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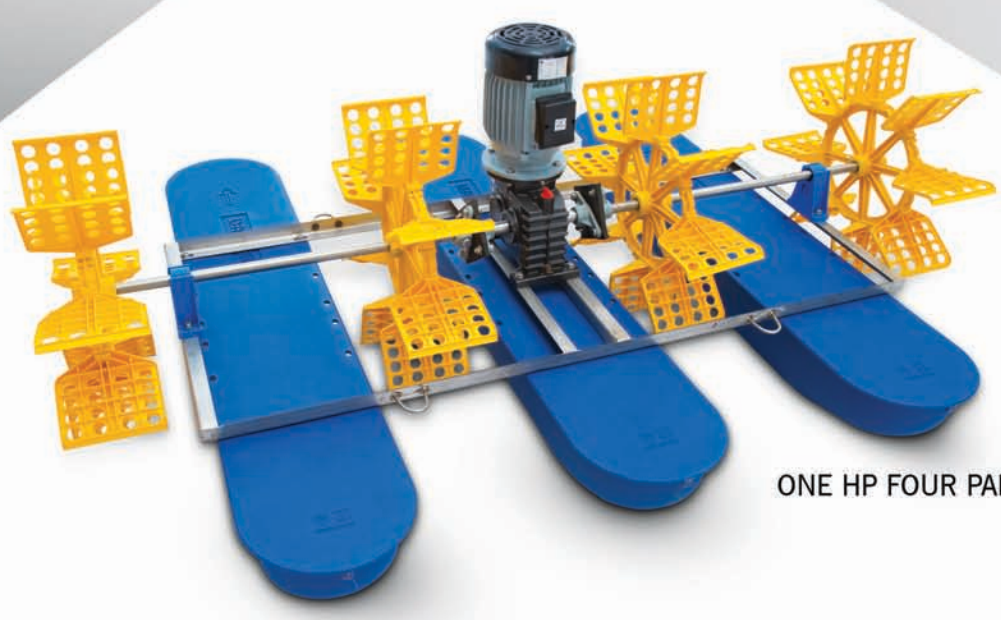

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You have one life, Do the best for yourself and for others, Our work and efforts should help the present and future generations to lead a happy, prosperous and peaceful life

Dear Readers,

Greetings from Aqua International for a Happy, Prosperous and Peaceful New Year 2023 to the readers and advertisers.

I wish that all of us get organised well personally and in the profession in this New Year 2023. Let us focus on maintaining good health, check whether you are going financially in a right and safe direction, ensure that you save money for future needs, maintain good relation with all.

Why not we change our thinking for an open and positive mindset that we do our bit for the well being of all in the society too. You have one life. Do the best for yourself and for others. Be fair for yourself and for others. Help to prevail peace and prosperity all over the world. Our work and efforts should help the present and future generations to lead a happy, prosperous and peaceful life.

The January 2023 issue of Aqua International is in your hands. In the news section you may find news about ...

The current turmoil in the global shrimp market marked by excess supply and the dwindling price has important lessons for the Indian seafood industry in general and the shrimp farming sector in particular. Ecuador flooding the market with highly competitive pricing, fears of a global recession, China persisting with Covid19-related lockdown practices and uncertainties linked to the Ukraine war are some of the immediate reasons for the slowdown. It is true that these factors have a role in reversing the fortunes of shrimp farmers, processors and exporters in the country. The stakeholders in the Indian shrimp sector need to sit down and take a close look at the factors that led to the success of Ecuador. The adoption of SSP has enabled the Ecuadorians to achieve sustainable and high-value output and emerge as one of the leading global shrimp exporters in a short span of four years.

In recent times in West Bengal, it is observed that progressive fish farmers and rural youths are showing increasing interest in farming of new high-valued freshwater finfish species in intensive fish culture systems like indigenous and imported model of RAS, farming in Biofloc and semi-Biofloc (partial bottom clean) systems, circular 8000 – 10,000 litre concrete tanks - all of which will make use of less volume of water and follow 'water reuse' principle. Fishes under culture are dependent on the feed provided (not on natural food of aquatic environment); water must be replenished (exchanged) at a high rate to maintain DO levels and remove waste matter. Since stocking is more, DO content of pond water kept at proper level (7 – 8 ppm) using paddle wheel aerators. Pond bottom is kept hygienic using lime and bottom treatment done before stocking, absence of black sediment. Black, durable, waterproof, polythene (geomembrane) sheet used as complete bottom liner in earthen shrimp culture ponds.

As stocking densities in intensive shrimp farms increase, farms must contend with greater risks of disease outbreaks and transmission, as well as deteriorating water quality during the farm cycle. These conditions are stressful for the shrimp and can lead to high mortality rates and substantial economic losses. To combat these challenges, shrimp farmers are increasingly turning to probiotics. These bacteria act as a prophylactic tool as they can help improve water quality and improve nutrient utilisation in the shrimps' digestive system. Though this makes probiotics seem like a panacea, researchers have learned that they need to be applied properly to see production benefits. In addition to optimising probiotic application, emerging research suggests that including exogenous enzymes to the culture system can yield benefits as well – but researchers aren't aware of the impacts of using the two strategies in tandem.

The prevalence of infectious diseases in aquaculture industry and the limited number of safe and effective oral vaccines has posed a challenge not only to both fish immunity and the wider aquaculture industry. More oral fish vaccines are becoming available, but researchers have outstanding questions on how they work and their impact on the immune system of fish. A recurring challenge in developing oral fish vaccines relates to their efficacy – many

Contd on next page

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Aqua International

Our Mission

Aqua International will strive to be the reliable source of information to aquaculture industry in India.

AI will give its opinion and suggest the industry what is needed in the interest of the stakeholders of the industry.

AI will strive to be The Forum to the Stakeholders of the industry for development and self-regulation.

AI will recognize the efforts and contribution of individuals, institutions and organizations for the development of aquaculture industry in the country through annual Awards presentation.

AI will strive to maintain quality and standards at all times.

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of the active antigens contained in vaccines degrade in the gastrointestinal tract of fish. Developing oral vaccination methods has been a significant advancement for aquaculture industry. In many cases, manually injecting fish is unfeasible. High stocking densities at large farms means that vaccinating entire ponds or cages is labour intensive and causes stress for the fish. Since oral vaccines can be administered through feed or other dietary supplements, producers are able to boost the immunity of their stocks as part of daily husbandry activities. Oral vaccination also lets producers immunise large stocks of fish without causing additional biological stress. Oral vaccines can be delivered to fish by fortifying formulated feed with a coating, through encapsulating antigens in a diverse range of polymers or by the bioencapsulation process in live feeds like rotifers, water fleas and Artemia.

A new initiative of sustainable shrimp cultivation provides hope for mangrove restoration in Sundarbans. For several years, environmentalists and experts have expressed concerns over unsustainable aquaculture, particularly shrimp collection, after cleaning large tracts of mangrove forests in Sunderbans. Under the initiative, Sustainable Aquaculture In Mangrove Ecosystem (SAIME), farmers have taken up cultivation of shrimp at 20 hectares at Chaital in West Bengal's North 24 Parganas, and 10 hectares at Madhabpur in adjoining South 24 Parganas. However, they are doing their part in restoring the mangroves as well. There are 42 shrimp farmers engaged in the pilot project and a majority of them say that they have had higher incomes compared to previous years. They are also cultivating indigenous varieties of shrimps such as black tiger shrimp (P. Monodon) and giant freshwater prawn (M. Rosenbergii).

According to Rajamanohar Somasundaram, founder and CEO of Aquaconnect, an end-to-end solution provider to shrimp and fish farmers, Tilapia farming is a low-cost but high-margin business with an added advantage of higher output since the fish can be farmed twice in a year. Somasundaram says, Easy cultivation makes tilapia a good choice for farmers as compared to Indian Major Carps because it is a hardy, meaty and an all-weather fish. Its bone content is also much less, which makes it ideal for fillets and other delicacies. The presence of hybrid and modified tilapia varieties like Genetically Improved Farmed Tilapia (GIFT) has added another dimension to its potential. The biggest advantage of tilapia for the grower is that the feed cost is very nominal since this is an herbivore fish and can survive on algae, so it does not need artificial fish food. Moreover, it seldom gets infected with any disease due to its hardy character.

The Pradhan Mantri Matsya Yojana aims to increase fish production to 220 lakh tonne, average annual growth rate of fish production to 9 percent, fisheries exports to Rs 100,000 crore, reduce post harvest losses to 10 per cent and increase employment in the sector to 55 lakh by 2024 - 25. It also aims to expand the horizons of specific sub sectors, like seaweed culture and product development, ornamental fish culture and exports, exponentially increasing seafood exports. Infrastructure development in fisheries is also getting a big fillip. Massive budget outlays are enabling structural growth at the ground level. The extension of Kisan Credit Card (KCC) to fisheries sector is a master stroke. However, there is not much of a technology push that has been built into PMMSY. Private investment in IT-driven fisheries is happening independent of the official big push.

In the Articles section – ***Fish Paste: A viable option for Indian Seafood export industries,*** authored by Dr C.O. Mohan, Dr Elavarasan. K and Dr C. N. Ravishankar, ICAR – Central Institute of Fisheries Technology, Kochi, discussed that fish paste is a value added product prepared from deboned fish by mixing with condiments, salt and oil. Fish flesh with other choice of ingredients is mixed in a meat bowl chopper to get fine paste consistency and taste. Both fatty and non-fatty fishes of marine origin and fresh water fishes of low value are preferable for fish paste production. Marine fatty fishes could serve as rich source of omega-3 fatty acids and impart characteristics taste of fatty fishes. Fish paste can be prepared from variety of fishes even from fishes with low economic value. Considering the great nutritional advantage and convenience, fish paste can be a very good viable option for the Indian market, where the value addition is very limited. Although, fish paste has huge demand in International market, currently it is not being exported from India.

Another article titled ***Blue Carbon Ecosystem: A strategy to mitigate global climate change***, authored by Mr Suman Nama, Ms Sahina Akter, Fisheries Resource Harvest and Post-Harvest Management Division, ICAR-Central Institute of Fisheries Education, Mumbai, said that the earth's warming in recent decades has caused an overwhelming consensus amongst climate scientists because different human activities and anthropogenic activities have increased the number of greenhouse gases in the atmosphere. To mitigate the severe impact of climate change, we need to adopt a range of different strategies, among which Blue Carbon is an essential strategy. Blue Carbon is organic carbon that has been captured and sequestered by coastal marine plants. Seagrasses, mangroves, and tidal marshes ecosystems are highly productive and act as the largest carbon repositories in coastal ecosystems. Vegetated coastal ecosystems (mangrove forests, seagrass beds, salt marshes) are disproportionately important in sequestering carbon dioxide than terrestrial ecosystems. These ecosystems are exquisite carbon sinks and provide various ecological services such as shelter for the various fauna such as fishes, crabs, and migratory birds.

Article titled ***ECOLOGICAL IMPORTANCE OF TURTLE,*** authored by S. Ashik Ahmed, Dr M. G. R. Fisheries College and Research Institute, Ponneri, Tamil Nadu Dr J. Jayalalithaa Fisheries University, informed that there are 360 turtle species living around the world. Turtles belongs to the Class – Reptilia and Order – Testudines. They are large reptiles, air breathing species. Their shells consists of two sections namely carapace (upper section) and plastron (lower section). Turtles are considered as oldest reptile species. Their internal temperature varies according to the environment that is ectotherms (cold blooded). Turtles are further classified into amniotes, means that they do not lay eggs underground, even though most of turtles live in water. They lay eggs on dry or sandy beaches. Turtles use to come to surface often to refill their lungs. Depending on species immersion periods vary between 60 seconds tom 1 hour.

Readers are invited to send their views and comments on the news, special feature and articles published in the magazine which would be published under "Readers Column". Time to time, we shall try to update you on various aspects of Aquaculture sector. Keep reading the magazine Aqua International regularly and update yourself. Wish you all fruitful results in your efforts.

M.A.Nazeer
Editor & Publisher
Aqua International

A wake-up call for Indian shrimp industry

The current turmoil in the global shrimp market marked by excess supply and the dwindling price has important lessons for the Indian seafood industry in general and the shrimp farming sector in particular. Ecuador flooding the market with highly competitive pricing, fears of a global recession, China persisting with Covid19-related lockdown practices and uncertainties linked to the Ukraine war are some of the immediate reasons for the slowdown. It is true that these factors have a role in reversing the fortunes of shrimp farmers, processors and exporters in the country. At the same time, we should not be deceived by thinking that the current slump is something that could be tagged with the commodity cycles characterised by boom and bust alone. The over four-decade-old experience in the seafood sector tells me something different.

The emergence of Ecuador as the major competitor for Indian shrimp export is not something that happened overnight. The winds of change from Ecuador were felt by all those having their eyes and ears on the ground. In 2022 Ecuador is expected to cross the record volume of 8,41,000 tonnes of exports achieved in 2021 (Jan-Dec). The exports in the first six months of 2022 (Jan-Jun) were up by 35 percent compared with the same period in the past years. Industry experts feel that exports from Ecuador may cross one million tonnes by the end of this year. The South American country's tryst with shrimp farming began in the 1970s and registered steady growth till the end of the last century. But the year 2000 turned out to be a nightmare with devastating disease outbreaks leading to a 70 percent contraction in production. The aquaculture sector making steady recoveries since then went for a major change in 2018 by adopting the sustainable shrimp production (SSP) system. The core principles of SSP comprise 100 percent traceability, zero use of antibiotics, net neutral impact on the environment and certification from the Aquaculture Stewardship Council, a regulatory agency. The most important highlight of the SSP is its ability to realise the highest value at the lowest cost. The success of Ecuador is mainly due to its willingness to invite global experts to develop SSP practices suiting their requirements and thereby converting a crisis into an opportunity.

The stakeholders in the Indian shrimp sector need to sit down and take a close look at the factors that led to the success of Ecuador. The adoption of SSP has enabled the Ecuadorians to achieve sustainable and high-value output and emerge as one of the leading global shrimp exporters in a short span of four years.

The success of Ecuador holds an important lesson for the Indian shrimp farmers and other stakeholders in the sector. The time has come for the stakeholders in the Indian shrimp farming sector to change their focus from solely increasing the tonnage in terms of output to improving the revenue realisation potential of each farmer. We need to follow the model of Average Revenue Per User or ARPU as used by the telecom services providers. The difference is instead of per user we needed to focus on each farmer. It is high time for the Indian shrimp sector to shift its focus from tonnage to increasing the revenue realisation potential (RRPF) of each farmer. The matter assumes importance because the farmer is the backbone of the entire shrimp value chain. Adverse impact on the farmer will have a cascading effect on the chain comprising seed makers, hatchers, processors and exporters. The increase in RRPF on a sustainable basis is the way forward to overcome the present situation. The art of improving revenue per farmer will automatically lead to the issue of improving the quality of the product. And that would lead to the drawbacks connected with the current aquaculture practices and their possible remedies.

Kings Infra Ventures has been promoting the theme of shifting the focus from tonnage to RRPF as part of its strategy to realise high-value output using sustainable practices.

Uni-President

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2. HIGH ACTIVITY OF SPORES

No cultivation is needed. Easily adapt to the changes of surroundings and grow fast in freshwater or seawater culture farming, even under low oxygen environment

3. DECREASE AMMONIA CONTENT

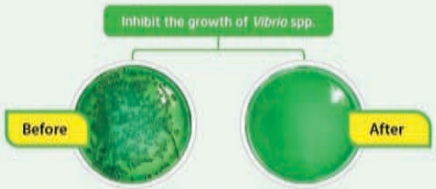
Prevent the accumulation of toxic substances such as NH_3, NO_2, etc.

4. IMPROVE WATER COLOR

Improve water color regulate the algae and bacteria balance in water, turning your pond from green to clear

5. ESTABLISH BALANCED POND BACTERIA SYSTEM

Compete nutrition with vibrio and inhibit them to grow. Provide nutrition for probiotics in the pond, to establish a well-balanced farming system.



6. INCREASE AQUACULTURE PRODUCTION

Good quality of water prevents fish/prawn infections, making high profit of production

* COMPOSITION:

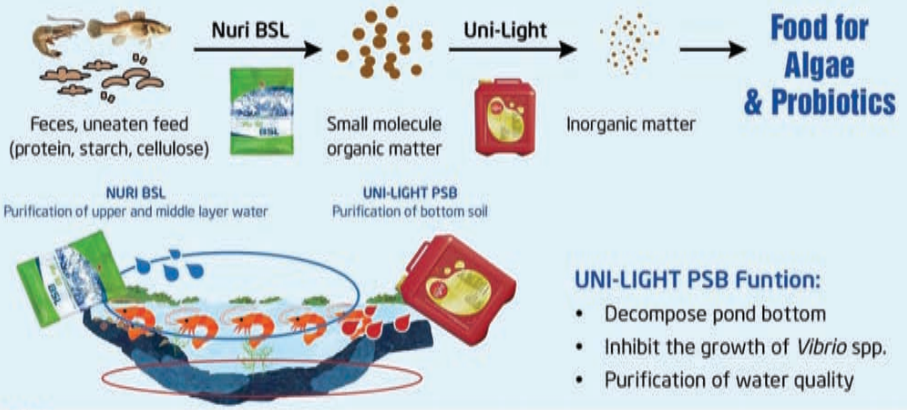
Bacillus spp. > 1x 10^{11} cfu/kg	15%
(Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus licheniformis)	
Carrier (rice bran, corn gluten)	75%
Moisture	10%

* STORAGE:

Keep at dry, well-ventilated condition. Avoid direct sunlight exposure and use as soon as possible once opened for best quality.

* DIRECTION OF USE:

No cultivation is needed. Apply Nuri BSL with water-soluble bag near to the working water wheel or pour into the pond evenly. Recommend apply Uni-Light PSB together with Nuri-BSL on sunny day to achieve a clear pond more efficiently.



UNI-LIGHT PSB Funtion:

- Decompose pond bottom
- Inhibit the growth of *Vibrio* spp.
- Purification of water quality

BSL Dosage:

/10,000 m³ Quantity	10 - 30 pl/m² tiger prawn or < 80 pl/m² Vannamei	For >30 pl/m² tiger prawn or > 80 pl/m² Vannamei	For > 150 pl/m² Vannamei
7 days before stocking	800 g - 1,000 g	1,200 - 1,500 g	1,200 - 1,500 g
Day of stocking	300 g - 500 g	800 g - 1,000 g	800 g - 1,000 g
Every 7 - 10 days after stocking	300 g - 500 g	800 g - 1,000 g	3 - 5 days / use 1,000g - 2,000g

****Dosages can be adjusted according to the water conditions and practices.*

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The other important area that needs the immediate attention of the policymakers and other stakeholders is the domestic market. The development of a vibrant domestic market for quality protein at an affordable cost will be a shield for Indian shrimp farmers to guard against the vagaries of the global market. The domestic market for protein-rich seafood in the country remains a highly fragmented and unorganised sector. Everyone agrees that the country has huge potential for developing a market for quality seafood. The supply-chain bottlenecks and lack of institutional support mechanisms are acting as major hurdles in this direction. The disruptions in global trade during the Covid19 pandemic highlighted the importance of having a domestic market. The policymakers realised the importance of a domestic market. The formation of the fisheries ministry has escalated the process further and a slew of schemes are currently available for helping the domestic market. Unfortunately, many of these schemes remain largely unknown to many of the persons in the fisheries sector. The processors and exporters along with the farmers needed to pay greater attention to the various schemes at the institutional level to develop a vibrant domestic market.

It is gratifying to note that the National Fisheries Development Board (NFDB) has mooted several schemes that would help in providing institutional support for developing a domestic market. The Pradhan Mantri Matsya Sampada Yojana (PMMSY) and Fisheries and Aquaculture Infrastructure Development Fund (FIDF) are two flagship projects of the NDFB that could be effectively tapped for developing the necessary infrastructure support for the domestic market network. A supply chain network with a quality cold storage facility is the primary requirement for developing a vibrant market for a highly perishable commodity like fish. The State governments have a greater role in this matter as social, economic and cultural practices differ from State to State.

The current turmoil in the global shrimp market is a wake-up call for everyone involved in the Indian shrimp and seafood sector. The downtrend should be used as an opportunity for a course correction and to scale up higher in the value chain. As I have stated before, a course correction focusing on sustainable aquaculture has tremendous potential to elevate India as the global hub of quality protein food at competitive rates.

Issues to be taken up to set right the present crisis in shrimp farming

N.V.S. Subba Raju, Proprietor, Vishnupriya Aqua Feeds

Mr N.V.S. Subba Raju, Proprietor, Vishnupriya Aqua Feeds situated in Bhimavaram, Andhra Pradesh gave his ideas and suggestions to come out of the present crisis in shrimp farming sector. Below are his suggestions:

1. Hatchery:

• Relaxation on import duty of shrimp brooders and hatchery larval and post larval feeds.

2. Feeds:

• As feed cost is increasing, it is important to provide relaxation on import duty of raw materials to all feed companies so that cost of production can be reduced and thereby feed companies can supply feed to the farmers by reducing feed cost.

3. Aqua health products:

• Most of the imported medicines and chemicals are costly. So relaxation of import duty on these medicines will enable the aqua medicine manufacturers and suppliers to reduce the cost of those medicines. When the poultry sector is in crisis, government has relaxed the duty through NEC Committee on certain items. The same relaxation can be extended to aqua sector also.

4. Power Tariff:

• Subsidy on power tariff is to be extended to shrimp farmers, ice plants and processing units.

5. Export:

• MPEDA should provide subsidy to exporter (Say Rs.20 per Kg through reimbursement to exporter) who in turn will give subsidy to the farmer.

6. Domestic Market Improvement for processed shrimp:

• NFDB and MPEDA should identify the companies who are providing domestic processed food. They should be given a target of 20 lakh tons for domestic sales by the end of 2028. First 3 years (By 2025) 8 lakh tonnes and the next 3 years (By 2028), the remaining 12 lakh tonnes, thus the total target of 20 lakh tonnes will be achieved by 2028.

7. Others:

• NFDB should create a Best Sales Award to the Indian companies for selling shrimp in the domestic market.

Note: The above relaxations should be given for a minimum period of 3 years.

- VISHNUPRIYA SUBBA RAJU
Bhimavaram,
Andhra Pradesh,
Mobile: 94416 45555

Fish farmers showing increasing interest in intensive fish culture

In recent times in West Bengal, News communicator Subrato Ghosh observed that progressive fish farmers and rural youths are showing increasing interest in farming of new high-valued freshwater finfish species in intensive fish culture systems like indigenous and imported model of RAS, farming in Biofloc and semi-Biofloc (partial bottom clean) systems, circular 8000-10000lit concrete tanks - all of which will make use of less volume of water and follow 'water reuse' principle.

Such a system is well-managed form of fish farming under full control, an improved approach to fish culture. Every possible attempt is made to achieve maximum production of fish from a minimum quantity (volume) of water. Fry/advanced fry of finfishes stocked @ 10-50nos or more per 1000lit water or per cubic. mt water. High density stocking (large number of fishes confined in small area) and application of inputs (externally-supplied) at higher dosage are main features here, in comparison to earthen ponds. Intensive culture practice of Indian major carps with commercially-available quality feed with high protein content, aqua-products and aeration can give production of 8000-15000kg/hectare/year; bigger-sized fingerlings 100-200gm stocked in ponds. Soil and water quality parameters are strictly maintained in fish ponds; water purifiers and Dissolved oxygen (DO) enhancers used.

Fishes under culture are dependent on the feed provided (not on natural food of aquatic environment); water must be replenished (exchanged) at a high rate to maintain DO levels and remove waste matter. Since stocking is more, DO content of pond water kept at proper level (7-8ppm) using paddle wheel aerators. Pond bottom is kept hygienic using lime and bottom treatment done before stocking, absence of black sediment. Black, durable, waterproof, polythene (geomembrane) sheet used as complete bottom liner in earthen shrimp culture ponds. Constant monitoring done by expert farm technicians from fry/fingerling stocking till day of harvest. Cost of production (capital cost) is high, and also profit margin at end of farming; needs experienced and skilled employee in fish/shrimp farms. Atlantic salmon *Salmo salar* and rainbow trout *Oncorhynchus mykiss* (*Salmo gairdnerii*) in European countries; Pangas catfish *Pangasianodon hypophthalmus* in Vietnam; seabass *Lates calcarifer* in open sea mariculture cages; *Salmo trutta fario* and *Salmo gairdnerii* in raceways; monosex Tilapia in rectangular cement tanks are cultured in intensive methods. Quantity of table-sized fishes produced (harvested) per unit rearing water area is high. It is a high-tech aquaculture practice, completely opposite to small-scale rural fish farming and organic fish farming. DO, water quality and food supply are closely controlled - space in confined system is fully utilized. Contribution of natural water productivity into fish production is low or negligible, where single species culture of high value and consumer demand is preferred.

The imported high-cost model of RAS has advanced-type water purification systems.

In culture of monosex 'all-male' Tilapia and other fishes, water is continuously aerated and does not depend on phytoplankton for DO production. Its fry/advanced fry are often densely stocked in cages, RAS, Biofloc system and outdoor tanks (all under intensive culture system); which saves space and can be cultured at high stocking density. In intensive RAS, only 0.6-1.0 cubic.mt or 600-1000lit of new water is consumed to produce 1kg fish in one year. Biofloc and RAS fish culture tanks can be 4mt in diameter, 1.5mt in height (1.2mt water depth); water holding capacity of each tank 8000-15000lit (8-15cubic.mt). Tanks are made up of tarpaulin (large piece of heavy waterproof cloth used as a covering), or FRP or HDPE - RAS tanks (indigenous model) can be of concrete cement structure. Fish species preferred for culture are air-breathing catfishes, *Anabas testudineus, Mystus vittatus*, *M. cavasius*, monosex Tilapia, *Ompak pabda, Puntius sarana*. Intensive culture practice of air-breathing catfishes, non air-breathing catfishes and climbing perch (as in Column D and E) is summarized in Table-1, and a comparison of intensive culture practice of *Peneaus monodon* with conventional system is summarized in Table-2.

Fish species - A	Size of fish (fry stage) at stocking - B	Fry stocking in culture in normal earthen ponds - C	Fry stocking in culture in small outdoor tanks with concrete sides and bottom (rectangular) - D	Fry stocking in improved RAS and in Biofloc method of culture - E
Desi Magur *Clarias batrachus*	800nos/kg or 1.25gm	45000nos/hect.mt or 4-5nos/1000lit	**50nos/1000lit**	**500nos/1000lit**

Singhi *Heteropneustes fossilis*	1200nos/kg or 0.85gm	60000nos/hect.mt or 6-6.5nos/1000lit	**50nos/1000lit**	**500nos/1000lit**
Koi *Anabas testudineus*	2500nos/kg or 0.4gm	80000nos/hect.mt or 8nos/1000lit	**50-100nos/1000lit**	**250-1000nos/1000lit**
Pabda *Ompak pabda*	3000nos/kg or 0.33gm	60000nos/hect.mt or 6-6.5nos/1000lit	**50-100nos/1000lit**	**250-1000nos/1000lit**
Sona tengra *Mystus vittatus*	3000nos/kg or 0.33gm	60000nos/hect.mt or 6-6.5nos/1000lit	**50-100nos/1000lit**	**250-1000nos/1000lit**

Table - 1

	Extensive	**Semi-intensive**	**Intensive**
Stocking of post larvae of *Penaeus monodon*	20 days old; 4cm	20 days old; 4cm	**20 days old; 4cm**
Stocking density	15000-25000nos/hect	50000-100000nos/hect	**200000-450000nos/hect**
Pond area	5-7 hect or 50000-70000sq.mt	0.20-0.50 hect or 2000-5000sq.mt	**0.09-0.12 hect or 900-1200sq.mt**
Production of adult shrimp	500-700kg/hectare	1000-2000kg/hectare	**5000-7000kg/hectare**
Management method	Not a scientific method; no application of inputs; very little or no pond management; shrimp production on natural pond productivity	Urea, SSP, raw cow dung applied infrequently; traditional home-made feed applied; no use of aerator	**Commercial pelleted feed and aqua-products used; fertilization schedule strictly followed; aerator and recommended antibiotics used**

Table -2

Probiotic and enzyme combination shows benefits in intensive white shrimp cultivation

A new publication has found that leveraging a combination of probiotics along with complementary exogenous enzymes in an intensive culture system can boost growth parameters and improve the culture environment for farmed shrimp.

As stocking densities in intensive shrimp farms increase, farms must contend with greater risks of disease outbreaks and transmission, as well as deteriorating water quality during the farm cycle. These conditions are stressful for the shrimp and can lead to high mortality rates and substantial economic losses.

To combat these challenges, shrimp farmers are increasingly turning to probiotics. These bacteria act as a prophylactic tool as they can help improve water quality and improve nutrient utilisation in the shrimps' digestive system. Though this makes probiotics seem like a panacea, researchers have learned that they need to be applied properly to see production benefits. In addition to optimising probiotic application, emerging research suggests that including exogenous enzymes to the culture system can yield benefits as well – but researchers aren't aware of the impacts of using the two strategies in tandem.

To test this, researchers from Jakarta Technical University of Fisheries, National Research and Innovation Agency, PT Sinergi Samudera Biru and Biomin Holding GmbH evaluated the efficacy of feeding multispecies commercial probiotics,

Shrimp farmers are beginning to adopt probiotics during the farm cycle as the bacteria can help improve water quality and feed uptake in shrimp

enzymes and the fermentation process on the growth parameters and culture environment of Pacific white shrimp (Litopenaeus vannamei), in an intensive cultivation system.

Multispecies probiotics and enzymes

For this trial, researchers continuously applied commercial multispecies probiotics and enzymes at three different doses (0.2, 0.4 and 0.6 mg/L) during the first 30 days of intensive culture of Pacific white shrimp. The probiotics were applied every alternate day, while the enzymes were added to the culture system every six days during the experimental period.

The results show that the group that received 0.6 mg/L of probiotic + enzyme presented the highest final biomass, the highest average weight and the best protein retention rate, as well as a lower feed conversion rate, in comparison with the control group," the researchers report.

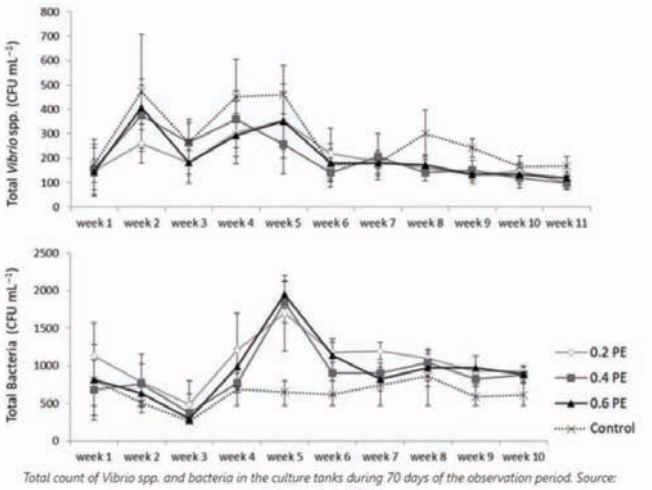
According to the study results, the 0.6 PE group had an 8 percent higher final biomass and an 11 percent higher final average weight. In addition, the feed conversion rate was 7.4 percent lower compared to the control treatment and the protein retention rate was 13 percent higher in shrimp treated with 0.6 PE.

Likewise, the abundance of Vibrio spp. remained below 103 cfu/mL throughout the test. The water quality indicators, TAN, NO_2N and NO_3N, reached peak values in weeks three to five and then decreased until the end of the culture period in all tanks. This decline was significantly faster in the probiotic + enzyme treated shrimp tanks.

Effectiveness of commercial probiotics

"The present study demonstrated the effectiveness of commercial probiotics, containing *Bacillus sp, Enterococcus sp, Pediococcus sp, Thiobacillus sp and Paracoccus sp* in combination with an enzyme cocktail to increase shrimp growth and the productivity of the culture environment," the researchers reported.

According to the study, the results demonstrate that the continuous application of multispecies probiotics and enzymes can reduce the total number of Vibrio spp., in culture environments.



Total count of Vibrio spp. and bacteria in the culture tanks during 70 days of the observation period. Source: Novriadi et al (2022)

Previous studies have found that probiotics can inhibit the growth of a wide variety of opportunistic bacteria, including Vibrio spp. and reduce the prevalence of viruses.

The culture density used in the growth test was 500 PL/m², so it can be defined as an intensive culture system. In this type of cultivation, applying appropriate management strategies are essential to ensure feed optimisation, which also affects farm productivity.

The researchers believe that because the shrimp digestive system is particularly activated in the larval and early postlarval stages, the use of additional protease, xylanase, cellulase and amylase enzymes could have a synergistic effect, which in turn could explain the better growth and protein composition of shrimp treated with probiotics and enzymes during the culture period.

Multispecies probiotics and enzymes have potential applications to control Vibrio spp, maintain good water quality conditions and increase shrimp growth in intensive culture systems,

the researchers conclude.

Based on the results of the study, for intensive shrimp culture systems, multispecies probiotics and enzymes should be applied at 0.6 mg/L for the first 30 days, 0.8 mg/L until day 60, and 1.0 mg/L until harvest. This will help stimulate better productivity, control of Vibrio spp. and the maintenance of good water quality conditions in intensive cultivation environments.

Gassen Plus

Bon Ammonia and obnoxious Gasses

Shrimp / Fish performs all their body functions and growth in water. Good quality water and proper D.O. levels determines the success or failure. Good quality water, optimum D.O. level is of prime importance for health and growth of Shrimp / Fish.

Irregular water exchange, excess and leftout feed, dead algae, fecal matter, increases the organic load at the pond bottom. Accumulation of such waste absorbs available oxygen, creating anaerobic condition which leads to pollution of pond bottom. Polluted pond bottom and unhealthy environmental conditions triggers the release of toxic gasses like Ammonia, H_2S, Methane, etc, The toxicity of Ammonia, Hydrogen Sulphide, Methane attributed mainly due to unionized form. As the concentration in water increases, ammonia excretion by aquatic organism diminishes and the level of ammonia in blood and in other tissues increases. Ammonia increases oxygen consumption by tissues, damage gills and reduces the ability of blood to transport oxygen, and increases the disease susceptibility. To eliminate / overcome the above problems 'GASSEN PLUS' Yucca Schidigera, it contains Steroidal"Saponin" which help to reduce ammonia and other noxious gasses such as H_2S, Methane, etc., Microbial enzyme "Urease' Production inhibited by Saponin which leads to an increases D.O. and reduction of BODand COD levels.

Bacterial strains such as Bacillus Subtilis, Nitrobactor, Nitrasomonas, rapidly converts ammonia into Nitrates, Nitrites and finally non-toxic Nitrogen. Hydrogen Sulphide converts into Sulphates, Sulphites and finally non-toxic Sulphur, Methane into Non-toxic carbon. This conversion reduces the obnoxious gasses in the pond bottom. Reduction of this gasses improve the D.O. level in the water and bottom.

COMPOSITION:
YUCCA SCHIDIGERA
ALOEVERA
BACILLUS SUBTILIS
BACILLUS POLYMIXA
BACILLUS LICHENIFORMIS
NITRASOMONAS
NITROBACTOR
STABILIZERS

DOSAGE : 1 Kg per Acre or consult your Aqua Technician For Specific Usage & Dosage

PRESENTATION: 500 gms &1 kg

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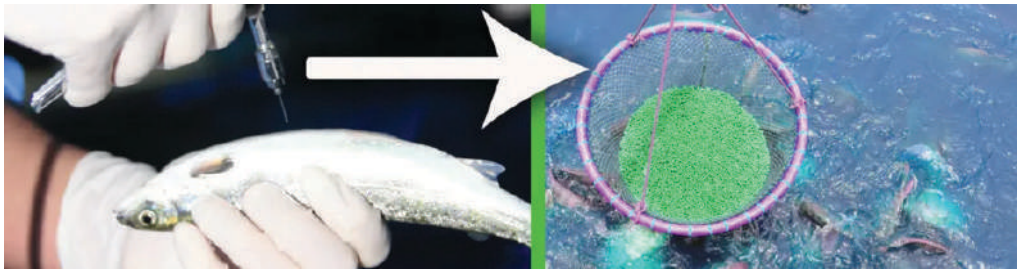
How do oral vaccines work in Aquaculture?

Researchers are putting additional resources into encapsulation ***methods and fortifying live feed for oral fish vaccines as the*** *market expands, hoping that these steps could improve vaccine* ***effectiveness and further safeguard fish immunity.***



Instead of manually injecting fish, innovators are turning to oral solutions to boost fish immunity

The prevalence of infectious diseases in the aquaculture industry and the limited number of safe and effective oral vaccines has posed a challenge not only to both fish immunity and the wider aquaculture industry. More oral fish vaccines are becoming available, but researchers have outstanding questions on how they work and their impact on the immune system of fish.

A recurring challenge in developing oral fish vaccines relates to their efficacy – many of the active antigens contained in vaccines degrade in the gastrointestinal tract of fish. In light of this, researchers from the National College, Alagappa University and Saveetha University have reviewed various encapsulation methods that would keep oral vaccines viable after initial digestion. They have also outlined recent advancements in oral vaccination in aquaculture – and its role as a sustainable disease prevention measure.

Oral vaccination – protection status in aquaculture

Developing oral vaccination methods has been a significant advancement for the aquaculture industry. In many cases, manually injecting fish is unfeasible. High stocking densities at large farms means that vaccinating entire ponds or cages is labour intensive and causes stress for the fish.

Manually vaccinating a tilapia

Since oral vaccines can be administered by through feed or other dietary supplements, producers are able to boost the immunity of their stocks as part of daily husbandry activities. Oral vaccination also lets producers immunise large stocks of fish without causing additional biological stress. Oral vaccines can be delivered to fish by fortifying formulated feed with a coating, through encapsulating antigens in a diverse range of polymers or by the bioencapsulation process in live feeds like rotifers, water fleas and Artemia.

Despite the benefits of oral vaccines, there are few vaccines approved for use in the aquaculture sector. This low number was attributed to the lack of immune response when compared to injectable vaccines. Researchers noted that the vaccine antigens tended to degrade as they passed through the stomach of the fish.

The types of oral aquatic vaccines

There are various types of vaccines. Conventional varieties consist of inactivated organisms, live attenuated organism vaccines and protein subunit vaccines. For live attenuated vaccines, one or more viruses or bacteria have been modified to express lower virulence or inherent low pathogenicity towards the target fish species. Researchers can modify viruses or bacteria through physical or chemical methods, serial passage in cell culture, culture under aberrant circumstances and molecular genetic modification to create the active antigens.

Live-attenuated oral vaccines mimic live pathogen infection by stimulating the biological pathways and responses that upregulate immune factors associated with innate and adaptive immunity. These vaccines replicate within the host, allowing the animal to develop sufficient cellular memory and build long-lasting immunity.

According to the researchers, live attenuated vaccines are effective in most cases. However, they can present a risk if they revert to their virulent form – causing infectious diseases. Live attenuated vaccines can

Some feed companies are incorporating antigens in aquafeed

also be pathogenic in immunocompromised hosts and can have residual virulence.

Examples of live attenuated oral vaccines currently used in the aquaculture industry include Arthrobacter salmonid vaccine against bacterial kidney disease (BKD), catfish vaccine against Flavobacterium columnare, viral haemorrhagic septicaemia virus (VHSV) vaccine, a viral vaccine against Koi herpesvirus (KHV) for carp and attenuated V. anguillarum vaccine in rainbow trout.

Inactivated or killed oral vaccines

Whole cell killed or inactivated oral vaccines contain thermally or chemically killed pathogens in suspension, which can elicit a protective immune response against pathogens when administered to hosts susceptible to infectious diseases.

Inactivated vaccines are used to suppress bacterial infections in fish, including those causing vibriosis and septicaemia-causing Aeromonas such as V. anguillarum, V. ordalli, Y. ruckeri, V. salmonicida and A. salmonicida. Killed oral vaccines are commercially available as formalin-inactivated whole cell vaccines that can be applied with or without adjuvants.

There are currently vaccines on the market that can tackle some pathogenic viruses in farmed fish, such as infectious pancreatic necrosis virus (IPNV), infectious hematopoietic necrosis virus (IHNV), viral haemorrhagic septicaemia virus (VHSV) and spring carp viraemia virus (SVCV).

Artemia nauplii

Modern oral vaccines

Modern oral vaccine technologies in aquaculture use recombinant DNA vaccine technology, recombinant protein vaccines and peptide vaccines. The discovery of the immunogenic component or protein of a pathogen of interest, in addition to the validation of its pathogenicity in vivo and in vitro, is the first step in the production of a recombinant protein vaccine.

The purified IHNV and VHSV glycoproteins, for example, have been used as subunits of fish vaccines and have been shown to be immunoprotective, and, like recombinant vaccines, they are frequently used in aquaculture.

Encapsulated oral vaccines

Various forms of vaccine delivery are currently being studied. The key challenge is finding a way to preserve the integrity of the antigen before it reaches the site of the immunological target. Researchers are turning to an encapsulation technique that allows the antigenic compound to be integrated with a "carrier" that can protect it from the adverse gastric conditions of the fish.

There are three basic encapsulation techniques for vaccines: using adhesives like edible oil or gelatin, spraying the formulated food with liquid vaccine suspension and co-processing the antigen with aquafeed during the manufacturing process. However, the researchers report that these processes have disadvantages. Encapsulation can lead to the uneven distribution of the vaccine in feed and can inadvertently degrade the antigen due to directly exposing it to the digestive environment during feeding.

Encapsulation techniques have been modified with better strategies for better protection and immune response, such as alginate, chitosan, poly D,L-lactic-co-glycolic acid (PLGA) encapsulation, which have shown promising immune responses.

For vaccines to reach their full potential, they must be easy to administer, effective, powerful and safe – and come without consequences for humans and the environment surrounding fish farms.

Vaccination has emerged as the most significant and sustainable solution for disease prevention and control in aquaculture. For vaccines to reach their full potential, they must be easy to administer, effective, powerful and safe – and come without consequences for humans and the environment surrounding fish farms.

Compared with other vaccination methods, oral vaccination methods can trigger the necessary immune response while imposing less stress on fish. These methods are also easier to administer and come at a relatively lower cost than manual techniques. The researchers note that nano-encapsulation is a promising method that could significantly increase vaccine production for aquaculture. Likewise, live food, such as brine shrimp, can be used as powerful biological carriers due to their small size and easy cultivation as food.

Sustainable shrimp cultivation provides hope for mangrove restoration in Sundarbans

In an effort to restore the unique ecosystem of the Sundarbans, the SAIME initiative has shrimp cultivators tending to mangroves around their farms as well

A new initiative of sustainable shrimp cultivation provides hope for mangrove restoration in Sundarbans. For several years, environmentalists and experts have expressed concerns over unsustainable aquaculture, particularly shrimp collection, after cleaning large tracts of mangrove forests in Sunderbans.

Under the initiative, Sustainable Aquaculture In Mangrove Ecosystem (SAIME), farmers have taken up cultivation of shrimp at 20 hectares at Chaital in West Bengal's North 24 Parganas, and 10 hectares at Madhabpur in adjoining South 24 Parganas. However, they are doing their part in restoring the mangroves as well.

Dinobandhu Das, a shrimp farmer from Chaital who has two acres under cultivation, says, "Our previous generation has cleared mangrove forests and cultivated shrimps. Under this initiative, we are planting mangrove trees around the shrimp ponds."

Farmers like Animesh Rai and Pintu Kumar Das from Chaital, also part of the initiative, point out that where they had to buy shrimp feed in the past, now the mangrove leaf litter provides nourishment for the crustaceans. "A research program on the contribution of mangrove leaf litter in the nutritional dynamics in SAIME ponds has been initiated in collaboration with the Centre for Excellence in Blue Economy (CoE-BE) of the Indian Institute of Science Education and Research (IISER), Kolkata," a press statement by Nature Environment and Wildlife Society (NEWS) said.

The rate of survival of planted mangrove saplings, which is usually 5-10%, has ranged between 30-50% in the initiative.

The community-based initiative of sustainable shrimp cultivation is being conceived by NEWS and Global Nature Fund (GNF), Naturland Bangladesh Environment and Development Society (BEDS).

Ajany Dey, Joint Secretary and Programme Director of NEWS, says that the initiative — started in 2019 — has established a collaborative ecosystem integrating several key stakeholders from government departments, academia, and research institutes for co-creation and comprehensive advancement of this project.

Shrimp cultivation is integrated into the mangrove ecosystem but when people extended the fisheries inwards, they excluded the mangroves, she explains. "What we are trying is to integrate the shrimp into the mangrove ecosystem. This pilot project has come out with a significant result in the last three years' span, providing a per hectare average yield of fishes and shrimps amounting to 535 kg, out of which shrimp amounts average 275 kg (black tiger shrimp-200 kg and with freshwater giant prawn-75 kg)," she notes.

The environmental activist also adds that the rate of survival of planted mangrove saplings, which is usually 5-10%, has ranged between 30-50% in the initiative.

Fishing, particularly shrimp cultivation, is one of the key occupations of the people of Sundarbans, which is a complex network of rivers and low-lying islands that face a tide surge twice a day. Shrimp cultivation is practised in about 15,000 to 20,000 hectares of the unique ecosystem in India. The Sundarbans forest is about 10,000 sq. km across India and Bangladesh, of which 40% lies in India.

There are 42 shrimp farmers engaged in the pilot project and a majority of them say that they have had higher incomes compared to previous years. They are also cultivating indigenous varieties of shrimps such as black tiger shrimp (P. Monodon) and giant freshwater prawn (M. Rosenbergii).

Fishing, particularly shrimp cultivation, is one of the key occupations of the people of Sundarbans.

Courtesy: The Hindu

Tilapia tales: Can the small fish make a big splash?

New Delhi: Long considered a poor cousin of its more illustrious rivals such as rohu, catla and mrigal the humble 'tilapia' is gradually acquiring a prominent place in India's aquaculture story because of its huge export potential and burgeoning domestic demand.

According to a recent report by the Confederation of Indian Industry (CII) and WorldFish, titled "Business Case for Scaling the Production of Tilapia in India', the country would need an investment of around 5,023 crore over the next 10 years to reach its desired Tilapia production level of 0.766 million tonnes by 2027 and 2.155 million tonnes by 2032.

Currently, India's domestic production of tilapia is just around 60,000-80,000 tonnes per annum and its share in the country's aqua-culture exports is negligible.

The annual production of Indian Major Carps (Rohu, Catla and Mrigal) is estimated to be almost 6 million tonnes and over 80 per cent of India's $5-7 billion annual aquaculture export is dominated by VannameiShrimps.

There are multiple reasons for the focus on Tilapia.

But first, a look at the fish's potential and unique characteristics that make it a first choice for several cultivators.

Why Tilapia?

According to Rajamanohar Somasundaram, founder and CEO of Aquaconnect, an end-to-

end solution provider to shrimp and fish farmers, tilapia farming is a low-cost but high-mar- gin business, with an added advantage of higher output since the fish can be farmed twice in a year.

"Easy cultivation makes tilapia a good choice for farmers as compared to Indian Major Carps because it is a hardy, meaty and an all-weather fish," Somasundaram told Business Standard. Its bone content is also much less, which makes it ideal for fillets and other delicacies.

The presence of hybrid and modified tilapia varieties like Genetically Improved Farmed Tilapia (GIFT) has added another dimension to its potential.

According toAquaconnect's calculations, the cost of producing an average-sized tilapia varies between 40 and 65 per kilogram (depending on the type of farming systems adopted). While the average farm gate-price fetched by tilapias is somewhere around 60- 90 per kg (depending on the size) and when it is sold in the market, the price can go up to 80-150 per kg.

This means a neat profit of around 40-50per cent just at the farm-gate level only 20 per cent of the total Tilapias produced in the country weigh over 1 kilogram, which helps in getting more production in less space.

"The biggest advantage of tilapia for the grower is that the feed cost is very nominal since this is an herbivore fish and can survive on algae, so it does not need artificial fish food. Moreover, it seldom gets infected with any disease due to its hardy character," Somasundaram said.

Another major advantage is that it gains weight faster than other comparable varieties. "While an average IMC takes around eight months to gain a weight of 300-500 gm, tilapia takes just half of that-3-5 months," he said.

This means that more fish can be produced in the same period of time.

That apart, tilapia has a huge export market in Africa and West Asia.

On the business front, the CII report projects a healthy return on investment of 24 per Cent - 30 per cent for everyone investing in the tilapia value chain.

"It is anticipated that by 2023, the volume of farmed tilapia will attract more investment into processing and manufacturing of value- added products for domestic and international customers," the CII report said.

Meeting the target

According to the CII report, the projected revenue from tilapia exports by 2027 is esti- mated at $1.135 billion, which would be eight per cent of the total estimated seafood export revenue of $14 billion by 2025.

And, by the 2032 financial year, the government estimates that revenue from tilapia exports will grow to $3.92 billion, thereby contributing over 15 per cent of the Indian exports of freshwater and marine aquaculture, which is estimated to be around $24 billion.

Of the targeted annual production of 2.155 million tonnes of whole, round fresh tilapia, around 0.738 million tonnes would be export- ed by 2032-0.59 million tonnes in the form of fillets processed from 1.78 million tonnes of whole, round fish.

This would be mainly to premium markets in the US, Europe and Japan, and also in the form of whole, round frozen fish to African countries.

The remaining 0.23 million tonnes would be sold in the domestic markets, both as fresh, whole, round fish and as fillets.

To achieve this ambitious target, the CII report projects the need for setting up around 1,151 new hatcheries. These would include 977 small hatcheries (each 2 million fry per year), 145 medium hatcheries (each 10 mil- lion fry per year) and 29 large size hatcheries(each 50 million fry per year).

"An investment of 236 crores between in getting more production in less space. 2022 and 2032 is needed to develop this hatchery infrastructure," the report said.

In addition to the required hatchery infra- structure, the tilapia value chain will also require assets such as semi-intensive ponds (13,200 hectares), intensive ponds (2,800 Ha), small rectangular cages of 100 cubic metres (89,000) and large circular cages of 1,000 cubic metres (21,000).

"All these will require a capital expenditure of around 25,023 crore over a 10-year period," the report said.

TILAPIA FACTS

- **Domestic production:** 60,000-70,000 tonnes per annum (estimated)
- **Targeted production: 0.766** million tonnes by 2027 and **2.155** million tonnes by 2032
- **Cost of production (COP):** 40-65 per kg (depending on production system)
- **COP by traditional method:** 35 per kg
- **COP bysemi-intensive method:** 55-65 per kg
- **Farm-gate realisation:** 60-90 per kg (depends on size)
- **Market price: 80-150** per (depending on size)

NOTE: Only 20 per cent tilapias weigh over 1 kg source: CII report &A quaconnect research.

Muneer Siddique, a senior consultant in Aquaculture receiving a memento from M.A. Nazeer, Editor, Aqua International, during Aquaculture Expo 2022 held in Hisar, Haryana on November 20. Muneer gave consultancy services to over 50 corporate and small farmers since 1989 in Andhra Pradesh, Gujarat, Maharashtra, Haryana, Rajasthan and Punjab. Muneer is known as specialist in Bore water and sea water. P.E. Cheran is also seen in the picture.

*A Special feature on **Shrimply** in February 2023 issue*

Fishing for wealth

With some tweaks, new fisheries scheme can work

Helping small farmers is vital

The product profile of fish in urban hyper markets is fast getting revolutionised. Companies are storming the market with plant based fish alternatives. They are rightly positioning themselves as leaders striving to comply with SDG 14 of the UN satiating the consciousness of the urban ecology-conscious Indian. We also have companies that manage 60,000 plus fish and shrimp farmers digitally.

The Pradhan Mantri Matsya Yojana (PMMSY), aims to increase fish production to 220 lakh tonne, average annual growth rate of fish production to 9 per cent, fisheries exports to ₹100,000 crore, reduce post harvest losses to 10 per cent and increase employment in the sector to 55 lakh by 2024-25.

Sub-sectors' scope

It also aims to expand the horizons of specific sub sectors, like seaweed culture and product development, ornamental fish culture and exports, exponentially increasing seafood exports. Infrastructure development in fisheries is also getting a big fillip. Massive budget outlays are enabling structural growth at the ground level. The extension of Kisan Credit Card (KCC) to fisheries sector is a master stroke.

However, there is not much of a technology push that has been built into PMMSY. Private investment in IT-driven fisheries is happening independent of the official big push.

The fisheries sector has already opened up fully to Foreign Direct Investments (FDI). Aquaculture, cage culture technology and re-circulatory and bio-floc systems are most ideal investment avenues for FDI. Core areas of fisheries flagged for PPP mode of development, like harbour, cold storages, landing centres development, could take the FDI route.

Involvement of chambers of commerce is very important to push private investments in the sector. The poultry and meat giants who are keen to enter this sector are constrained by logistics and technology issues such as volumes, timeliness and regularity of delivery to drive the market. Rural electrification is a big concern.

Credit push

The fulcrum of development is credit. The rapid strides in non-banking financial (NBFC) intermediation in agriculture and growth of micro finance companies will greatly benefit the fisheries sector with timely and easy credit.

But NBFCs are yet to tap the opportunities in marine fisheries and inland aquaculture constrained by their poor knowledge of fisheries. India is still a word of mouth country. Farmers adopt practices that are recommended by their brethren. Digital extension has been successful in agriculture. But for small scale (potential) fish farmers, especially those in the hinterlands, the PMMSSY still remains unknown. Banking correspondents can be trained to disseminate information about PMMSY to expand its reach among small fishers.

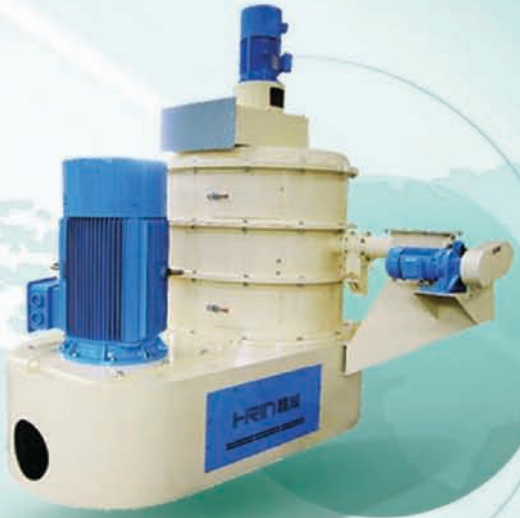
Only 1,13,076 KCCs have been sanctioned for the fisheries sector (October 2022) out of 20 million marginal fishers identified for direct income support. The post office banking system should be used for the rapid spread of the KCC. If banks can sell insurance products, post office banking system can definitely support KCC in the hinterlands.

Aquaculture of high value species is a high technology, management intensive and investment heavy enterprise. Expecting the small holders to push production to the targets set is short sightedness.

Private investments in such areas of hi-tech aquaculture should lead the way, including the local population in their HR profile. Technology in fisheries production, product development and marketing needs to be closely followed. Plant based fish and cellular based seafood could have a cataclysmic impact on structure of employment in the sector as the level of education across the country improves. An inclusive approach of the official line with the tech line of the private sector could help PMMSY pip the post.

The writer Former Principal Scientist & Head, ICAR – Central Institute of Fisheries Education

Professional Feed Machinery Manufacturer



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Fish Paste: *A viable option for Indian Seafood export industry*

Email: comohan@gmail.com

Dr Elavarasan K., Dr C. O. Mohan & Dr C. N. Ravishankar
ICAR-Central Institute of Fisheries Technology, Kochi.

Fish paste is a value added product prepared from deboned fish by mixing with condiments, salt and oil. Fish flesh with other choice of ingredients is mixed in a meat bowl chopper to get fine paste consistency and taste.

Fishes suitable for fish paste preparation

Both fatty and non-fatty fishes of marine origin and fresh water fishes of low value are preferable for fish paste production. Marine fatty fishes could serve as rich source of omega-3 fatty acids and impart characteristics taste of fatty fishes. Fish paste can be prepared from variety of fishes even from fishes with low economic value.

List of some of the suitable fishes and their approximate cost

Marine fish/prawns/fresh water price	*Cost in Rs (Average landing centre /farm gate price)
Sardines	47-98*
Mackerel	130-180*
Tuna	180-250
Pink Perch	125-150
Croaker	150-180
Ribbon fishes	140-271*
Squid	215-280
Non-Penaid prawns	220-330*
Tilapia	120-180
Indian major carps/exotic carps	160-220
Pangasius	90-160

*CMFRI annual report 2018-2019.

Highlight Points

- Fish paste is very rich in highly digestible protein with well-balanced essential amino acids
- Fish paste has promising market potential in domestic as well as international market.
- Fish paste production, suitable ingredients and nutritional benefits are discussed in this article.
- Indian seafood export industry needs diversification and value addition
- Information provided would help in new entrepreneurship development in seafood sector

Note: The cost varies with location, season and demand supply. For the purpose of business, lower the cost of fish better the return and viability.

A wide variety of ingredients have been tried in the formulation of fish paste (Table 1). Commercial products in the market having customized ingredients in the recipe to meet the local consumer preferences. Normally preservatives like, nitrite (E 250), Sodium nitrate (E 251), potassium nitrate (E252) are used as curing agents in the formulations. Ammonium carbonates (E 503) and diacetyl tartaric acid esters of mono- and diglycerides (DATEM) (E472e) are used as raising and stabilizing agents, respectively. Also, derivatives of ascorbic acid like sodium ascorbate (E301) is used as antioxidant especially when fatty fishes are used in fish paste preparation like sardine, mackerel, tuna etc.

Table 1. Ingredients used in recipe formulations

Tomato paste	Soya Protein	Mustard Flour	Lemon Juice
Corn starch	Rapeseed Oil	Wheat Flour	Chicken Stock
Corn starch	Egg Yolk	Calcium Carbonate	Yeast extract
Potato starch	Vinegar	Minerals	Fibre extract
Vinegar	Sugar	Vitamins	Mushroom
Preservatives (E252, E251, E250)	Nutmeg extract	Mayonnaise	Skimmed milk powder
Raising agent (E503)	Onion powder	Herbs extract	Stabilizer (E472e)
Antioxidant (E301)	Ginger paste	Garlic paste	

Note: Ingredients inclusion could be customized based on the consumer targeted/needs

Fish paste is very rich in easily digestible protein compared to chicken and beef paste with the digestibility factor of 93 – 98%. A comparison of the nutritional information of fish paste with chicken and beef paste is represented in Table 2. The added advantage of fish paste when prepared from fatty fishes like sardine, mackerel etc supply therauputicΩ-3 fatty acids which are very limited in paste prepared from other meat varieties.

Table 2. Nutritional information (per 100g) of fish paste - a comparison with market products available commercially

Nutrients	Fish paste	Chicken paste	Beef paste
Protein	14-17 g	13-15g	13-15 g
Fat	9-10 g	11-13 g	15-17 g
Carbohydrate	6-9 g	4-6 g	1-5 g
Salt	1.5-2.0 g	0.75-1.25g	1.0-1.5 g
Omega-3	1-3 g	---	--

Salient features of fish paste:

- Very rich in highly digestible protein with well-balanced essential amino acids
- Can be customized to variety of taste
- Helps in concealing the identity of the original fish from which it is made and consumers may not hesitate to accept this even though the original fish would have been unacceptable as whole fish.
- It finds application in processing several 'convenience foods' like salad dressings, spread (bread spread / spread on roti / chapatti), condiments etc.
- Suitable for all age groups including kids, lactating women and aged persons.

Storage:

- Can be stored under chilled condition (+0 to 2°C) with a shelf life of few days to few weeks
- Can be stored under frozen condition (-18°C) with a shelf life of 6 to 12 months
- Fish paste in Ready-to-eat (RTE) form can be stored at ambient temperature with a shelf life of minimum 1 year

Conclusion:

Considering the great nutritional advantage and convenience, fish paste can be a very good viable option for the Indian market, where the value addition is very limited. Although, fish paste has huge demand in International market, currently it is not being exported from India. To cope up with the growing competition for innovative fish products in the international market, Indian seafood Industry and other aspiring entrepreneurs can consider fish paste as a viable business option.

Blue Carbon Ecosystem: *A Strategy to Mitigate Global Climate Change*

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Abstract: Raising the carbon dioxide (CO_2) concentrations in the atmosphere leads to global climate change, and it causes the sea level to rise, Tsunami, and damage the coastal and marine ecosystem. Coastal vegetation such as mangroves, sea grass, and salt marsh called blue carbon ecosystem got the considerable potential to store the CO_2 from the environment to the root system, the soil below ground, and litter. Apart from carbon sequestration, it provides various ecosystems ecological services such as shelter for the various fishes, mammals, crabs, and migratory birds. However, due to anthropogenic and natural threats, the blue carbon ecosystem is destroying reducing its capability to store carbon. This system needs to be conserved to mitigate global climate change and also to obtain ecological services.

Introduction: The Earth's warming in recent decades has caused an overwhelming consensus amongst climate scientists because different human activities and anthropogenic activities have increased the number of greenhouse gases (GHGs) in the atmosphere. To mitigate the severe impact of climate change, we need to adopt a range of different strategies, among which Blue Carbon is an essential strategy. Blue Carbon is organic carbon that has been captured and sequestered by coastal marine plants. Seagrasses, mangroves, and tidal marshes ecosystems are highly productive and act as the largest carbon repositories in coastal ecosystems (Nellemann *et al.*, 2009; Sappal et al., 2016). Vegetated coastal ecosystems (mangrove forests, seagrass beds, salt marshes) are disproportionately important in sequestering carbon dioxide than terrestrial ecosystems. These ecosystems are exquisite carbon sinks and provide various ecological services such as shelter for the various fauna such as fishes, crabs, and migratory birds. According to the different researchers, the coastal blue carbon ecosystems have great potential in sequestering carbon within its living biomass and within the soil below ground (sediments), where roots, litter, and deadwood can be found. The potential for sequestering blue carbon is estimated to be decennial over the short term in biomass and millennial over six longer time scales in sediments (Duarte *et al.* 2005a; Lo Iacono *et al.* 2008; Mcleod *et al.* 2011). Oceans play a vital role in capturing and recycling atmospheric CO2 and globally absorbed over one-third of anthropogenic CO2 emissions through biological, physical, and chemical processes due to the gaseous exchange at the ocean and atmosphere interface (Siegenthaler and Sarmiento, 1993; Tamis and Foekema, 2015). Coastal ecosystems represent less than 5% of the earth's total surface but play a significant role in regulating the global carbon cycle (Twilley *et al.*, 1992). These ecosystems store around 3418.5 metric tons of carbon dioxide equivalent per hectare (t CO2/ha) in their biomass and sedimentary carbon.

Highlight Points

Global climate change raising threats for the coastal areas. Climate change causing sea level rise, Tsunamis etc that damage the coastal ecosystem. Blue carbon ecosystem such as mangroves, the salt marsh has got huge potential to sink the atmospheric carbon and mitigate the global climate change. Unfortunately, the natural and anthropogenic activities (destruction of mangrove for shrimp farming) cause heavy destruction of the blue carbon ecosystem. As a result, the atmospheric carbon content is rising day by day and the earth became warmer. Conservation and protection of blue carbon ecosystems will mitigate CO2 emissions. Conservation of blue carbon ecosystems will also help in the conservation of biodiversity, protection of the community along coastal zones, conservation of valuable fisheries, prevent erosion, and also prevent the degradation of adjacent communities.

This coastal blue carbon provides benefits to climate change mitigation because of their ability to store carbon under adverse conditions. Due to this, it has got the attention of the scientific community at large. A significant portion of biogenic carbon reaches the seafloor, where it can be buried and effectively locked away from the atmosphere over long time scales constituting a sink of CO2 and contributing to mitigate climate change (Bowler *et al.,* 2009). OSPAR Biodiversity Committee (BDC) meeting in March 2015, considered a blue carbon ecosystem has colossal potential to mitigate the global climate change in the OSPAR maritime area (OSPAR, 2015). Marine and coastal ecosystems play a crucial role in carbon storage and sequestration and mitigate global climate change (Duarte et al., 2005a; Nelleman et al., 2009; Murray et al. 2011). Vegetated coastal habitats are widely distributed and are estimated to be globally responsible for the burial of 120–329 Tg C /yr, which accounts for at least half of the lower estimate for global carbon burial in marine sediments (Nellemann et al., 2009). In recent years "blue carbon" sinks are being lost at critical rates, and action is urgently required to prevent further degradation and loss of these blue carbon ecosystems. The high priority restoration and conservation management should be followed to understand the different factors that influence carbon sequestration and improve scientific activity to prevent these ecosystems' degradation.

Blue carbon ecosystem and biodiversity: Coastal blue carbon habitats are hot spots for biodiversity and provide valuable ecosystem functions, including a massive carbon sink capacity (Duarte *et al.,* 2008, Duarte*et al.,* 2009; Nellemann *et al.,* 2009). However, in recent years, this habitat's destruction and degradation are increasing due to different anthropogenic activities. Restoration of these habitats results in blue carbon development as well as the conservation of the biodiversity of these ecosystems. So, the protection of blue carbon habitats and large-scale restoration of lost blue carbon sinks is a win-win strategy as it mitigates CO2 emissions and improves coastal resources (Nellemann et al., 2009;) and biodiversity.

Blue carbon ecosystems and carbon storage: Blue carbon ecosystems remove CO2 from the atmosphere via photosynthesis, return some to the atmosphere through respiration and oxidation, and store the remaining carbon in two pools: living biomass (both above ground in the wood, leaf, and belowground vegetation in roots) and soil organic carbon. The carbon sequestration rate is the total amount of carbon is added to the biomass and soil annually. These ecosystems typically have mature vegetation that maintains steady biomass, and all the sequestration ends up buried in the soil carbon pool. Blue carbon ecosystems are hot spots for carbon sequestration because they convert CO2 into plant biomass, found in depositional environments, and soils have high accretion rates resulting in the rapid burial of organic matter in anoxic conditions, which accumulate both autochthonous and allochthonous particulate carbon (Kennedy *et al.,* 2010; Saintilan *et al.,* 2013; Donato et al., 2011; Lo Iacono et al., 2008; Serrano et al., 2016a).

Annual carbon sequestration rates vary in the different coastal habitats such as marshes and mangroves. Average carbon sequestration is between 6-8 tonnes/ CO_2e/ha/yr. Seagrasses tend to sequester carbon at approximately 4 t CO_2e/ha/yr (Lewis et al. 2009). The rate of carbon stored in living biomass in seagrasses is 0.4–18.3 t CO_2/ha, and salt marshes at 12–60 t CO_2/ha. Mangrove forests maintain 237–563 t CO_2/ha in living biomass. However, the long-term preservation and continuous accretion of carbon in a tidal marsh, mangrove, and seagrass soils result in the formation of organic-rich deposits several meters in thickness (Mateo et al., 1997; Donato et al., 2011). According to many researchers, the carbon storage and sequestration rate in the different blue carbon ecosystems are given below (Table 1).

Ecosystem	Global Extension (km^2)	Global C Burial Rate (Tg C/yr)	Global C Stock in Soil (Pg C)
Tidal marshes	22,000 - 400,000	4.8 - 87.3	0.4 - 6.5
Mangroves	137,760 - 152,3615	22.5 - 24.9	5 -10.4
Sea grasses	177,000- 600,000	48 - 112	4.2 - 8.4
Macroalgae	1,400,000 - 5,700,000	61 - 268	n/a

Table 1: Extension and Carbon Stocks and Burial Rates Within the top 1 m of Soil of Tidal Marsh, Mangrove and Seagrass Ecosystems, and Macroalgae C Buried in the Ocean (Source: Serrano *et al.,* 2019).

The carbon storage rate in the soil and biomass of the blue carbon ecosystem is Seagrass: 512 Mg CO_2e/ha, Saltmarsh: 917 Mg CO_2e/ha, and Mangroves; 1028 Mg CO_2e/ha. Blue carbon ecosystems regularly remove CO_2 from the atmosphere and sequester them in the form of soil carbon. The average carbon sequestration rates of these ecosystems are Seagrasses: 138 gC/m^2/yr equal to 5.1 tCO_2/ha/yr, Salt marshes: 218 gC/m^2/yr equal to 8.0 tCO_2/ha/yr, Mangroves: 226 gC/m^2/yr equal to 8.3 tCO_2/ha/yr

Factors influencing carbon storage in blue carbon ecosystems: Organic carbon sequestered in the blue carbon ecosystem reaches the seafloor and gets covered by a layer of sediments. Carbon sequestration occurs when the sediments' burial rates are more significant than the long-term rates of erosion, bioturbation, and decomposition. Multiple factors influence carbon storage, including biotic and abiotic factors acting in the water column, canopy, the soils, and the landscape's history and past variation in sea level. The other factors are given in Table 2.

Factors	Influence and Discussion
1) Spatial variability in sedimentation I. Open ocean II. Coastal margins III. Submarine canyons	Sedimentation is the rate at which suspended particulate sink and accumulated on the ocean floor. The amount of suspended sediment and the rate of deposition vary drastically in the different places of the ocean like Open ocean-low sedimentation rate due to wind Coastal margins- high sedimentation rate due to input by rivers Submarine canyons- Carbon burial rate in the marine canyons are more significant than the adjacent continental slope.
2) Human changes in global sedimentary systems I. Agriculture/ land cleaning II. Dams	Different numbers of human activity have done the modification of sediment cycles. Global sedimentary cycling started to change when humans started clearing the land for agriculture and constructing a dam. Land cleaning causes an increase in erosion rate. Dams are nearly 100% efficient sediment traps.
3) Density of vegetation	The density of vegetation in the mangrove forest, sea grass meadows, and tidal marshes sufficient to change water flows, which is enough to reduce erosion and increase sediment deposition because they exert primary control on carbon storage through the production of biomass and nutrient cycling (Lavery et al., 2013; Serrano et al. 2014, 2016a; Kelleway et al., 2016a; Atwood et al., 2018;2015)
4) Nutrient load	Both mangrove and sea grass ecosystems, which have been subjected to high nutrient loads, increase the carbon capture and sequestration rate.

Table 2: Factors influencing carbon storage in blue carbon ecosystems

Blue carbon and climate change mitigation:
Carbon storage in the blue carbon ecosystem is one of the cheapest, safest, and most comfortable solutions to sink the greenhouse gas emissions and promote adaptation to climate change (Jones *et al.,* 2012, Turner *et al.,* 2009). Two central primary mechanisms to reduce greenhouse gas emissions in this ongoing loss of coastal habitat and marine ecosystems is:

1) Conserving historically sequestered pools of carbon.

2) Restoring and rebuilding degraded carbon pools.

From the disturbance of blue carbon ecosystems, the rate at which carbon is lost is much more than the rate at which it can be restored. The other advantages of blue carbon ecosystems are like mangroves act as natural barriers, serving as the first defence from storm surges, stabilizing shorelines, and reducing coastal communities (Barbier, 2007; Das and Vincent, 2009). Seagrass meadows also reduce shoreline erosion by trapping suspended sediments in their root systems (Barbier, 2007). Coastal ecosystems absorb pollutants like heavy metals, nutrients, suspended matter, and pathogens, help maintain water quality, prevent eutrophication, and develop dead zones. A healthy coastal ecosystem also provides various recreational opportunities such as snorkeling, recreational fishing, boating and coastal ecotourism is one of the fastest-growing sectors.

Threats to Blue carbon storage: Mangrove, seagrass, and salt marsh areas have already been lost over the past several decades due to the intervention of different human activities like reclamation, deforestation, engineering, and urbanization, transformation to aquaculture ponds (Green and Short 2003; Duarte et al. 2005b; Silliman et al. 2009. Over the past decades' seagrass habitat decline due to coastal eutrophication, siltation, and development (Green and Short 2003; Duarte et al. 2005b; Waycott et al. 2009), whereas the mangroves and salt marshes habitats have been damaged by dredging, filling, drainage, trophic cascades, and also due to introduction or accidental invasion of invasive species (Valiela et al. 2001; Alongi 2002; Silliman et al. 2005; 2009). Sea-level rise and sea surface temperature increase due to the climate change is another threat to the coastal ecosystem which can erode and flood mangroves and salt marshes and increase water depths and reduce the availability of light to support photosynthesis (Björk et al. 2008; Woodroffe 1995; Silliman et al. 2009). The global average annual loss of blue carbon ecosystem losses reduces their carbon storage capacity. It has severe implications for human populations that depend on these ecosystems for food, livelihoods, and coastal protection. Considerable conservation and management strategies should be addressed to protect these blue carbon ecosystems and controls carbon dynamics in coastal systems (Middleton and McKee, 2001; Kristensen et al., 2008).

Current policies needed to safeguard carbon associated blue carbon ecosystems: Different policies exist to incentivize nature-based mitigation activities for blue carbon ecosystems by different carbon policies and financial mechanisms. A few examples are highlighted below in Table 3.

Policies and Opportunities	Description
UNFCCC Article 4	Promote sustainable management, conservation, and enhancement of sinks and reservoirs of all greenhouse gases, including oceans and other coastal and marine ecosystems.
Reducing Emissions from Deforestation	A framework for encouraging and financing activities that reduce emissions or enhance removals of GHGs from forest-related activities
Nationally Appropriate Mitigation Actions (NAMAs)	Part of the UNFCCC mechanisms for developing countries to access carbon finance and provide opportunities to include land-use change, conservation, and restoration activities in coastal ecosystems into national mitigation efforts.
Clean Development Mechanisms (CDM)	Developing countries can obtain funding for eligible projects with a net GHG benefit, including CO2 sequestration from forests. The CDM has approved a large-scale mangrove restoration methodology.
Voluntary Carbon Market	Provides the possibility of generating financial support for blue carbon ecosystems conservation or restoration activities and provides a framework for accounting GHGs emission reductions in coastal wetlands, mangroves, tidal and seagrasses, deltas, floodplains, and peatlands, among others.

Table 3: Current policies needed to safeguard carbon associated blue carbon ecosystems (Sources: Climate Focus, 2011; Conservation International, 2008; Pendleton et al., 2012).

Conclusion: In recent years blue carbon ecosystems have received international attention for its potential role in mitigating CO_2 emissions. Conservation and protection of blue carbon ecosystems will help maintain global carbon sequestration in the future and prevent emissions that are termed land-use change. Conservation of blue carbon ecosystems will also help in conservation of biodiversity, protection of community along coastal zones, conservation of valuable fisheries, prevent erosion, and also prevent the degradation of adjacent communities. We need to create mass awareness regarding the importance of blue carbon ecosystem so that the ecosystem can sustain.

Reference can be provided on request

ECOLOGICAL IMPORTANCE OF TURTLE

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Highlight Points

- Turtles play a major role in maintaining the Marine ecosystem in balance
- They actively helps in maintaining a healthy seagrass bed and coral reefs, providing key habitat for other Marine life ,helping to balance Marine food webs .
- Turtles facilitates nutrient cycling from water to the land
- The nutrients left behind by eggs and hatchlings that don't survive provide an important source for coastal vegetation

INTRODUCTION:

There are 360 turtle species living around the world. Turtles belongs to the Class – Reptilia and Order –Testudines. They are large reptiles, air breathing species. Their shells consists of two sections namely carapace(upper section) and plastron (lower section).turtles are considered as oldest reptile species. Their internal temperature varies according to the environment that is ectotherms (cold blooded).

Turtles are further classified into amniotes, means that they do not lay eggs underground, even though most of turtles live in water. They lay eggs on dry or sandy beaches. Turtles use to come to surface often to refill their lungs. Depending on species immersion periods vary between 60 seconds tom 1 hour.

Jelly fishes and sponges are the typical food for sea turtles, adult turtles usually eats snails, worms and insects. Turtles are playing a major role in maintaining food web and ecology. Unlike other animals, turtles make up a significantly higher percentage of an ecosystem's biomass. Many marine organisms rely on sea turtles as a place to call home.

Sea turtle populations around the world have dwindled in recent centuries and in many places, continue to decline. They are facing unprecedented threats to their population, despite being incredibly important animals. At present, many conservations have been established for saving turtles from extinction.

LIFE CYCLE OF TURTLE:

The turtle life cycle begins with female sea turtles laying a nest of 100-200 eggs. After 40 to 60 days depending on the species nests begin to hatch. Hatchlings crawl as fast as possible to the sea and swim towards the open ocean as soon as they come out of the nest. After a few years, immature turtles will settle close to shore where it may take them more than 30 years to reach adulthood. Growing areas of juveniles varies according to the species and food availability. Sea turtles have a very low natural survival rate- only 1 in 1,000 turtles will make it to adulthood.

On reaching adult stage, turtles usually have long life span ranging from 50-100 years depending on species. A turtle from subspecies of Aldabra giant tortoise named Jonathan is the oldest known terrestrial animal in the world. It was hatched on 1832 and survived many years and in the year 2019 its age was 187.

IMPORTANCE OF SEA TURTLES IN ECOLOGY:

It is important to understand roles of turtles so that it will help us to know losses in the ocean ecosystems, the environmental effects of remaining populations due to absence of turtles and conservation measures required for sea turtles. Turtles have positive impacts on seagrass beds, coral reefs, food web, providing habitat. It will become a great ecological collapse if any one of the impact of turtle is affected as a result of turtle extinction.

Turtles redistribute energy in multiple ways, such as by being a food source for predators. In addition to being prey themselves, their eggs are food for many creatures. Sea turtles lay their eggs on land, but only 27% of the energy in those eggs actually returns to the ocean as hatchlings. The eggs and hatchlings provide food for many predators, and the empty shells and eggs that don't hatch provide nutrients that can be recycled by invertebrates and micro-organisms.

If sea turtles went extinct, dune vegetation would lose a major source of nutrients and would not be as healthy and would not be strong enough to maintain the dunes, resulting in increased erosion. Once again, all parts of an ecosystem are important, if you lose one, the rest will eventually follow. Sea turtles are a **"keystone species"**, which means they are an important part of their environment and influence other species around them. If a keystone species is removed from a habitat, the natural order can be disrupted, which impacts other wildlife and fauna in different ways.

IMPACT ON FOOD WEB:

The largest of the sea turtles, Leatherbacks travel the farthest of any sea turtle species. They have wide ranging effects on the ocean ecosystem, Leatherbacks get their nutritional needs from jellyfish. Leatherbacks rely on large concentrations of jellyfish to fulfill their appetites. They have been known to consume up to 440 pounds of jellyfish. Leatherbacks play a great ecological role as a top jellyfish predator.

Declines in leatherback turtle lead to increase in jellyfish population. Declining fish stocks leave jellyfish with less competition for food, resulting in proliferation of jellyfish around the world. The increase in jellyfish leads to decline in fish stocks since jellyfish prey on fish eggs and larvae. Because leatherbacks consume large amounts of jellyfish, jelly fish populations can be controlled.

Turtles carry barnacles, algae and other similar organisms known as epibionts, they provide a food source for fish and shrimp. Other organisms such as sheep shead bream, wrasse, angelfish and barber pole shrimp, act as "cleaning stations" for sea turtles.

Sea turtles expose their bodies, offering food to fish and shrimp. This also benefits sea turtles by keeping their skin and shells clean. This is also known as mutualism. Some species get their food strictly from epibionts found on sea turtles. Without this food some species have to search for alternative unsuccessful methods for food.

Every sea turtle species are also a prey, both on shore and at sea. Sea turtles are most vulnerable to predation as eggs, hatchlings and juveniles. As hatchlings emerge from the nest, they provide another feeding opportunity for seabirds. By aerial view of birds, hatchlings are hunted from the water surface even after the hatchlings reached water. Reef fish are common predators of both hatchlings and juvenile sea turtles. As sea turtles grow, risk of predation decreases. Still adult green turtles are hunted by tiger sharks and white sharks.

IMPACT ON SEAGRASS BEDS:

A herbivores species called Green sea turtles eat seagrass and help to maintain healthy seagrass beds. They are a fundamental link in marine ecosystems and help maintain the health of coral reefs and sea grass beds. Green sea turtles increase the productivity and nutrient content of seagrass blades when they graze.

Its large and powerful jaws serve as an effective tool for dismantling its prey. Young loggerheads are exploited by numerous predators; the eggs are especially vulnerable to terrestrial organisms. Sea turtles play a significant role in balancing the oceans' food chain. They feed on more than 200 taxa of vertebrates and invertebrates, including marine sponges, jellyfish, molluscs and crustaceans. Green turtles, for instance, help to maintain healthy seagrass beds, by grazing on it.

Seagrass beds become overgrown and obstruct currents, shade the bottom, begin to decompose if green turtles does not graze. This results in a 15-fold decrease in the supply of nitrogen to seagrass roots, which impacts plant species, nutrient cycling, and predator-prey relations. The decline of green sea turtles can result in a loss of productivity in the food web.

IMPACT ON CORAL REEFS:

Hawksbills are found mainly throughout the world's tropical oceans, predominantly in coral reefs. They are a fundamental link in marine ecosystems and help maintain the health of coral reefs and sea grass beds. Hawksbill sea turtles equipped with beak-like mouths, forage on a variety of marine sponges. By doing this, they change distribution of sponges in coral reef ecosystems. Sponges greatly compete for space with reef-building corals. By removing sponges from reefs, hawksbills allows coral, to colonize and grow. Without hawksbills, sponges will affect corals and modifying the very structure of coral reef ecosystems.

The physical defenses mechanism of sponges prevent most fish and marine mammals from eating them. As hawksbills kills sponges apart during feeding, it will be easier to provide food to marine species which are typically unable to penetrate the sponge's exterior and making sponges more vulnerable to predators.

By doing this, hawksbill turtles impact the overall diversity of coral reef communities. If Hawksbill Sea Turtles went extinct, the populations of the organism they feed on, such as sponges and sea urchins, would likely explode, causing large-scale erosion and even the collapse of marine ecosystems such as coral reefs.

IMPACT ON OCEAN FLOOR ECOSYSTEM:

Loggerheads find prey by clearing sand away to expose their meal. Loggerhead turtles are named for their large heads that support powerful jaw muscles, allowing them to crush hard-shelled prey like clams and sea urchins as they glide along the sea floor in search of food, loggerheads create trails in the sediment. This foraging behavior is important for both loggerheads and the habitat. The loggerheads leads to aeration and nutrient distribution of the sediment, and also the species diversity and dynamics of the benthic ecosystem. This foraging behavior helps greatly in ocean floor ecosystem.

PROVIDING HABITAT:

Many marine organisms rely on sea turtles for home. These small creatures called "epibionts" attach themselves turtle shells. Loggerheads play as host to the largest and most diverse groups of epibionts. More than 100 different species have been identified on loggerhead shells. Columbus crabs (Planes minutus) found on loggerheads are more successful foragers with a diverse diet, than those crabs found on debris which mainly consume algae. Columbus crabs consume on other epibionts found on loggerhead shells, and the shedding skin and feces of loggerheads.

Sea turtles provide numerous benefits to the epibionts they host. A basking loggerhead turtle becomes a small oasis, offering its body and shade as habitat for sea birds, invertebrates and algae. Gradually, this habitat builds up a bait ball of small fish, an essential source of food for great ocean voyagers as sharks, tuna, mahi mahi and cetaceans.

In the open ocean, miles from shore, sea turtles offer an oasis to seabirds. Olive ridleys species are most frequently associated with seabirds in providing oasis. Olive ridleys expose the center of their shell and create a platform for seabirds to perch. Small baitfish also use sea turtles for protection, by forming tight schools beneath the turtle's body. These schools of baitfish then provide a food source for resting seabirds. Seabirds also feed on epibionts inhabiting the sea turtle's shell.

MAJOR THREATS TO TURTLE:

In some Asian countries, turtle shells are used to make decorative boxes, combs, brush handles, earrings and even jewelry. The shells are also be inlaid with gold, silver and even mother-of-pearl. Turtle population is declining every year due to human activities such as hunting them for producing medicines and decorative items. They are also caught in trawls even though they not a target species. Oil spills and some other accidents cause disastrous death rate of turtles. This declination in turtles such as leatherback turtles, Green turtles, Loggerheads, Olive ridelys leads to collapse in food web, ocean floor ecosystem.

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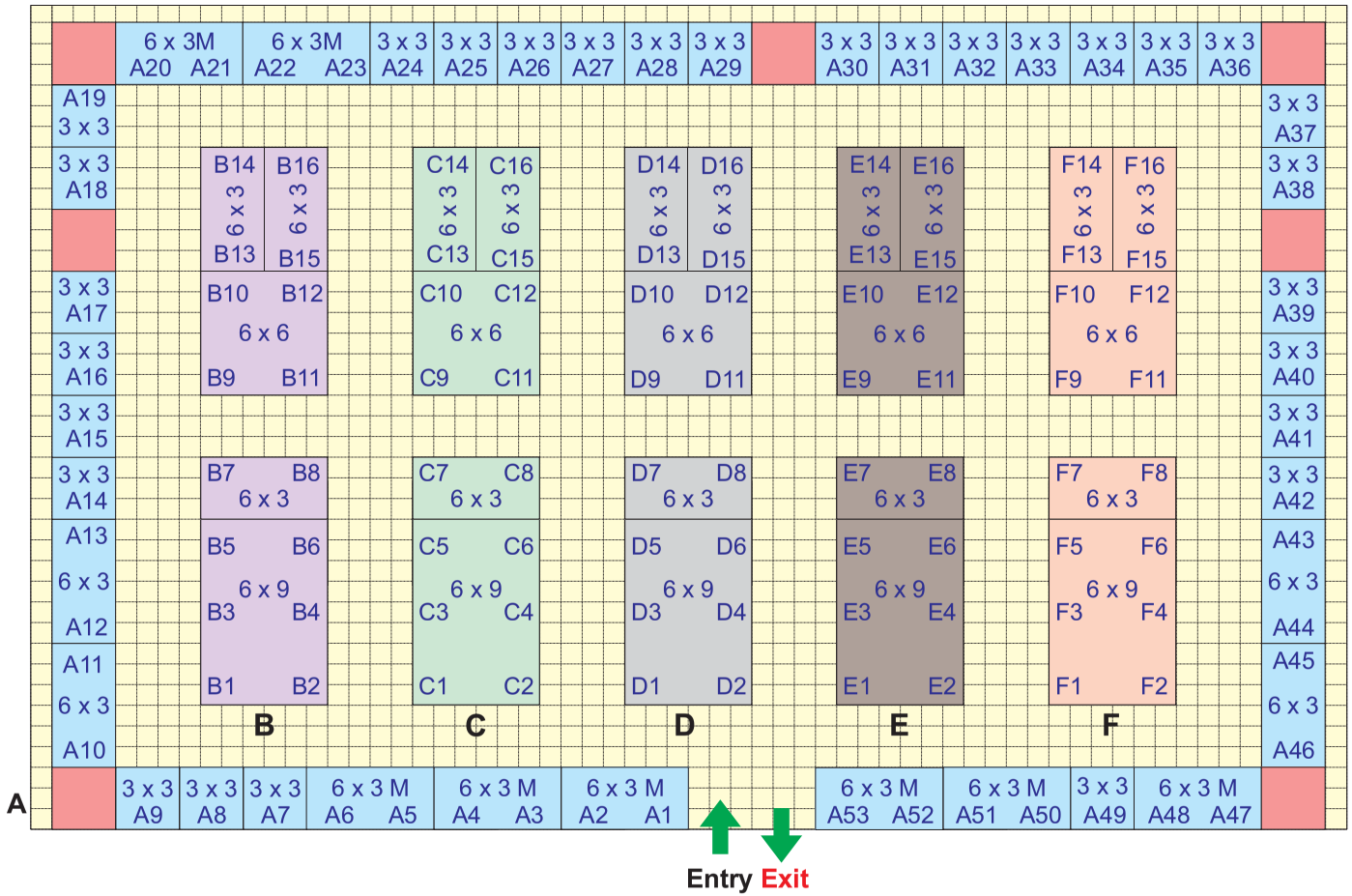

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Turtles are majorly hunted for eating purposes. The most commonly eaten sea turtle meat comes from Green sea turtle, loggerheads, ridleys, hawksbills and leatherbacks are also consumed by humans in various regions around the world. Most countries around the world have banned the hunting and selling of sea turtle meat for animal cruelty reasons. Many acts have been established to control hunting of turtles nowadays.

TURTLE PROTECTION ACTS AROUND THE WORLD:

Sea turtles are given protection in the **United States** under the **Endangered Species Act (ESA-1973)**, which lists the hawksbill, leatherback, ridley and green turtle as endangered and the loggerhead is considered as threatened. This act makes illegal to kill any sea turtles, hatchlings or their eggs, import, sell or transport turtles or their products. Other countries too have their own conservation laws to protect sea turtles.

Costa Rica established **"Protection, Conservation and Recovery Law on sea turtle populations"** from **2002** that makes trafficking on sea turtles is illegal, which might be punished by sentence. **Panama** established **"Inter-American Convention for sea turtle protection and conservation"** in **2008** which the country guarantee protection and conservation of these species through management measurements, creating reproductive and nesting grounds. This law also forbids consumption and trafficking on sea turtle products.

The **"Convention on International Trade in Endangered Species" (CITES)** controls international trade in endangered and threatened species. Sea turtles are come under **Appendix I** of this agreement and receive protection from international trade by all countries that have signed the treaty.

TURTLE PROTECTION ACTS IN INDIA:

Every year, thousands of sea turtles are accidentally captured, injured or killed by mechanised boats, trawl nets and gill nets operated and used by commercial fishermen. There are 5 species in Indian waters — Leatherback, Loggerhead, Hawksbill, Green and Olive Ridley. In India, though sea turtles are protected under the **Indian Wildlife Protection Act of 1972**, under the **Schedule I Part II**.

Appendix I of the **CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)**, which prohibits trade in turtle products. The mass nesting beach at Gahirmatha is a part of **Bhitarkanika Wildlife Sanctuary** and the waters around Bhitarkanika were declared as **Gahirmatha (Marine) Wildlife Sanctuary in September 1997**, to protect the nesting and breeding habitat of the Olive Ridley.

The coastal waters off Devi and Rushikulya rookery are declared as a no fishing zone during the sea turtle breeding season under the **Odisha Marine Fisheries Regulation Act (OMFRA), 1982** and **Odisha Marine Fisheries Regulation Rules, 1983**. The Coast Guard is empowered to enforce the provisions of the Act. To reduce accidental entrapment and death of turtles, the Odisha Government has made it mandatory for the mechanized fishing trawlers to use **Turtle Excluder Device** or **TED**s, which is a specially designed net with an exit cover that retains the catch while allowing the turtles to escape.

CONCLUSION:

Turtles play an important role in ocean ecosystems by maintaining healthy seagrass beds and coral reefs, providing key habitat for other marine life, helping to balance marine food webs and facilitating nutrient cycling from water to land. It is human responsibility to protect the endangered turtle species to maintain a healthy ecosystem. If we fail to protect turtles, then Coral reefs will be affected greatly due to sponge's competition for space. Epibionts eating fishes will be affected. Jellyfish population will be increased and it will feed on fish eggs and hatchlings leading to decline in fish stocks.

A new report warns that freshwater turtles and tortoises are among the world's most threatened groups of species, with more than 40 percent at risk of extinction due to habitat loss, the illegal pet trade, and consumption for food and traditional medicine. So many conservation projects have been started to protect and prevent turtles from extinction. Initiation of new conservation acts greatly helps in protecting these endangered species.

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Fish skin to treat burnt victims

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Highlight Points

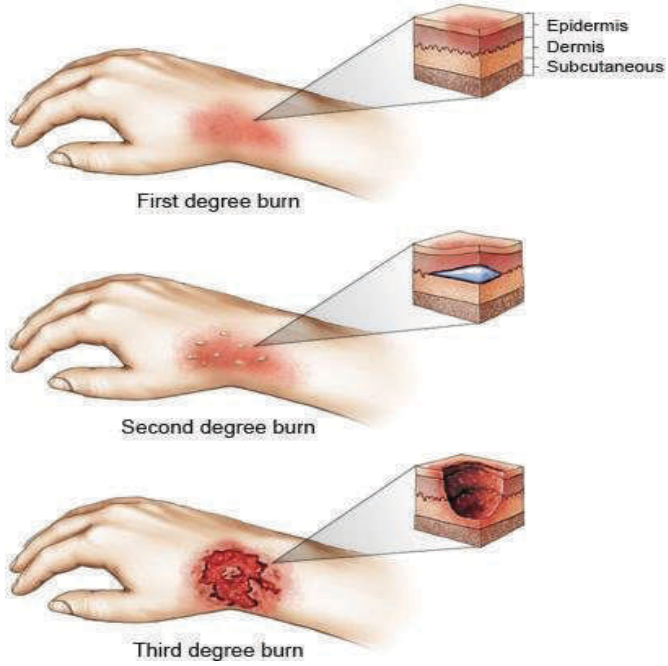
- Biological wound dressings are that derived from natural resources and are known for their biocompatibility and biodegradability.
- Skin substitutes are considered a useful alternative for occlusive dressings in the treatment of superficial burns as they reduce the frequency of dressing replacement.
- The fish skin is usually thrown away, but this product can be converted it into something of social benefit.
- Fish skin contains collagen type I and III in large quantities, a protein that is potential to promote wound healing.
- Fish skin has been used for the first time as a biological wound dressing for the second- and third-degree burns of humans in Brazil.

Introduction;

Xenograft or heterograft is a tissue taken from an animal which is used as graft for another species. Several research has been done with the skin of many organisms like pig, cow and frog but they are not completely successful. Tilapia fish skin has several benefits over the use of any other skin for burn treatment. First this aspect of using tilapia skin for burns is inspired from the research of Brazilian doctors, because of the less availability of human graft and other graft sources in Brazil. Nile tilapia is abundant in rivers of Brazil, so they thought of using the fish skin for human benefits instead of throwing the skin as waste. Tilapia fish has become first nationally studied animal skin registered by National Sanitary Surveillance Agency (ANVISA). The use of Tilapia Fish Skin for burn wounds is innovative, easy to apply and highly available product that can be widely used for effective treatment of burns.

Viable alternative NTFS;

Conventionally gauze bandages &human donor skin has been used to treat burns. Recently for treatment of burns biological dressings, such as amnion, allografts, xenografts, bioengineered tissues, etc. But collagen dressings are majorly used because of their beneficial properties including low antigenicity, enhanced inflammation, hemostasis, accelerated fibroplasia and epithelization. Collagen dressings derived from cattle and pig skin are inappropriate due to the risk of disease transmission or religious and cultural reasons. Collagen dressings obtained from tilapia fish skin is a potential natural material in the management of burns and wounds because of its collagenous, histological, and mechanical compatibility to human skin, even though pig skin also used as xenograft because it is 78% compatible with human skin but it has the risk of transmitting disease, lower resistance for stretching and higher cost compared to TFS. The use of Nile Tilapia (*Oreochromisniloticus*) fish skin as a Tilapia skin is a readily available, quality, safe, inexpensive material that is easy to apply but tilapia fishskin is a feasible alternative. The use of Tilapia skin to treat burn patients which heals burns more quickly is quite popular in Brazil but still it is in experimental stage of medical use.



Generally during skin grafting a thin layer of skin from another part of patient's body is extracted and placed over the burn site is known as autograft , If the burn area is too great in size there won't be enough healthy skin left to form complete graft, hence animal donor skin is used as xenograft, so tilapia skin willbe a successful xenograft to facilitate healing process. By the use of tilapia skin as xenograft the treatment cost can be reduced by 60 - 75%. Tilapia is an effective option to treat patients with second and third degree burns, after processing and sterilization of TFS.

TFS composition ;
Proximal composition of TFS;

- Moisture – 72.6%
- Lipid – 3.85 %
- Protein- 21.30%
- Ash – 4.24%

Tilapia skin has several properties suitable for using as a graft in humans. Tilapia skin has non infectious microorganism in it and high amounts of type 1 collagen which is similar to morphological structure of human skin and omega3 collagen, Collagen 1 and Omega 3 collagen are the main components in healing of burns. These are the structural proteins promotes and supports angiogenesis & cell in growth respectively. Omega 3 fatty acid is an antioxidant and has anti inflammatory effects in human body. Hence it has potential to be used as xenograft for the treatment of burn wounds. Nowadays xenograft is preferred over allograft because of their higher safety and reduced price. Laboratory analysis said that fish skin graft is safe because of its biocompatibility with human skin. The fish skin graft not only acts as a aid for revascularization and repopulation of patients cells but it also has anti inflammatory and anti microbial properties which prevents from further infection.

NTFS processing and application;
NTFS (Nile Tilapia fish skin) undergoes processing before it is used for treatment; it includes chemical sterilization, glycerolization and irradiation, then microbiological tests taken from the skin to ensure absence of bacteria and fungi, lastly stored in refrigerated sterile packaging. Skin is sterilized using various agents and irradiation kills any virus in the skin before it is chilled and packed , treatment also removes fishy odour. Prior to its use in the patient it is washed in sterile 0.9% saline for 5 minutes for three times in a row. After the process of chemical sterilization and irradiation there is no changes in structure of skin and its consistency is brought back by rehydration process. The burned part of patient skin is covered with fish skin and covered by a bandage, without use of any other cream. No dressing changes were needed in areas covered with NTFS, because of its great adherency to wound bed and it potentially reduces pain in burn patient.

Doctorscovering child's burnt skin with tilapia skin

After 10 days based on the degree of healing, the bandage is removed, tilapia skin at that stage is completely dried and loosened burn is removed with hand. Nile Tilapia Fish Skin treatment lead to improved healing process. The treatment for burns using tilapia fish skin was given to a patient, when tilapia skin applied to the burn lesions, it led to complete re-epithelialization within 12 & 17 days of treatment. Hence it is used as bandages to treat burns. It reduces healing time up to several days and decreases the use of analgesics.

Healing of burn byNTFS Treatment;

1. Patient suffered from deep partial thickness burns, upper limb after cleaning necrotic and fibrinous lesions;

2. After covering of limb with NTFS;

3. Sixth day of the treatment, there is good adherence of NTFS to wound bed;

4. After 17 days of treatment , after removal of tilapia skin; it shows the re-epithelialization of wound area;

Benefits of using NTFS as xenograft;

- There is no need for dressing changesfor average of 9 to 11 days, which reduces the painthat caused while dressing every time, once placed fish skin only be removed at the end of the treatment
- Tilapia skin has no possibility to transmit disease because of various sterilization processes it undergoes before using for treatment.
- Tilapia fish skin has higher resistance; it withstands mechanical stress like stretching.
- It reduces the treatment cost up to 60 – 75%.
- Healing period is reduced compared to other methods.
- High degree of moisture content and high level of collagen in TFS facilitate quickerhealing process of burns.
- The tilapia skin once cleaned and treated, it can be stored and lasts up to 2 years.

Recent study discovered that tilapia collagen induces epidermal and fibroblast growth factors expression, which can lead to proliferation and differentiation of fibroblasts and keratinocytes.

Conclusion

Millions of people suffer burns each year, the main victims are the children and low income people, use of NTFS for treating burns is a very viable and effective method, as tilapia is a very common fish, they are also vastly cultured all around the world and it's a prolific breeding species, so it is fairly inexpensive allows reduction of treatment cost. The use of NTFS for burn treatment accelerates healing, reduces use of medication and reduces the cost. We must know the importance of low cost NTFS treatment for burns in humans, so that low income people also can assess it. Now researches and phase 1 & phase 2 trials are happening with the skin of *Oreochromisniloticus* (nile tilapia) to treat burns, which will lead to firm NTFS as relevant option around the world for treating and management of burn wounds in humans in near future.

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