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Commentary

Significance of Membrane Lipid Fatty Acids and Their Modifications in Cattle Sperm Cryopreservation

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DESCRIPTION

The structure and function of the sperm cell are distinctive in many ways. It can fertilize eggs and works in a body unrelated to its origin or gender. Its plasma membrane's lipid makeup likewise differs from that of the majority of other cell membranes. High levels of Polyunsaturated Fatty Acids (PUFA), particularly diPUFA (phospholipids esterified with two PUFA), which are exclusively present in sperm, the retina, and specific regions of the brain, are present in it. PUFA in particular are known to contribute to the elasticity and fluidity of membranes. Phospholipids, of which phosphatidylcholine, phosphatidylethanolamine, and sphingomyelin are the main constituents, constitute the most typical lipid fraction of the membranes of sperm cells.

Sperm cell lipid and fatty acid content varies not only between animals but also between species, even between fertile and subfertile populations of the same species. Only after epididymal maturation do ejaculated spermatozoa acquire their distinct lipid pattern. It has been demonstrated that the plasma membrane lipids of the spermatozoa of the goat, ram, and boar underwent significant modifications during epididymal maturation. Boar, bull, ram, and rat whole sperm experience a decrease in lipid content during epididymal maturation, and ram, rat, and hamster sperm experience a decrease in cholesterol content. Whole ram sperm have lower cholesterol to phospholipid ratio and phosphatidylserine, phosphatidylethanolamine, cardiolipin, and ethanolamine plasmalogen concentrations. The amount of lipid reduces during epididymal development, according to studies utilising plasma membrane separated from pig spermatozoa. Despite a drop in cholesterol, there is no discernible change in the ratio of cholesterol to phospholipids. Phosphatidyl ethanolamine and phosphatidyl inositol are also decreased, while dermosterol, cholesterol sulphate, phosphatidylcholine, and polyphosphoinositides are increased. Fatty acid levels are dropping while diacylglycerol levels are rising, but fatty acid saturation levels remain unchanged. Ram sperm's anterior head region's plasma membrane is especially abundant in ethanolamine and choline phosphoglycerides. During epididymal maturation, the ratio of cholesterol to phospholipids increases while dermosterol and ethanolamine levels in this area of the plasma membrane decrease. Phosphatidylcholine and phosphatidylethanolamine are two ether lipids that are notably abundant in the plasma membrane of goat sperm. Diacyl phosphatidylethanolamine drops most dramatically (by around 65%) as sperm mature in the epididymis, out of all the membrane phospholipids. It is considered that ejaculated sperm is more sensitive to cold shock than testicular sperm because of changes in the number and make-up of lipids in the plasma membrane of sperm during maturation. Sperm membrane integrity is impacted by cryopreservation. The capacity of male gametes to be frozen depends on differences in spermatozoa's fatty acid composition and lipid class ratios between species. Reduced sperm motility and fertility are linked to higher levels of free cholesterol, free fatty acids, triacylglycerol, and cholesterol ester. Also, it is clear from the works on bull semen that the composition of fatty acids, particularly PUFA and DHA, decreases as a bull's age increases.

Egg yolk is a popular and widely recognised key component of diluents used to freeze bovine spermatozoa for use in Artificial Insemination (AI). Spermatozoa are effectively protected from cooling and thawing by it. Frozen spermatozoa are given cryoprotection by various lipid extracts. Spermatozoa that have been frozen in an egg yolk lipoprotein have shown to retain their fertility, according to Foulkes and Stewart. Immunological studies have provided a clear understanding of egg yolk lipoprotein's irreversible binding and its function in cryopreservation. Because the whole egg yolk reduces spermatozoa's respiration and mobility, some authors are hesitant to use it as an extender for cryopreservation. Low Density Lipoprotein (LDL), which is a necessary component for cryopreservation, may be easily extracted using simple methods, and it has been noted that LDL extenders are better at preserving sperm viability and motility than commercial egg yolk extenders.

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Pigeon egg yolk has the highest success rate when thawed with bull sperm, according to a comparative research of egg yolk from five bird species used as a cryoprotectant. Post-thaw sperm properties were improved by adding bull semen extender with n-3 fatty acid and -tocopherol. Prior to semen freezing, the percentage of DHA was higher in the group receiving fatty acid therapy than in the group receiving no fatty acid, and it considerably dropped in both groups after thawing.

Overly high levels of lipid peroxidation during sperm cryopreservation could be a feasible explanation for this decline. This is caused, as previously claimed, by excessive peroxidation.

Nevertheless, adding -tocopherol is efficient and can have the opposite effect. Similar studies in ram semen produced results with FA and -tocopherol that were comparable.

Sterols, steryl esters, and 1-O-alkyl-2,3-diacyl glycerol reduced noticeably among neutral lipids, but phosphatidylcholine and phosphatidylethanolamine significantly declined among phospholipids. When the proportion of saturated acids increased, the amount of unsaturated fatty acids linked to the phospholipids decreased. During the freezing stage of goat cryopreservation, the addition of egg yolk is crucial, and the addition of trehalose significantly increased its cryoprotectant action.