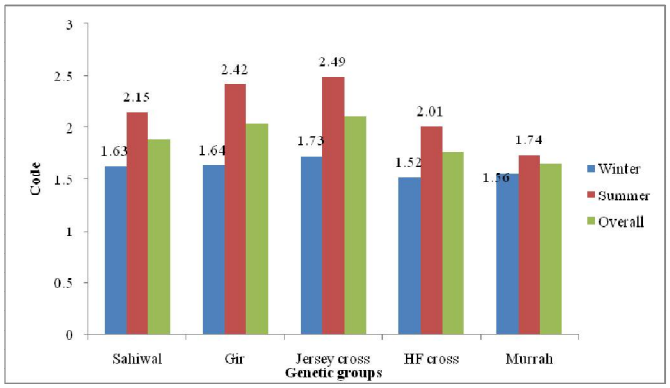

Figure 4: Crenellation pattern of different genetic groups in different seasons

CONCLUSION

Variation in semen quality was shown by different genetic groups of stud bulls. Better semen quality (semen volume, initial motility, post-thaw motility and crenellation pattern) was observed during winter than summer season. The differences found might be due to the species specificity of the bulls or due to the different expression of the trait as a result of genotype-environmental interactions, adaptability towards environment and management condition.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, Frozen Semen Bull Station, Nadia (West Bengal) for permitting to carry out the research work**.** It is also acknowledged to the official veterinarians and staff members of Frozen Semen Bull Station, Nadia (West Bengal), India for providing support in the work.

REFERENCES

[1] Troxel, T.R., Barham, B.L. "Comparing the 2000 and 2005 factors affecting the selling price of feeder cattle sold at Arkansas livestock auctions", *Journal of Animal Science*,.85, 12, December 2007, pp. 3425- 3433.

[2] Fraser, A. F., Broom, D. M., Farm Animal Behaviour and Welfare, 3rd Edition, Bailliere Tindall, London, 1990.

[3] Bhakat, M., Mohanty, T. K., Raina, V. S., Gupta, A. K. and Khan, H. M., "Frozen semen production performance of Murrah Buffalo bulls", *Buffalo Bulletin*, 30, 2, June 2011, pp. 157-162.

[4] Mandal, D. K. and Tyagi, S., "Body growth, gonadal development and semen quality of Frieswal bulls in relation to heat tolerance" *Indian Veterinary Journal* **86, 4, August 2009, pp.** 356-359.

[5] N.R.C., 2001, Nutrient Requirements of Dairy Cattle, 7th edition. National Academic Press, Washington DC., 2001, pp. 7-30.

[6] Amann, R. P. and Almquist, J. O.,"Bull management to maximize sperm output", in *proceedings the 6th Technical Conference on Artificial Insemination and Reproduction*, Milvaukee, USA, National Association of Animal Breeders, Columbia, Missouri, February 20-21 1976, pp. 1-10.

[7] Herman, H. A., Michell, J. R. and Doak, G. A., "The artificial insemination and embryo transfer of dairy and beef cattle", A handbook and laboratory manual, 8th edn. Interested Publishers Company, INC, Danville, Llinois, USA 1994, pp. 45-55.

[8] Salisbury, G. W., VanDemark, N. L. and Lodge, J. R. "Physiology of Reproduction and Artificial Insemination of Cattle", 2 edn. WH Freeman & Company, San Francisco, USA. 1978, pp. 428 - 441.

[9] Mortimer, S.T., "CASA-Practical aspects", *Journal of Andrology*, 21, 4, January 2000, 515-524.

[10] Rabidas, S. K., Talukar, A. K., Alam, M. G. S., Bari, F. Y., "Relationship between Semen Quality Parameters and Field Fertility of Bulls" *Journal of Embryo Transfer*, 27, 1, 21 January 2012, pp. 21-28.

[11] Elliot, F.I., Semen evaluation. "Physiology of Reproduction and Artificial Insemination of Cattle", 2nd edn. GW Salisbury, NL VanDemark, JR Lodge WH (edn), Freeman Company, San Francisco, USA, 1978, pp. 400-427.

[12] Ax, R.L., Dally, M., Didion, B.A., Lenz, R.W., Love, C.C., Varner, D.D., Hafez B. and Bellin, M.E., "Semen evaluation". In : Hafez, B. and E.S.E. Hafez (eds), Reproduction in farm animals, 7th edition, Lippincott Williams & Wilkins, Philadelphia, USA. 2000, pp 365-375.

[13] Tiwari, R., Mishra, G. K., Singh, R. B., Rehman, S. U., Rathora, K. S., Saxena, S. K. and Siddiqui, M. U. " Seasonal variations in the quality and freezability of Red Sindhi bull semen". *The Indian Journal of Animal Sciences*. 82, 11, pp. 1344 - 1346.

[14] Chaudhari, P. J., Dhami, A. J., Chandhari, D. V. and Parmar, S. C., "Freezability of cattle and buffalo semen and association of fresh and frozen - thawed sperm quality parameters". *International Journal of Current Microbiology Applied Science*, 6, 12, December, pp. 1445-1454.

[15] Harvey, W.R., User guide for LSMLMW and MIXMDL Package. Mix Model Least Squares and Maximum Likelihood Computer Programme, PC-2 version, Mimeograph, Columbia, Chio, USA, 1990.

[16] Snedecor, G.W. and Cochran, W.G., Statistical methods, 8th ed., Ames., Iowa State University Press, Ames, Iowa, USA, 1994.

ISBN: 978-93-85822-71-1

[17] Singh, S. P., Bhakat, M. and Singh, P., " Sexual Behaviour and its relatioship with semen quality parameters in Sahiwal breeding bulls", *Veterinary World*, 8 , 6, June 2015, pp. 745-749.

[18] Shanmugavel, S. and Singh, S. V. (2002) "Physical and biochemical constituents of Sahiwal bull semen in relation to their quality", The *Indian Journal of Animal Sciences*, 72, (1), January 2002, pp. 57-58.

[19] Pal, A., Chakravarty, A. K. and Chatterjee, P. N., " PCR-RFLP of growth hormone gene and its association with semen traits in buffalo and crossbred cattle", *in Proceedings 6th Indian Veterinary Congress, OUAT, Bhubaneswar*, Orissa, April 2006, pp. 22-28.

[20] Pal, A., Chatterjee, P. N. and Chakravarty, A. K., "Genetic study of dairy cattle and buffalo bulls based on growth, milk production and reproductive traits", *Iranian Journal of Applied Animal Sciences*, 2 , 3, September 2012, pp. 239-245.

[21] Javed, M. T., Khan, A. and Kausar, R.., " Effect of age and season on some semen parameters of Nili Ravi buffalo (*Bubalus bubalis*) bulls", *Veterinarski Archiv*. 70, 2, 2000, pp. 83-94.

[22] Chander, R., Bugalia, N. S., Karwasra, S., Garg, S. L. and Agrawal, V. K.,"Testosterone profiles and seminal characteristics in GnRH treated cow bulls", *The Indian Journal of Animal Sciences*, 74, 2004, pp. 180-181.

[23] Srivastava, S. and Kumar, S., "Effect of certain additives on the freezability of crossbred bull semen", *Asia Pacific Journal* of *Reproduction*, 27, 1, January 2006, pp. 1-5.

[24] Patel, J. B. and Dhami, A. J., "Computer assisted sperm analysis of Fresh and Frozen-Thawed HF X Kankrej (F1) bulls semen and their interrelationship", 47, 4, August 2013, pp. 315-320.

[25] Shaha, S. P., Alam, M. G. S., Khatun, M. and Ahmed, J. U., "Breeding soundness of stud bulls", *The Bangladesh Veterinarian*, 25, 2, December 2008 pp. 51-61.

[26] Mondal, D.K., *Effect of surface cooling on reproductive performance of Murrah buffalo bulls*, , NDRI Deemed University, Karnal, India, Ph. D. Thesis, 1998.

[27] Rao, T. T., Rao, M. M., Rao, K. B. and Naidu, K. V., "Semen ejaculates characteristics and fertility in Ongole bulls", *Indian Veterinary Journal*, 88, 2, April 2011, pp. 36-37.

[28] Hossain, M. E., Khatun, M. M., Islam, M. M. and Miazi, O. F., "Semen characteristics of breeding bulls at the central cattle breeding and dairy farm of Bangladesh", *Bangladesh Journal of Animal Sciences*, 41, 1, October 2012, pp. 1-5.

[29] Ray, K. and Ghosh, B. B., "Semen Ejaculates Characteristics, in vitro fertility and their interralationships in Sahiwal Bull Semen". *Iranian Journal of Applied Animal Sciences*, 3, 3, September 2013, pp. 483-489.

[30] Kumar, A. S. and Prakash, K. R. "Comparative study on physio-morphological characterstics of semen from Murrah Buffaloes and Jersey crossbred cattle", *Cibetch Journal of Bio- Protocols*, 3, 3, September - December 2014.

[31] Pandey, A.K. *Effect of blood serum and caffeine on cryopreservation of buffalo spermatozoa*, G.B. University of Agricultural and Technology, Pantnagar, India, M.V.Sc. Thesis, 2001

[32] Shukla, M. S. and Mishra A. K. "Correlation between seminal characteristics in Murrah bulls", The *Indian Journal of Animal Sciences* 75, 3, March 2005, 263-266.

[33] Ghasemi, M. V. and Ghorbani, A.," Environmental and Genetic Factors Affecting on Semen Quality in Iranian Holstein Bulls", *Iranian Journal of Applied Animal Science*, 4, 1, March 2014, pp. 33-37.

[34] Mostari, M. P., Hasanat, M. S., Azmal, S. A., Monira, K. N. and Khatun, H., "Effect of seasonal variation on semen quality and herd fertility", *Pakistan Journal of Biological Sciences*, 8 ,4, October 2005, pp. 581-585.

[35] Rehman, Z. U., Samo, M. U., Qureshi, T. A., Khan, S., Qureshi, M. S., Khan, F. A. and Bahadadr, S., Studies on the freezability of Kundhi Buffalo bull semen. *Proc. Int. Workshop. Dairy Sci. Park, Agric. Univ. Peshawar, Pakistan*. *The Journal of Animal and Plant Sciences*, 22(2 Suppl.), Nov. 21-23 2012, pp. 18-23.

[36] Mandal, A., Sharma, A. and Ramachandran, N. Assessment of crenellation patterns of semen in Karan Fries bulls. *The Indian Journal of Animal Sciences*. 78 (11), 1261-1262. November 2008.

[37] Kumar, U., Gawande, A. P., Sahatpura, S. K., Patil, M. S., Lakde, C. K., Bonde, S. W., Borkar, P. L., Poharkar, A. J. and Ramteke, B. R., Assessment of semen quality in pure and crossbred Jersey bulls, *Veterinary World*, 8 (10), October 2015, pp. 1266 - 1272.

ISBN: 978-93-85822-71-1