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REVIEW ARTICLE **OPEN ACCESS**

Highlights of Artificial Pearl Culture from Traditional to Biotechnological Aspects

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ABSTRACT
In developing countries, pearl oyster culture acts as major source of economic opportunities for domestic to industrial based cultivation. Through the export of pearl remarkable revenue generation is done followed by the reduction in economic aids from other countries. For the traditional cultivation of pearl, common bead material to all other material which share identity to natural bead material will promote nacre formation. This variation will help in development of various kind of pearl through artificial methods ranging from conventional trend to systematic approach. In this review, we discuss the various historical traditional methods to current biotechnological approaches for culturing of pearl oysters.
Key words*: Pearl culture, Traditional culture, Biotechnology*

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INTRODUCTION
Pearl's mineral phase which is composed of calcite, aragonite and vaterite in ratio determines pearl quality. The matrix protein contributes in biomineralization in the formation mechanism of pearl. The molecular mechanism of pearl biomineralization is extremely complicated regulation of matrix protein. Thus, there is emphasis on the regulation mechanism of matrix proteins with predominant concern to molecular mechanism in which nucleated pearl biomineralization and the matrix protein has been identified as major targets. *Pinctada fucata* and *Pinctada maxima are the famous examples for these studies.* Future research ought to focus on exploring the mechanism of freshwater formation. The characteristic structure of pearls showed that it tends to have a thin prismatic layer before nacre mineralization the regulatory role of matrix protein in pearl formation has been known and developed, now little research has been done to connect matrix proteins with pearl quality traits, such as color, shape, and weight. Therefore, it is necessary to increase the connection between the mechanism study and the pearl industry.

CULTURED PEARLS
Mortality of oysters can take place due to the effects of surgery and infection and due to many other factors, such as disease, shell boring, and biofouling. Annual mortality should be kept within 10% of the stock through proper farm management, In the higher diameter range of nucleus, nucleus rejection is a common feature. This should be kept to a minimum through improvements in the surgical procedure. The process of pearl formation in summarized in Figure1 and 2.

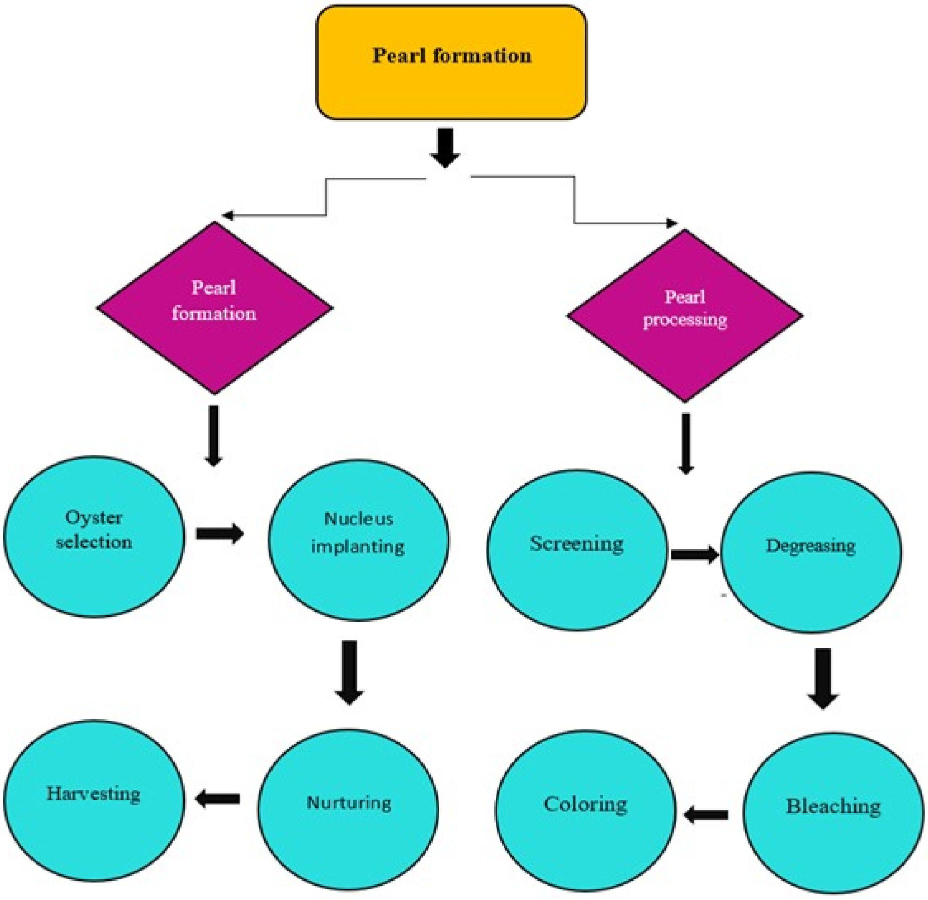

FIGURE1: GENERAL APPROACH OF PEARL PROCESSING AND FORMATION

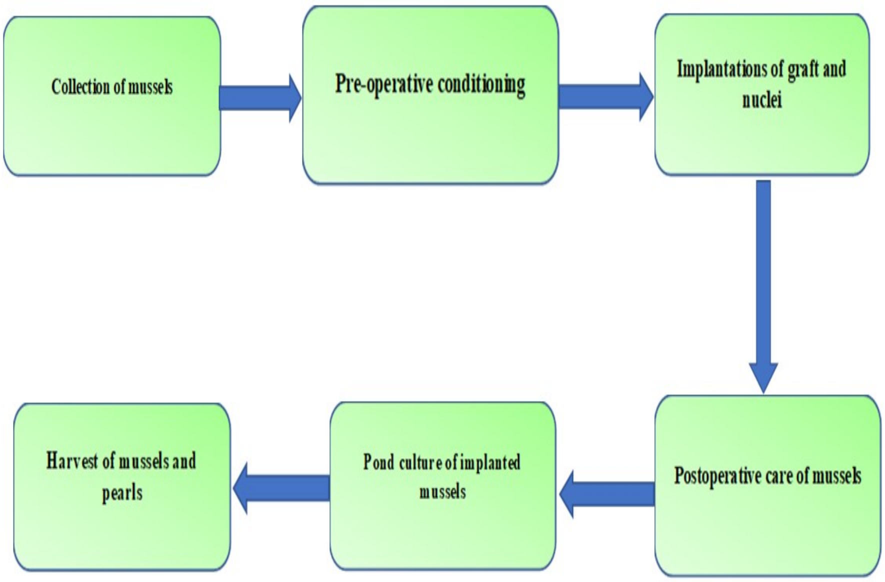

FIGURE2: PEARL FORMATION THROUGH BIOTECHNOLOGICAL APPROACH

HISTORY

First artificially cultured pearl (Blister pearls) in Japan by Kokichi Mikimoto under Kakichi Mitsuri; a professor at Tokyo Imperial University. Biomineralization and genome analysis is making rapid progress in pearl culturing industries. Countries like India, China, Egypt, Persia, and Rome have been cherishing pearls since ancient times [1,2,3]. Genetic research is progressing and playing an important role in the field of science. Genome analysis in pearl research is progressing [4,5,6,7] and giving a clear concept of the mechanism of nacre formation. [8,9,10]. A recent development is seen by the draft genome sequencing of Japanese Akoya Oyster in 2011 [11]. These researches add to advancement in pearl culturing and managing bioresources. Advancement in pearl culture also contributes to development in medical treatments, medicine, and other industries. Japan developed a technique for obtaining a gem-quality pearl [12]. Techniques for nucleus insertion operation have been improvised such as the production of large pearls by ova extraction method and advancement of surgical tools [13,14,15]. Culture management techniques such as shell cleaning and winterizing progressed rapidly. Other improvements include pearl quality yield by preparing oysters before and recovering after operation [16,17] and shell cleaning in culture management[18,19]. Maintaining a stable oyster supply such as natural spawning and hatchery has been used in the breeding of oysters [20]. Genetic and hereditary approaches are expected to make large contributions in the future development of technologies improving the yield and quality of the pearl [21,22].

USE OF ORGANIC AND BAROQUE SHAPED NUCLEI:

Recent developments show the use of organic nuclei for beaded baroque cultured pearls. Pearls with irregular shapes ranging from minor aberrations to distinctly ovoid, lump, etc. are called baroque pearls. Cultured freshwater pearls are baroque shaped as they are not beaded nuclei instead, they are mantle nucleated. Three things required for freshwater cultured pearl are (1) a host oyster (2) donor oyster's mantle tissue or Saibo (3) nucleus. [23,24] Pearl sac formation takes place around a nucleus by grafted mantle cell in around 30 days.[25] The pearl sac secretes and deposits the concentric layer which is known as cultured pearl. Alternating materials like Tridacna spp [26], Chinese cultured pearls,[27] and natural pearls of low quality are used due to the high cost of Mississippi nuclei. [28,29,30] Bironite an altered form of dolomite is also suggested but it was not accepted widely in the market.[31] A new advancement has been done recently by the use of organic nuclei in place of inorganic nuclei. Organic nuclei have properties similar to SAP (super absorbent polymer) spheres like absorbing liquid and growing. Nuclei are coated with a thin film to make it compatible with regular nuclei of oyster which contains a coating of fibronectins, bio coating contaifibronecting which help in the healing of oyster after surgical nucleus insertion. No rounded pearl is cultured with organic nuclei, only baroque shaped pearl has been cultured.

BIOMINERALIZATION

To produce minerals, (mineralized tissues) by living organisms through a process is called Biomineralization. Through this process living forms influence the precipitation of mineral materials. A.H. Jharen, in Treatise on Geochemistry a better understanding of the complex mechanisms related to nacre and pearl formation is essential and can be approached through massive parallel technologies. (whole transcriptome sequencing and biomineralization gene architecture associated with cultured pearl quality traits in the pearl oyster to use RNA seq to compare whole transcriptome expression of pearl sacs that had to produce pearls with high and low-quality total 262is found as expressed gene, (DEGs) with 246 up and 16 down-regulated genes as low-quality pearls. Out of the 262 DEGs, 216(82.24%) had at least one match with known protein sequences. Finally, only 114 of the DEGs (43.5%) had at least one associated GO term high- and low-quality pearls are differentiated by several biomineralization genes. The characteristic feature of most of the gene is of prismatic and prism-nacre layers found up-regulated in high-quality pearls is the blue mussel shell protein-like (BMSP-like) coding gene. Family effect on cultured pearl quality in black-lipped pearl oyster *Pinctada margaritifera* and insight for genetic improvement. The objective of biomineralization genetic make-up was to observe the impact of temperature on pearl formation using an integrative approach describing the rotation of the pearls, the rate of nacre deposition, the thickness of the aragonite tablets and the biomineralizing potential of the pearl sac tissue through the expression level of some key genes (influence of temperature and pearl rotation on biomineralization in pearl oyster.

The deposition of the mother-of-pearl by the cell of the pearl sac continuously on the nucleus leads to the formation of the pearl by the superimposition of mother-of-pearl layers around the nucleus at a rate of 3 to 4 per day. [33,34]

The shape of the pearl can be spherical, drop, or baroque(irregular) as well as varying color and size.[36]

BACTERIA

Nacre (natural composite) has impressive mechanical properties that arise from there, multiscale hierarchical structures, which span from nano – to macro scale and lead to effective energy dissipation. The toughness of natural nacre (property of bioinspired materials), current production methods are more complex which involve toxic chemicals, extreme temperatures, or high pressures. Bacteria were used to produce nacre – inspired layered calcium carbonate- polyglutamate composition minerals that exceed the toughness of natural nacre, while high extensibility and high stiffness, is introduced. Genetic engineering and the extensive diversity of bacterial metabolic abilities allow for the creation of a library of bacterially produced, cost-effective, eco- friendly composite materials.For the production of advanced structural materials, the development of simple, environmentally friendly methods is becoming increasingly important for industrial-scale production of compounds such as polymers e.g., poly (lactic-co-glycolic acid) (PLGA).[36],polyhydroxyalkanoate (PHA)[37],cellulose.[38]The use of bacteria as cell factories is a well-established and cost-effective biotechnological process. Bacterially produced materials are typically far simple than complex hierarchical materials made by living organisms in nature, results in poorer mechanical properties. Their superior mechanical properties of natural materials such as tooth enamel, nacre, or bone attain by combining organic and inorganic components into hierarchical composite structures spanning across different length scales.[39,40] Nacre, the tough, iridescent layer constituting the inner surface of mollusk shells, consists of a tessellated structure of layered calcium carbonate platelets interconnected by the organic matrix to create a hierarchical composite structure. The composition of the nacre is approx. 95 wt.% calcium carbonates in its aragonite polymorph, while the rest of the material is a complex organic matrix containing beta- chitin, Lustrin, and silk-like proteins. The natural bacteria composite has desirable qualities like toughness and extensibility, without sacrificing stiffness, which is the desired combination of properties that is difficult to achieve in man-made materials.[41]The key advantage of our method of bioinspired materials production is performed exclusively with bacteria: under ambient conditions, using only ecologically friendly and renewable components, and without producing toxic waste.

FROM BACTERIA TO NACRE

For making artificial nacre, alternating thin layers of crystallized calcium carbonate like cement – and the sticky polymer is created. In the artificial technique of nacre production urea is mixed with *Sporosarcina pasteurii* bacteria and a calcium source, then a glass slide is dipped into the solution. Due to the reaction between the urea and the bacteria a thin layer of calcium carbonate is crystallized onto the slide. To make the polymer layer, the slide is placed into a solution of the bacteria *Bacillus licheniformis*, then the beaker is allowed to sit in an incubator.

About a day to approximately five micrometres thick, a layer is built which is made up of calcium carbonate and polymer. Currently, Meyer is researching on coating other materials like metal with nacre, and trying to make thicker, nacre- like materials using new techniques. Biocompatible (made of materials that the human body produces or that humans can eat naturally) is one of the most beneficial characteristics of a nacre produced in Meyer's lab. As it is very lightweight, a quality that is especially valuable for vehicles like airplanes, boats, etc. No, any complex instruments are required for the production of bacterial nacre, and the nacre coating protects against chemical degradation and weathering naturally, it holds the promise for civil engineering application like crack prevention, protective coating for the erosion control, or conservation of cultural artifacts, and could be useful in the food industry, as a sustainable packaging material. The qualities of nacre might also be an ideal material to build houses on other planets or the moon other than this nacre is very beautiful as jewellery. Each stacked layer of nacre has approximately the same wavelength as visible light. Bacterial nacre does not interact with visible light because the layers are thicker than natural nacre, it could interact with infrared wavelengths and bounce infrared off itself, that may offer unique optical properties.

CONCLUSION

Pearl, one of the highly esteemed jewels are very valuable due to its high demand and price for them. Uses of pearl are

- Used in jewellery
- Crushed and used in cosmetics
- Used in medicines
- Paint formulation etc.

Natural pearl production is done by molluscs as a result of a defence mechanism when a foreign particle invades the shell of the mollusc.

Nowadays natural pearl production is reducing due to

- Overexploitation of molluscs
- Water pollution.

As the demand for pearl production is increasing and natural pearl production is unable to satisfy the demands, the birth of artificial pearl culture took place.

In freshwater pearl culture, careful management is very important during the culture period, as it affects the quality and quantity of pearl production,
Particularly in terms of water quality and food production through fertilization and manuring.
Some recent advancement in artificial pearl culturing is:

- Use of organic and baroque shaped nuclei
- Biomineralization (hardening or stiffening existing tissues)
- Use of bacterial for nacre production

At present pearl farming, a difficult business environment presents an obstacle to promote sustainability, but consumer demand could increase the sustainability
the sector provides to coastal areas and ecosystems.

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