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A PUBLICATION OF KENYA MARINE AND FISHERIES RESEARCH INSTITUTE (KMFRI)
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ISSUE #38
JUNE, 2023

In brief:

1. *KMFRI survey reveals indigenous knowledge of fisher communities is handy in sustainable aquaculture and fish production*
2. *Effectiveness of using trash fish as an alternative source of protein for mud-crab*
3. *Integrated multi-trophic aquaculture*

COMPILED BY: Dr Jonathan Munguti & Jane Kiguta #LocalFisheriesKnowledge #SurveyFindings @KmfriResearch

Fisher folks indigenous knowledge is key in managing fisheries, KMFRI findings show

Kenya Marine and Fisheries Research Institute (KMFRI) research has revealed that indigenous knowledge plays a major role in the management of fisheries resources. In a survey led by Aquaculture Director Dr Jonathan Munguti and Sang'oro station head Dr Kevin Obiero, findings show indigenous people use traditional methods derived from local knowledge to conserve fish and boost fish production.

The study was aimed at identifying the role of indigenous people's knowledge in fish conservation as a way of improving aquaculture, with a specific

KMFRI Aquaculture Director Dr Jonathan Munguti

focus on the conservation of aquaculture fish species in Kenya. Indigenous knowledge is the information that a group of people who live in a specific region have accumulated over time as a result of their experiences and interactions with the environment. This knowledge gives them a grasp of their surroundings.

Indigenous knowledge in the conservation of fish resources is useful in achieving continuous genetic diversity in fish because local communities involved in fishing activities have vast knowledge that can be tapped into to manage fisheries.

KMFRI top researcher & Sang'oro station head Dr Kevin Obiero

Local knowledge is critical in the conservation of wild fish genetic resources, and in developing fish seed that

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will boost aquaculture production. Local fisher communities rely on aquatic resources mainly for livelihood and subsistence, and have therefore come up with systems to manage these resources for sustainable use.

In KMFRI survey, data was collected from individual fisherfolk through semi-structured questionnaires, face-to-face interviews and field observations. Researchers used purposive sampling to select 100 fisherfolks as respondents.

KMFRI researchers performed Pearson's chi-square tests on variables that were predicted to influence indigenous knowledge. Results revealed a significant relationship between an individual's years of residence in the area and indigenous knowledge. All interviews were conducted in line with the World Health Organization (WHO) guidelines on COVID-19 prevention.

According to previous research by other scholars, the local-level knowledge is important in establishing fish populations and spawning areas, and in controlling resource usage and traditions. Their findings show that in many nations across the globe, fish farmers have developed sustainable aquaculture techniques after using indigenous technical knowledge leading to increased aquaculture production and improved livelihoods.

Traditional methods used

Strategies used by fisher communities to conserve fish species include restriction of species fished to allow for conservation and regeneration of some species, use of traditional fishing gears that regulate the size of fish caught; closing off some areas from fishing activities and allowing fishing only during specific periods of the year.

Other methods reported include the implementation of rules and regulations formulated at the village level to ensure wise use of fisheries resources from rivers and lakes, and avoiding pollution of the lake by not draining wastewater into it to avert fish kills.

The communities also conserve fish in dams and dig trenches along the rivers so that when it rains, the fish swim against the direction of water moving downstream and end up in the trenches, which stops them from swimming into the lakes.

Common reed traps laid for seed and broodstock collection in Lake Victoria

KMFRI researchers also conducted a study on the indigenous knowledge of freshwater aquaculture fish. They found that about 98 and 96 per cent of the respondents from the lake region know Nile Tilapia and African catfish respectively as cultured species and their potential in freshwater.
About 21 per cent of the local people are involved in fish farming. This explains why the two species are mainly farmed in Kenyan warm water aquaculture.
Results show despite having the potential, the culture of indigenous fish species like *L. victorianus, O. esculentus and O. variabilis* is not popular among farmers because of their low production levels and survival.

While observing the fishers, KMFRI researchers learnt that fisherfolks involved in fish farming usually line fish breeding grounds with common reed traps mainly during rainy seasons for the fish to spawn and later collect the eggs and fry from the wild.
The fishers also collect mature Nile tilapia brooders from the wild for open pond rearing and subsequent fish multiplication. Brooders are selected based on their physical characteristics like size, physical strength and wellness to ensure quality seed production.

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In similar findings in India, fishers in Assam hills collected seed of murrels which move in shoals and come near the water surface for air, making it easy to collect them. The earliest means of collecting fish broodstock was through harvesting eggs and fry from the wild. This is still going on for species for which a large number of fry are readily available.

Sex identification is done by examining fish genital papilla, body formation and body colour in Nile tilapia. The fish are fed on worms, termites and sweet potatoes, kales and cassava leaves. Some farmers also to feed tilapia in their ponds with duckweed.

Wood sticks used for periphyton technology in an earthen pond.

Researchers also observed some of the seed producers use periphyton technology, a traditional method where farmers drive wood sticks into the muddy bottoms of their earthen ponds. This method is used to improve productivity in aquaculture.

English name	Scientific name	Local name	Family
Nile tilapia	*Oreochromis niloticus*	*Nyamami* (Luo), *Esotsi* (Luhya)	Cichlidae
Victoria tilapia	*Oreochromis variabilis*	*Mbiru* (Luo), *Imbuiru* (Luhya)	Cichlidae
Singida tilapia	*Oreochromis esculentus*	*Ngege* (Luo), *Ingeke* (Luhya)	Cichlidae
African catfish	*Clarias gariepinus*	*Mumi* (Luo), *Ituli* (Luhya)	Clariidae
African carp	*Labeo victorianus*	*Ningu* (Luo), *Eningu* (Luhya)	Cyprinidae
Lungfish/mudfish	*Protopterus aethiopicus*	*Kamongo* (Luo), *Imonye* (Luhya)	Lepidosirenidae

Local names of various fish species identified by the indigenous people

In the KMFRI study, the fisherfolks said they use appearance, colour, breeding areas, body stripes and scales, among other features, to identify and distinguish different fish species. These findings are consistent with those of scholars Granadeiro and Silva whose research shows fish colour patterns, their difference in shape, size and count of scales, otoliths, difference in body size and the difference in size and types of their fins, as external morphological traits, have traditionally been used in the identification of fish species.

Involving indigenous communities in fish farming is therefore important in maintaining fish genetic resources, which is a major concern in aquaculture development. The fish get to multiply naturally, without alterations in their genetic component, since the indigenous people do not use technologies that compromise their genetic integrity.

In view of the findings, KMFRI researchers recommend that scientists and policy actors adopt the indigenous people's knowledge as a source of baseline information for fisheries and aquaculture research, and as additional or alternative strategies for the management of fish genetic resources.

The role of indigenous knowledge in fisheries resource management for aquaculture development: A case study of the Kenyan Lake Victoria region
by

Kevin Odhiambo Obiero, Jimmy Brian Mboya, KevinOkoth Ouko, Elijah Migiro Kembenya, Elizabeth Akinyi Nyauchi, Jonathan Mbonge Munguti, Nicholas Otieno Outa & Cecilia Muthoni Githukia

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Edits: Phionalorna Nzikwa

Formulation and effectiveness of using trash fish as an alternative source of protein for mud crab

Background

Mud crabs are members of crabs that inhabit a sheltered area of a coastline such as estuaries and mangroves. They are native to the Indo-Pacific region with a presence reported in Africa, Australia, New Zealand and Asia. Mud crabs are a popular delicacy in their native areas and globally. There are four commercially recognized species of mud crab in the world but only one (*Scylla serrata*) has been reported in Kenya.

Mud crab fishing in Kenya is an important livelihood activity that supports about 1900 households along the Coast of Kenya. The production of Mud crab in Kenya has shown an increasing trend over the last two decades with much of it coming from capture fisheries.

Mud crabs are mostly traded as a live product when in a hard shell or frozen when in a soft shell. The main targeted markets are the local tourism industry and overseas. As a result of increasing demand for mud crab both locally and abroad, fishing effort has increased and undersized crabs are also targeted to meet the high demand, and this if not checked could alter recruitment patterns in the wild. Mud crab farming using wild-caught juveniles (crab fattening) was initiated to complement wild production and ease fishing pressure.

One major challenge facing mud crab farmers is the lack of a formulated diet to reduce reliance on fresh feed (Trash fish and Gastropods (*Terebralia palustris*) which are costly to preserve.

KMFRI's mariculture team developed an inert diet for juvenile mud crab that was formulated using *T. palustris* flesh as an alternative source of protein and compared its performance against two commonly used fresh flesh feed (Trash fish and*T. palustris*).

Image of a mud crab

Study site

The study was conducted by KMFRI Mariculture team in partnership with the Dabaso Crab Shark conservation group at Dabaso in Kilifi County. Crab rearing (fattening) cages were placed within Mangrove channels at Dabaso crab shark (3º20′47″S39º59′24″E) along the Mida creek.

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Sources of experimental diets

T. palustris was collected from a mangrove forest along Gazi-Bay, Kenya. Then, flesh from each individual was collected and stored in a refrigerator. Part of the flesh was used to formulate an inert diet (diet 1) as a major ingredient for protein. The remaining part was fed directly as a fresh diet (diet 2). Trash fish (diet 3) were purchased from local small-scale fishermen and were also preserved in the refrigerator for routine feeding. Diet 4 was a blend between *T. palustris* and trash fish.

Formulated diet, Gastropod flesh and trash fish

Stocking and fattening of Mud crabs

Juvenile mud crabs with no signs of diseases and injuries, and with all appendages intact were collected from the wild at Kibokoni and transported to Dabaso in Kilifi County. The sex, carapace length and width, and weight of each of the crabs were taken prior to placing each individual crab in a specific compartment of the cage facilities for fattening using the three diets experimental diets.

Feeding was done. The growth of the crabs being cultured was assessed every two weeks and involved measuring weight and carapace length using a portable kitchen balance and a ruler respectively.

Sampling of mud crabs for growth

Key findings

- Higher growth performance was observed in crabs fed *T. palustris* flesh followed by trash fish and the lowest was in crabs fed the formulated diet. Generally, female crabs reported higher growth than males.
- Feeding trash fish resulted in higher growth in male crabs than in female
- Crabs-fed trash fish recorded the highest survival rate while those offered formulated feed and Gastropod flesh recorded similar survival rates.

Conclusion and future work

The results have shown that feeding mud crabs with fresh *T. palustris* meat conferred a better growth rate than feeding trash fish or the formulated diet. Lack of adequate crude protein in the formulated diet and feeding habits of mud crabs were associated with low growth effects observed for the formulated diet.

In light of this, the study encourages mud crab farmers to use fresh *T. palustris* flesh for mud crab fattening. At the same time, recommended more research on suitable methods of processing fresh *T. palustris* flesh for incorporation in feed formulation to optimize its nutritional value.

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Edits: Phionalorna Nzikwa
#MarineFisheries@KmfriResearch

Integrated Multi-Trophic Aquaculture (IMTA) of marine prawns, sea cucumber, rabbit fish and seaweeds in cages at Dabaso, Kilifi County

Community-based aquaculture has been adopted in the Western Indian Ocean (WIO) region and has played a great role towards the growth of mariculture, enhancing food security and strengthening the resilience of the coastal communities to climate change effects and environmental challenges.

To increase production and diversify aquaculture products, fish farmers in Kenya have used the integrated aquaculture concept which is more dynamic and versatile entailing the use of an output from one farming system which would have been wasted to become an input for another subsystem. Integrated aquaculture has mostly been done in freshwater paddies and ponds for the production of fish-rice, fish–livestock, and fish-vegetable combinations. In the marine aquaculture sector, milkfish-shrimp, and milkfish-mullet combinations under pond polyculture systems have been tried in the intertidal areas.

The IMTA Technology

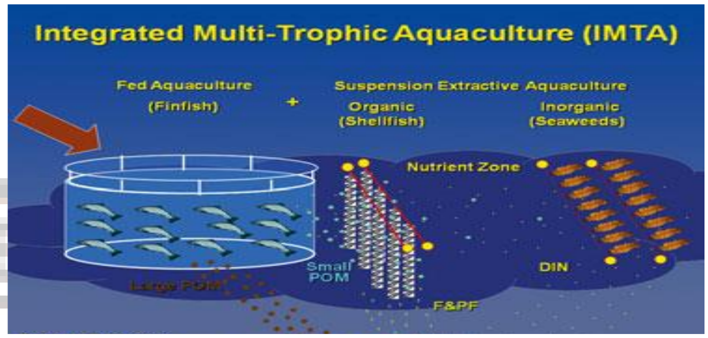

Photo illustration of Integrated Multi–Trophic Aquaculture (IMTA)

IMTA is an upcoming technology that provides a tremendous opportunity to integrate farmed fish species that can benefit from each other in an Integrated Multitrophic Aquaculture system. This is a concept that involves farming in proximity of aquaculture species of different trophic levels and with complementary ecosystem functions in a way that allows one species of uneaten feed, nutrients and wastes to be recaptured and converted into fertilizer, feed, and energy for the co-cultured organisms and to take advantage of the synergistic interactions between the cultured species.

The fed organisms can be either finfish or shrimps while the extractive organisms are marine plants that extract inorganic matter while 8 deposit feeders and filter feeders extract organic substrates from the culture environment. The suitability of the species combinations to be put in an IMTA has to be considered to achieve economic value from the farm. Examples of species combinations that have been tried include; fish/seaweed/shellfish, fish/shrimp, seaweed/shrimp

The proposed study applied the IMTA system with the ultimate aim of enhancing aquaculture production and profitability from a cage system.

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Study site

The site of the project is located at Dabaso Creek in Kilifi County, (039° 50′ 32′′ E, 03° 36′ 12′′ S).

Experimental design

The experiment was performed in floating cages of six compartments at the Dabaso Creek in Malindi Gede area Kilifi County. A model of Monoculture, polyculture and Intergrated Multi trophic Aquaculture (IMTA) was conducted with prawns (*Penaeus monodon)*, rabbit fish, sea cucumber and Seaweed obtained from community group projects at the North and South Coast of Kenya.

Stocking was done at a density of 15 pieces/m^2 for Prawns, 25 pieces/m^2 for rabbitfish, 5 pieces /m^2 for sea cucumber and 200g/m^2 for seaweed lines.

Organisms were purchased and transported to the site at Dabaso, conditioned for two days prior to the actual experimental trial for them to acclimatize to their new environment. No feeding was done for 24 hours at the arrival of the organisms.

Fish were fed the normal experimental diet used during the experiment and during the conditioning period. Afterwards, they were distributed to their respective cage compartments under the different models of Monoculture (Prawns), Polyculture (Prawns + rabbitfish) and IMTA (prawns + rabbitfish + Sea cucumber +Seaweed).

Each of the experimental models had a duplicate giving a total of 6 cage compartments for the experiment. Feeding was done twice every day at 10 am and 4.00 pm at 3% bodyweight with 48% Crude protein content feed formulated at the KMFRI Mombasa station. Sampling was done after every two weeks to obtain the length and weight of organisms which could be used to adjust the feeding ration.

Photo of a wooden fish cage at Dabaso Creek

Community mobilization, Cage condition inspection.

A site visit was done to assess the condition of the cage and to introduce the project to the community members. KMFRI established a working partnership with the Dabaso Crab Shark conservation group to facilitate the implementation of the experiment focused on investigating the performance of marine organisms (Prawns and rabbitfish) cultured in monoculture, polyculture and Integrated Multi trophic Aquaculture (IMTA) models.

Assessment of experimental cages

Previous experimental organisms were sampled and removed in readiness for the new experiment to be conducted. Fish cages were assessed, and cleaning up of holding nets to remove algae was done in each compartment. Based on the design of the experiment, 3 compartments were repaired before the start of the experiment. Assessment of culture facility, sampling of previous cultured organisms before project inception

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Sampling of marine organisms stocked in cages at Dabaso Creek

Collection and stocking of organisms

Sea cucumbers are usually collected by handpicking, collection by free diving, and by scuba diving. The collection for this study mainly used handpicking and scuba diving during low tides. The team with the help of Kijiweni fishermen who specialize in sea cucumber collection collected the 225 pieces of *Holothuria scabra* which were ready for pick up.

The holding tank was half-filled with ocean water upon arrival waiting for the sea cucumber to be packed in the plastic bags. Every bag carried 40pcs of sea cucumbers and then oxygen was filled to saturation.

The water in the holding tank was to act as a shock absorber during transportation. The bags holding the organisms were placed into the holding tank and then transported to KMFRI headquarters in Mombasa

Marine Prawns collection.

The collection of organisms was done late in the evening by the Kibokoni community group with assistance from the KMFRI mariculture team when temperature levels were a bit low. They were then taken to Dabaso and on arrival, they were placed in small holding tanks which could be carried using the canoes available in the floating cage. All prawns arrived at the cage with zero mortalities and then released into the cage after some minutes of acclimatization

Rabbitfish collection

Rabbitfish is one of the most delicate species to transport. The organisms were ferried straight to Dabaso in Kilifi County. Along the way, more oxygen was added to the air holding the organism to ensure dissolved oxygen. is within the acceptable range. They were immediately placed in the experimental setup at Dabaso using the canoes available at Dabaso.

Seaweed propagules collection

Seaweed seedlings were obtained from the kibuyuni seaweed station. Selection of the healthy *Euchema spp* propagules was done by KMFRI technicians with the aid of the local community in charge of the ocean farms.

Fresh seaweeds were collected and placed in a small sack early in the morning for transportation. They were collected during low tides by handpicking the strong and vibrant branches if possible or by snorkelling in case they are in deeper waters.

Collected seaweeds were packed into a sack which was covered with a dark cover to protect them from direct sunlight during transportation. The weeds were ferried to Dabaso immediately after packaging and the experimental set-up in the cage commenced.

Planting the seaweed was done using a nylon rope which was tied on the edges of the floating cage. Observing the normal spacing of 20-25, seaweeds were tied onto the rope after weighing and the initial data was recorded.

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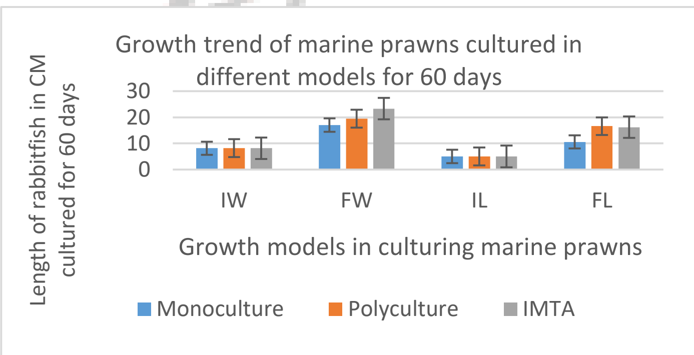
Formulation of the experimental diet

A sinking diet comprising Maize bran, fish meal and wheat used as a binder formulated at the Kenya Marine and Fisheries Research Institute (KMFRI) was used for the experiment.

Proximate Composition Analysis of the Diet

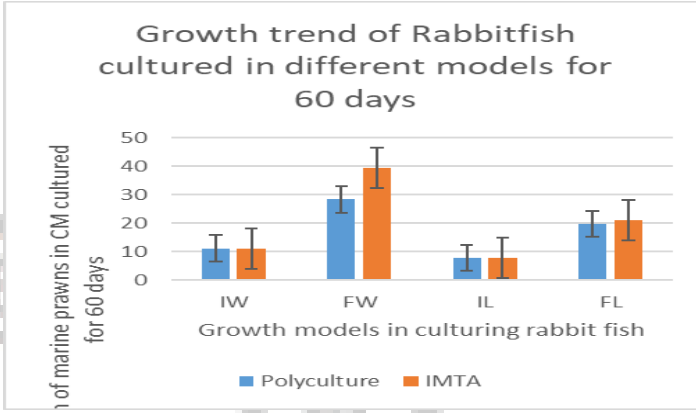
Proximate content	% composition
Crude protein	48
Crude lipid	6.95
Crude fibre	10.19
Carbohydrates	21.7
Ash content	15.94
Moisture	11.01

Research findings



It was observed that the weight gain of the organisms cultured in the IMTA models were high compared to organisms cultured in monoculture and polyculture models. Marine prawns cultured in the IMTA models had a 59.13% weight gain while those cultured in PC had a weight gain of 29.46%.

Rabbitfish had also a high percentage of weight gain (266.46%) in the IMTA model compared to those cultured in the PC (125.5%) and MC (108%).



The average Specific Growth Rate (SGR) of marine prawns cultured in the IMTA model was seen to be high at (1.55) compared to (0.86) of the PC model while rabbit fish had the highest SGR of 4.33 in the IMTA model as well followed by 2.71 in the PC model and lastly 2.44 in the MC model. This showed that all the organisms cultured in an IMTA model were seen to be more productive compared to the PC and MC models. Seaweeds and sea cucumbers did not thrive well in the cage system.

Farming in the sea can be a way to address the culture of marine organisms in ponds. Sea waters are relatively more dynamic that can be seen to support the growth performance of prawns and rabbitfish. The performance of these organisms in the cage IMTA model was seen to produce good results.

However, seaweeds and sea cucumbers did not thrive well which could be due to water quality challenges for the seaweeds and the lack of an appropriate substrate for sea cucumbers whose nature is buried in the sand. The increase in marine shrimps and rabbitfish growth rates in fig. (a) and (b) indicated that the IMTA system is better compared to MC and PC models.

Conclusion

As one of the commodities that have an economic value, marine prawns and rabbitfish should be developed to meet market demand. In an IMTA system, rabbitfish was used as a commodity to clean up the system by utilizing algae as a natural food source in the net cages.

Challenges observed

- Reliance on wild-collected seeds; due to lack of a marine hatchery the study and farmers in the region have overtime been relying on seeds from the wild which lenders mariculture and associated research an expensive affair especially in instances of a failed crop or when in need of repeating a research study.
- cage farming requires proper planning due to the heavy costs of installation, management, security and feeds.

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Compiled By: Brian Isoe, Millicent Hassan & Killian Ngowa

Women from Gogoni-Gazi Community Forest Association members plant mangrove seedlings in Chale Island, Kwale County during a tree-planting exercise conducted by KMFRI

KMFRI Kisumu staff make presentations to students from St Chrisphine Samia Girls Secondary School who were on an academic tour of the research centre.

Pupils from Jeddy's Academy and Busy Bee Kindergarten and primary schools during their tour of KMFRI, Mombasa. They dived into the world of coral reefs through Virtual Reality, explored the microscopic fauna and flora in the labs, and experienced marine habitats at the aquarium and museum.

KMFRI researchers display certificates after completion of data management and publication training course aimed at exchanging data management and publication expertise and strengthening bilateral cooperation between KMFRI and Flanders Marine Institute (VLIZ).

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Belgium's Flanders VLIZ and KMFRI through the State Department for Blue Economy and Fisheries sign a Memorandum of Understanding (MoU) for cooperation, collaboration, and partnership in marine research and capacity building.

KMFRI Ocean Coastal Systems Director Dr. James Mwaluma delivers his remarks during the UN World Oceans Day commemoration event at the Jomo Kenyatta Beach in Mombasa county. The day is marked on 8th June every year.

KMFRI's Principal Research Scientist Dr. Peter Odote based during a tree planting activity at the Shimo La Tewa Borstal prison in Mombasa county. He was representing KMFRI CEO.