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Opinion

Reproductive Biotechnology; An Under-utilized Tool in Poultry Breeding

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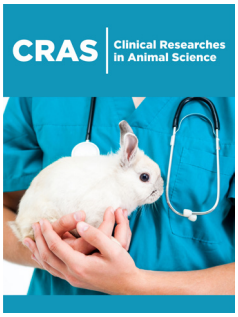
ISSN: 2770-6729



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Submission: July 19, 2022

Published: August 08, 2022

Volume 2 - Issue 2

How to cite this article: Balogun Adedeji Suleimon. Reproductive Biotechnology; An Under-utilized Tool in Poultry Breeding. Clin Res AnimSci. 2(2). CRAS. 000534. 2022.
DOI: 10.31031/CRAS.2022.02.000534

Abstract

Accelerating genetic gain in poultry breeding with reproductive biotechnology tools is quite important as it is practiced in other farm animals. Over the years application of reproductive biotechnology techniques in poultry breeding has been limited to Artificial Insemination (AI) in most parts of the world. Although this technique has greatly assisted breeding of large poultry species type of birds like turkey, ostrich etc. However, complementing this technique with other advance reproductive biotechnology techniques, such as semen dilution, semen liquid storage and cryopreservation of gametes and embryos is quite important. Achieving this ditto field application in poultry breeding like it is done in cattle will be of greater advantage to genetic improvement and in-situ conservation in poultry species. This few pages' opinion, therefore, harnesses the challenges and solutions to accelerate genetic improvement in poultry species through the application of advance reproductive biotechnology tools.

Keywords: Poultry; Genetic gain; Reproduction; Biotechnology; Breeding

Introduction

The use of recent advances reproductive biotechnology in poultry breeding over the years has been limited which resulted into inability to accelerate genetic improvement in poultry breeding industries. Although poultry species among other farm animals may have taken advantages of their short generation interval, and highly prolificacy rates for the genetic gain experience over the years till present. However, accelerating genetic gain of such species of farm animals with the use of advance reproductive biotechnology tools will be of greater advantage to poultry breeding industries.

Animal Breeding for the Genetic Improvement of Poultry Species

Animal breeding basically operates through the selection and designing mating pattern of genetically superior animals as parents for subsequent generations. So far artificial selection could therefore only be applied to traits which are "naturally" exhibiting genetic variation in the selected populations, i.e., traits characterized by some degree of "heritability". The rate of genetic progress or response to selection is a function of:

A. Percent heterosis resulting due to level of heterozygosity in the selected individuals.

B. The accuracy of selection, i.e., the precision in the identification of genetically superior animals.

C. The generation interval, the shorter the generation interval, the faster the genetic progress

D. The selection intensity, i.e., the more the future parental individuals deviate from the average breeding value of their contemporaries, the higher the genetic improvement they will cause.

E. Percent increase in performance resulting from change in gene frequency.

Three major topics can be distinguished in the area of biotechnology applied to the genetic improvement of livestock:

a) Reproductive technologies,

b) Livestock genomics and Marker Assisted Selection (MAS), and

c) Livestock transgenics.

What is Reproductive Biotechnology?

Is an art of using advance technology in reproduction for manipulation of reproductive processes in living things. It started in 1930s with Artificial Insemination (AI). Its use became widespread in the 1960s when AI organizations began to make routine use of frozen semen. One of the challenges for genetic improvement is to increase reproduction rates. Several reproduction techniques are available. The commonest of these are Artificial Insemination (AI), embryo transfer and associated technologies like semen dilution, liquid semen preservation, gamate and embryo cryopreservation. AI and embryo transfer techniques offer animal breeders a number of opportunities to enhance the rate of genetic progress in national breeding programs.

Reproductive biotechnology is being applied to enhance genetic progress in livestock through enhancing different mating system, breeding methods, conservation of gametes and genes. Among those technology of great relevant to reproduction are discussed below. In this text emphasis will be laid on reproductive biotechnology techniques or tools deemed for accelerating genetic improvements and conservation of poultry species.

Artificial Insemination (AI) uses in Livestock

No other technology in agriculture except hybrid seed and fertilizer use has been so widely adopted at a global scale as AI. Progress in semen collection, dilution and cryopreservation now enables a single bull to be used simultaneously in several countries for up to 100,000 inseminations a year [1]. The Advent of efficient semen freezing methods, has tremendously catalyzed AI to become the most widespread biotechnology applied to livestock most especially in cattle breeding and production. By allowing for the widespread use of small numbers of elite sires, AI has also had a dramatic impact on selection intensity.

In addition, progeny-testing practices in cattle production is partly achieved through AI, and which has had a major impact on the improvement of the herd by increasing the accuracy of selection despite the associated high generation interval. The high intensity and accuracy of selection arising from AI can lead to a four-fold increase in the rate of genetic improvement in dairy cattle relative to that from natural mating [2]. Additionally, use of AI can reduce transmission of venereal diseases in a population, reduces the need for farmers to maintain their own breeding males, facilitates more accurate recording of pedigree and is a cheaper means of introducing improved stock.

Artificial Insemination (AI) uses in Poultry Breeding

Although AI is the most widely available use reproductive biotechnology in poultry production in both developed and developing countries probably due to ease in the technicality to practice it on poultry species compared to mammals. However, other potentials or benefits achieved through AI in cattle production and other livestock species such as progeny testing, semen dilution and semen preservation is yet to be widely benefited or applied in poultry breeding and production.

Poultry Semen Characteristics

Poultry semen is viscous and highly concentrated, containing sperm concentrations of 6 (rooster) to 12 (tom) billion sperm per ml of ejaculate [3]. After collection, poultry semen must be diluted with buffered salt solutions, or extenders, to maintain the viability of sperm *in vitro*. Dilution of neat semen is also advantageous in that more hens can be inseminated from a single semen sample. The fertility capacity and sperm motility of fresh semen *in vitro* usually decrease within an hour after collection [4].

Semen Dilution

This is an assisted reproductive technique that serve as catalyst for AI practices in animal reproduction. Semen dilution is a simple practice of increasing the volume of ejaculate from a male animal to serve larger number of females thereby making efficient use of the sperm cells without harmful effects on the spermatozoa ditto fertilizing ability of the spermatozoa. For effective and successful semen dilution, a medium very close to seminal fluids in composition is required. i.e, non-toxic, isotonicity, good buffering capacity, nutrients and energy for sustainability of the sperm till fertilization. This kind of medium are generally referred to as semen extenders or semen diluents.

Semen Extenders

The primary quality for a satisfactory extender for semen are to provide enabling environment and a good medium for sperm activities. There are many variations in extender composition; however, the basic goals are to maintain pH and osmolarity, reduce metabolism, as well as provide an energy source for metabolism. Qualities of a good extender are highlighted below:

A. Isotonicity

B. Non-toxicity

C. Correct balance of electrolytes and non-electrolytes

D. Reduce metabolic rate of the preserved spermatozoa

E. Affordable to prepare at low cost

F. Assurance of livability of diluted and stored semen.

Semen Preservation

The two commonest techniques for semen storage are chilling and cryopreservation. For the chilling technique, semen is stored at 4-5 °C for 3 days for maximum and best results. In the cryopreservation technique, semen is exposed to liquid nitrogen at -196°C. Meanwhile, it is filled into 0.25-mL straws and finally preserved and stored in liquid nitrogen for years. Therefore, the crucial factors for long-term semen preservation to retain its quality include cooling for 2-3h, adding a cryoprotectant, and freezing in liquid nitrogen [5]. This technology has been greatly applied in cattle breeding and has tremendous impact on accelerated genetic improvement in cattle production. It has also greatly encouraged transfer and exchange of germplasm with ease in cattle production for genetic improvement and conservation.

However, this technology is still at prime stage and experimental phase in poultry breeding and production. Many researchers have identified so many factors limiting semen storage success in poultry species or inconsistent results in semen storage techniques [6-10]. Inability to effectively preserved poultry semen is suspected to the morphology of the sperm different from other farm animal species due to its tinny head nature of the sperm hardly differentiated from the tail or rest of the sperm body. Further-more it is suspected to be highly concentrated in protein than other farm animals which makes it turn rapidly gelatinous nature during processing and preservation. Also, insufficient level of antioxidant activities suspected to be obviously inadequate in poultry species. Iaffaldano et al. [11], also reported that semen of the domestic turkey cannot be stored longer than 6h without a loss of fertilizing capability.

The improvement of long-term liquid storage procedures of semen is important since the commercial production of turkey and other economic poultry species relies almost entirely on artificial insemination. Moreover, the exploring genetic improvement strategies like the use of line breeding by keeping the semen of the best performing sires for crossing of his progeny of successive generations to enhance grading up genetic improvement practices. Furthermore, transfer or exchange of germplasm and cryo-conservation has proven difficult and unpracticable in poultry breeding and genetic improvement [12].

Sex Selection

Recent improvements and success in flow cytometric sorting which allows for the effective separation of viable X and Y-bearing sperm in most mammals cannot be practice in poultry species. Since the female is the determinant of sex in poultry. Even when experimented the numbers of cells recovered are incompatible with conventional AI practices as it is in cattle. Compared to cattle, few, scanty and undocumented has been reported with IVF techniques in poultry species. While this might have become the most appropriate method of choice to reduce or alleviate excessive hatching and production of males in the breeding industries and achieve desired sex ratio after hatching of the chicks. However, in poultry species female is the determinant of the sex, which made this technology irrelevant in poultry breeding.

Gamete and Embryo Cryopreservation

Cryopreservation plays a crucial role in conservation programs aimed at maintaining genetic diversity and *in-vitro* storage of endangered species. However, this reproductive technology tool is still sparsely use in poultry breeding and production and make *ex-situ* conservation and line breeding of poultry species very difficult.

Conclusion and Recommendation

All the above discussed reproductive biotechnology tools are most widely used in cattle and other economic livestock species and being practice in both developed and developing countries. However, their uses in poultry species particularly in developing countries is far much less than in the developed countries. Although the technology is available in most developing countries, it has remained generally unexploited, being only used for “exploratory” purposes mainly by research institutions. And the technology is far from field application in poultry species, mostly countries have not even explored these tools for “upgrading” of their indigenous poultry species or conservation of their endangered and economic poultry species. Although all this technology is available for other domestic livestock and poultry species, its use is still more generally associated with dairy cattle. Research to improve and intensify efforts for the field application of semen dilution and preservation (liquid storage, freezing-and-thawing) of most poultry species gamate and genes is of utmost paramount for accelerate genetic improvement and conservation of endangered poultry species. With successful semen dilution and preservation in poultry, it is providing the impetus for many other developments which have had a profound impact on reproductive biotechnology.

References

1. Gibson JP, Smith C (1989) In: Babiuk LA, Phillips JP, et al. (Eds.), Pergamon Press, Oxford, UK, p.203231.
2. Van Vleck LD (1981) In: Brackett BG, Seidel GE, et al. (Eds.), New technologies animal breeding, Academic Press, New York, USA, pp. 221-242.
3. Donoghue AM, Wishart GJ (2000) Storage of poultry semen. Anim Reprod Sci 62(1-3): 213-232.
4. Dumpala PR, Parker HM, Mcdaniel CD (2006) The effect of semen storage temperature and diluent type on the sperm quality index of broiler breeder semen. Int J Poultry Sci 5(9): 838-845.
5. Baiee FH, Wahid H, Rosnina Y, Ariff O, Yimer N, et al. (2018) Impact of Eurycoma longifolia extract on DNA integrity, lipid peroxidation, and functional parameters in chilled and cryopreserved bull sperm. Cryobiology 80(2): 43-50.
6. Balogun AS (2021) Optimizing liquid storage duration of two poultry species semen with plant-based extender. Letters in Animal Biology 1(2): 01-06.
7. Balogun AS, Narang R, Cheema RS, Dubey PP, Dash SK, et al. (2021) Freezing ability of two slow permeating cryoprotectants on rooster semen diluted with tris egg yolk juice extender. Letters in Animal Biology 1(2): 07-13.

8. Balogun AS, Narang R, Cheema RS , Ajeet K , Narinder S et al. (2020) Comparison of conventional and automated freezing methods on PB_2 rooster semen cryopreserved with glycerol and dimethyl sulfoxide tris coconut-water extender. Bulletin of the National Research Centre 44(115): 1-8.

9. Balogun AS (2019) Evaluation of antioxidant potentials of tomato and orange juices on extended poultry semen preserved with egg yolk and coconut water diluents to improve selection intensity. Ph.D. Dissertation. Guru Angad Dev Veterinary and Animal Science University, India.

10. Balogun AS (2014) Survival and fertilizing potential of cock spermatozoa extended with diluent fortified with natural antioxidants. M.Sc. dissertation. University of Ibadan, Ibadan, Nigeria.

11. Iaffaldano N, Meluzzi A (2003) Effect of dialysis on quality characteristics of turkey semen during liquid storage. Theriogenology 60(3): 421-427.

12. Oluwatoba AA, Samuel AA, Mathias OK, Isaac O, Ibidapo AO, et al. (2017) Effect of *Borassus aethiopum* extract as a biological extender on semen characteristics, fertility, and hatchability in chickens. Journal of Agricultural Sciences 62(4): 385-393.