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Gynogenesis: Successful method for sex reversal

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Abstract
Gynogenesis is a way of Sexual reproduction to produced desired offspring only with the help of maternal gametes. Disabled sperm was used to fertilize the maternal egg to produce the progeny. Genetic material of sperm was ruined by using certain radiation like UV or X-rays. Concentration and the exposure duration of radiation were very important to disabled the sperm. After the fertilization of the egg with the deactivated sperm the main focus is on the restoration of diploidy which was achieved by applying shock treatment to the eggs. While the induction rate of gynogenesis was comprised of 90-100% but the survival rate of the progeny was mot maximum because it differs in various species due to certain factors like shock type, time of exposure and size of the organisms. Beneficial results have been shown in fish breeding to obtain maximum number of female progeny. This method was adopted to obtain monosex population to meet desired demand. The resultant progeny which were obtained from gynogenesis method was haploid in number.

Keywords: Gynogenesis, successful method, sex reversal

Introduction
A method of imitation in which progeny are made from maternal gametes only are known as gynogenesis [1-3]. The product obtained from the uniparental which is maternal genetic material are the gynogenetic products [4]. It is an induced method of reproduction in which maternal genome is activated with the help of hereditarily deactivated sperm. More potential of gynogenesis has been shown in fish breeding [5]. A distinct form of sexual reproduction in which fertilization is essential but the head of sperm penetrating into the ovum does not move into male pronucleus and the gynogenic embryos develop from the ovum nucleus only. Production of gynogenetic embryo held only by the fertilization of gynogenic female with the bisexual male [3].

Monosex population
From the techniques of gynogenesis all female population can be achieved. In the process of induction of gynogenesis by the inactivation of sperm genetically. The resultant generation is haploid in numbers unless diploid is restored by retaining second polar body [6]. For the identification of genetic mechanism of sex determination, the most preferred type is mitotic gynogenesis as compared to meiotic gynogenesis [7].

Steps involved in Gynogenesis Production
Basically, the method of gynogenesis is comprised of two steps which involves,

1. Fertilization of egg with inactivated sperm with the help of radiation artificially. Genetic material present in spermatozoa can be demolished by exposing milt to several radiations include UV, X-rays and gamma rays. The matter of concern is exposure time, intensity of radiations and the spermatozoa for the haploid production [4].
2. After fertilization restoration of diploidy by applying shock treatment to eggs or by suppressing the first mitotic cleavage [8]. Polar bodies were also retained for the production of triploids [9].

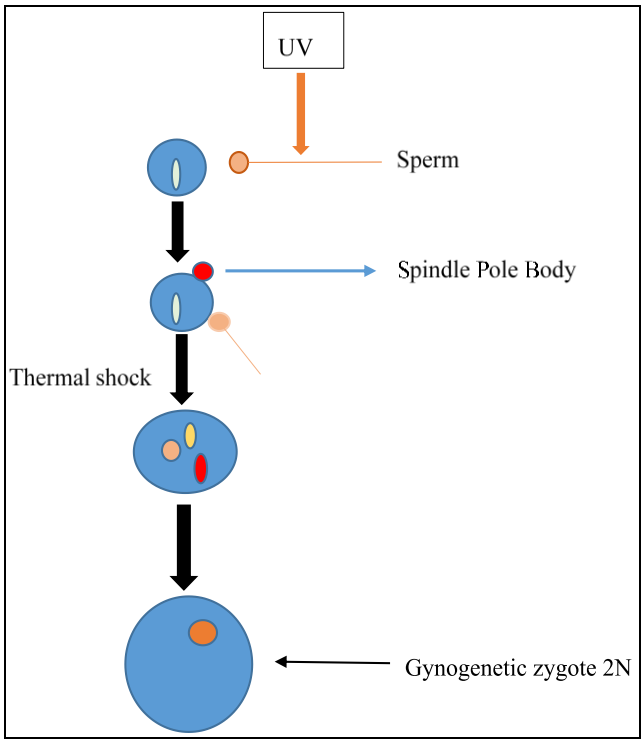

Fig 1: Production of Gynogenes by shock treatment

The effective and fastest method for the development of pure lines is gynogenesis. The gynogenetics either haploid or diploid is also a valuable tool for the production of genetic maps [10]. Along with several benefits gynogenesis also has drawbacks which include low competence to meet breeding requirements [11]. Due to gynogenesis the rate of viability decreases;also there is a chance to achieve the dominant component of genetic variance [12].

As compare to the higher animals, in fishes the sex determination is usually attained genetically but it can also be effected by few environmental aspects [13-16]. Heterosome and autosomes are the type of sex determination which are present in fishes [17]. In gynogenetic progenies investigation of sex ratios can offer valuable information for measuring sex determination mechanism [18].

Types of gynogenesis

The types of gynogenesis which are commonly found are named as meiotic gynogenesis and mitotic gynogenesis [19].

Meiotic gynogenesis

Meiotic gynogenesis also called as meiotic gynogenesis. Meiotic gynogenesis formed by the help of polar body in their meiotic division. Meiotic gynogenesis is a process designed by the involvement of second polar body after their second meiotic division. By inhibiting second meiotic division meiotic gynogenesis is obtained. Retention of polar body held within the egg after that fusion of egg is done with the maternal pronucleus for the formation of diploid zygotic nucleus. Set of maternal chromosomes is present within the polar bodies. Polar bodies are formed as a result of non reductional division of meiosis. Due to several recombinant events which changes the information regarding genetics during the chromosomes pair, polar bodies are identical to the haploid egg nucleus. For all loci on the genomes the meiotic gynogens are not homozygous in nature. The survival rate of meiotic gynogenesis is higher when compared to the mitotic gynogenesis and also meiotic gynogenesis is easier to perform according to practical purposes [20]. The efficient method to reveal the genetic mechanism of sex determination is meiotic gynogenesis [21]. The artificial method for the induction of meiotic gynogenesis is to activate the egg with the help of UV irradiated heterogynous sperm after that second polar body in the egg retained by the help of shock treatment i.e. cold [10].

Mitotic gynogenesis

Second name of mitotic gynogenesis is mit-gynogenesis. Mitotic gynogenesis is a process of duplication of maternal chromosomes for the purpose to generate two haploid set of chromosomes during their first embryonic cell cycle. In mitotic gynogenesis the two sets of chromosomes which are derived from the duplicated maternal nucleus haploid in nature. Cells involved in mitotic gynogenesis are homozygous for all the loci. As comparing to the meiotic gynogenesis the mitotic gynogenesis does not have the capability to produce much of the feasible fishes due to its homozygous nature for all the loci, even a harmful recessive alleles are capable to yield their phenotype [22]. By hindering first mitotic division with the help of anexterior shock mitotic gynogenesis can produce the double diploids. The production of homozygous lines in the first generation and the production of clonal lines in second generation done by mitotic gynogenesis [23]. Mitotic gynogenesis also has the potential to eliminate the harmful alleles from the inbred lines and then crossed to produce heterosis [24].

Shock Treatment

There are several techniques which are used for the restoration of diploid embryos which was done through the disruption of first mitotic division or suppressing the second meiotic division. These several techniques include thermal shock, cold shock, pressure shock, UV radiation, hydrostatic pressure and chemical shock. Along with the shock treatment manipulation of eggs and sperm can also be done by creating haploid, triploids and tetraploids.

UV- Treatment

The most commonly used shock treatment is UV radiation due to its high success ratio in order to cross link parental DNA and generatedeactivated sperm genetically [25, 26]. UV radiation only involves in in the inactivation of genetic material of sperm but they stay in the position of motile and alive. For the successful production of haploid embryo, the optimum duration and intensity of radiations can be determined [27]. This treatment was applied in silver carp for the purpose of proliferation through meiotic gynogenesis by the help of UV treatment [22]. It is an efficient method to persuadegynogenesis in several species like topmouth culter (*Culter alburnus*) by UV rays [11], Japanese crucian carp *(Carassius cuvieri)*[5] also in Eurasian perch(*Perca fluviatilis*) [28].

Cold Shock Treatment

In second step of gynogenesis which is the retention of polar bodies or suppression of mitotic division cold shock treatment were given due to its several benefits which includes no need of any special equipment, feasible, time saving because large numbers of ova can be processed at once [29, 30]. Better results can be obtained by focusing on the time, intensity and time period of shock [31]. Cold shock treatment is most commonly used for the retention of polar bodies and also for the induction of triploids [32]. For induction of gynogenesis in

fishes' cold shock was mostly used due to its profits. This method is induced in several species like Turbot (*Scophthalmus maximus*) [6] and yellow drum (*Nibea albiflora*, Sciaenidae) [33].

Hydrostatic Pressure

Hydrostatic pressure was also used for the retention of polar bodies and this treatment have large survival rate on the stage of hatching in fishes as compared to other several methods [34]. Second polar body was retained by Atlantic Halibut (*Hippoglossus hippoglossus*) [4] and meiotic gynogenesis was attained by hydrostatic pressure treatment in Atlantic cod (*Gadus morhua*) [35].

Pressure Shock

Pressure shock treatment was another method used for the retention of polar bodies and this treatment has less chance of error. Diploidization achieved through this method was more reproducible and easily accomplished [25]. This treatment helps in activation of gynogenesis in turbot (*Scophthalmus maximus*) [36].

Thermal Shock

Thermal shock treatment was also used for the retention of polar bodies and this treatment includes both cold and hot shock treatment. Heat shock treatment helps in inducing gynogenesis in several species which includes silver barb (*Barbonymus gonionotus*)[24] and also in Atlantic salmon *(Salmo salar)* [37].

This technique helps in the induction of production of all female population. In a single generation 50-100% inbred lines can be achieved. It is useful for the production of monosex stock of Silver carp [38] to breed it with normal progeny to produce 100% female population to meet the commercial demands. This is an efficient technique to produce males with the genotype of female.

Conclusion

Gynogenesis method was proved so valuable and more impactful on commercial point of view. Because Gynogenesis is a method to attain monosex population which proves fruitful for the farmers to attain the high yield and meet the commercial demands. Although this method is so sensitive and very hard hitting in the context of handling due to the intensity and the exposure time of the radiations used in it. But still it proves so favorable for the fish breeding. The mainly used radiations for the deactivation of milt are UV and X-rays. While for the restoration of diploid mainly cold shock and thermal shock therapy were used along with others.

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