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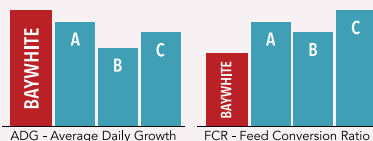
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A successful case of epizootic ulcerative syndrome (EUS) control in murrel (*Channa striata*) farming in Andhra Pradesh

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Development of domestic markets Crucial for sustenance of aquaculture sector in India:

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A SUCCESSFUL CASE OF EPIZOOTIC ULCERATIVE SYNDROME (EUS) CONTROL IN MURREL (*CHANNA STRIATA*) FARMING IN ANDHRA PRADESH

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Snakeheads in India

The air-breathing snakehead fish *Channa striata*; commonly called striped murrel in India, is one of the most sought-after freshwater fishes and is widely regarded as a high-value food fish in India. There are several species of murrel belonging to the genus *Channa* (syn. *Ophiocephalus*), but only four types of murrel species are usually considered as food fish in India, viz; giant murrel (*C. micropeltes*), Bullseye murrel (*C. marulius*), spotted murrel (*C. punctatus*) and striped murrel (*C. striatus*). Live snakehead fish fetch a stable high price between INR 400-500/kg (USD 6-8/kg) in different retail markets. Murrel has been officially declared as "state fish" for Telangana in 2016, aimed at the promotion of Murrel farming and conserving the indigenous aquatic diversity in the water bodies in Telangana.

Snakehead farming status in India

Though several attempts to breed murels in India have been successful, commercial farming of murrel seed is yet to become popular, mainly due to the difficulty in rearing of this highly carnivorous species; its cannibalistic behavior and lack of availability of suitable diets for larval rearing and grow-out farming. In most of the previous attempts to culture this species, farmers have used either live fingerlings, trash fish, trash fish mixed with pelleted feed or mash feeds made from powdered dry fish for feeding. Using such feeds or even farm made feeds/floating feeds without following proper management protocols, results in the deterioration of water quality and the pond bottom quality, making conditions ideal for infections such as

Epizootic Ulcerative Syndrome (EUS) to set in. EUS is a fast spreading deadly disease, to which this species is particularly vulnerable and entire stocks in the pond could be lost within a matter of days.

Considering the need to bring in more high value species into aquaculture in India, Uno feeds – one of India's largest extruded fish feed manufacturers had entered into a strategic co-operation agreement with Nutriera Group, one of the biggest aqua feed premix & additives enterprise in China, to bring the technology for domestication and grow out of *Channa striatus* in India. Since 2015, Uno Feeds has established a dedicated hatchery and research facility for breeding snakehead, *Channa striatus* at Bhimavaram, Andhra Pradesh with the assistance of Nutriera team. From 2016 to 2019, breeding of *Channa striatus* on a commercial scale has been successfully carried out at this facility. The fry was gradually weaned to specially formulated extruded diets that were produced under Nutriera guidance. Grow-out farming of these weaned fry were also carried out in a few farms spread over an area of 100 acres. However, during these intensive farming operations over the past 5 years, Uno Feeds have had to encounter several challenges such as limited water resources, extreme high temperatures during summer, and also severe disease outbreaks like the EUS.

Epizootic Ulcerative Syndrome

Epizootic Ulcerative Syndrome (EUS) is one of the most important diseases affecting more than 100 species of wild and cultured finfish. EUS was first officially recognized as a major problem and given its present

name in 1986 at a FAO Consultation of Experts on EUS in Bangkok and the use of the term “syndrome” highlights the complexity of the condition. A diverse mix of pathogens and factors are considered to be associated with the occurrence of EUS. It involves the interaction of a specific monoclonal fungus like organism, a variety of environmental factors and a range of secondary invading pathogens, which differ in each outbreak. A number of etiologies have been proposed for the outbreak of EUS in which the primary agent is thought to be virus or bacteria or parasite or fungi. Different groups of bacteria have also been isolated from EUS-affected fish.

Bacteria such as *Aeromonas*, *Vibrio*, *Pseudomonas* and *Micrococcus* that are mostly opportunistic pathogens have been associated with necrotic ulcers which are thought to be the secondary invaders leading to death in severely ulcerated fish. Apart from viruses and bacteria, parasites such as metazoans and protozoans

and fungi such as *Aphanomyces*, *Aprolegnia* and *Achlya* have also been frequently isolated from EUS affected fish.

EUS outbreak during Intensive Murrel intensive farming in India

During the Snakehead grow-out farming operations at Bhimavaram, two out of the last 4 crops were affected with severe EUS outbreaks during the winter season from the month of December to February.

As shown in the Fig.1 to 4 Epizootic Ulcerative Syndrome (EUS) symptoms in *Channa striatus* is manifested in muscle tissue as ulcers and sometimes even deep into the bones; with the head and fins also showing varying degrees of ulceration. The appetite of the affected fish is poor (Fig. 5), hepatic condition being yellowish and with a sub optimal health status. The mucus around the wounds is abnormally high, accompanied by a strong odour.



Fig. 1: Ulceration on dorsal fin of Murrel



Fig. 2: Ulceration on Murrel caudal fin



Fig. 3: Abdominal area with Ulcerations



Fig. 4: Ulceration on dorsal part of Murrel



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Etiology of EUS outbreak in last few crops

(1) Within the fish: Improper feeding and feed management over a long period results in sub-healthy fish that exhibit sub-optimal health conditions such as fatty liver (Fig. 7), yellowish liver (Fig. 6), fragile

liver, white spot liver, gall bladder enlargement, enteritis etc. Once the fish enter sub-health status, its immunity is considerably weakened when compared to normal healthy fish, and they become easily prone to secondary infections when exposed to physical stress or injury.



Fig. 6: Yellowish liver in farmed Murrel



Fig. 7: Yellowish and fatty liver in Murrel



Fig. 5: Healthy fish taking feed actively (inset) & poor appetite in sick fish

(2) In the external environment of fish: Firstly, during the winter season, the temperature fluctuation (diurnal variation from 16-30°C) is much more than the fluctuations during summer or monsoon. This variation causes extreme stress to the farmed fish making them vulnerable to pathogens in the environment. Low temperatures are also ideal conditions for some specific fungi, water mold and pathogens to thrive, making them difficult to control.

Secondly, during intensive farming of murrel (@15,000pcs/acre), it is daily fed with substantial quantities of high protein feed (42-44% crude protein) which results in large volumes of organic wastes being generated due to uneaten food (Fig. 8) and fish faeces and released into the pond water. When the self-purification of the pond environment does not match the speed of organic wastes generation, it leads to eutrophication. This eutrophication along with sediment deterioration (Fig. 9) leads to harmful algal blooms (*Microcystis aeruginosa* Fig. 10), pathogens outbreak (*Aeromonas hydrophila*, *Nocardia edwards*) as well as the parasite (*Lernaea*, *Argulus*) infestation.



Fig. 8: Uneaten feed floating on the pond surface



Fig. 9: Deteriorated pond bottom soil



Fig. 11: Fish jumping around the water inlet



Fig. 10: Microcystis bloom in pond water



Further, in order to flush out the accumulated wastes from the pond environment, frequent water exchange is necessary. During the water exchange process, fish are often stressed and jump into the air (Fig. 11) where fresh water is introduced. This activity makes them prone to physical injuries which are then exposed for secondary infections to enter.

Thirdly, pathogens such as fungi and water moulds propagate rapidly during low water temperature (as low as 18-25°C in West Godavari, Andhra Pradesh,) during winter season.

Therapeutic treatment for EUS in Murrel farm

The mortalities in EUS affected snakehead ponds are extremely high (Fig. 12) and the infection rapidly spreads infecting most fish in the pond within a few days if immediate control measures are taken. The first crop of Snakehead farming operations, was affected



Fig. 12: Severely affected-EUS resulted 100% mortality in 2017 January



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by EUS infection during the period from January to February of 2017, killing more than 35,000 mid-size (200-300g/pc) fish in different ponds, and around 3,000 numbers of spent brooders (700-1200g/pc). This experience demonstrated the necessity to focus on prevention of EUS by enhancing the immunity in fish and following best pond management practices as it would be extremely difficult to stop its spread of the disease and save the fish, once the disease is established in the pond.

Though antibiotics were widely used for treatment of fish diseases in the past, it has now become one of the most sensitive issues worldwide. To ensure food safety and sustainable development, most of the antibiotics have been banned or restricted for aquaculture use by the respective government departments of countries all over the world. Enrofloxacin, oxytetracycline, and doxycycline etc., were the most commonly used antibiotics but very rarely used in the Indian freshwater fish culture now. Most of these antibiotics were also used to control the bacterial ulcers of snakehead fish farming in China earlier. But the issue pertaining to antibiotic residues and anti-microbial resistance in farmed animals cannot be ignored for products entering into the end-consumption market. Besides, there are also reports that regular/prolonged antibiotic use also affects the growth rate in fish and often causes hepatic impairment and atrophy of the spleen. It thus became essential to evolve an alternate strategy without antibiotic use for treatment of EUS in murels.

Non-antibiotic therapeutic solutions for EUS affected Snakehead

Following thorough observation and in-depth study and analysis of the fish health and environmental conditions during EUS outbreaks, Nutriera and Uno technical team evolved a protocol to treat the disease, which was successful in preventing the spread of the disease during its occurrence in February 2019 at the Bhimavaram farm. The protocol involved the following steps:

1. Feeding rate in fish to be reduced from feeding till satiation to feeding till 70 -80% satiation.
2. Fortifying the feed with proven herbal additives to improve liver functioning, together with vitamins and a non-antibiotic (iodine based) supplement

before feeding (Fig. 13). Commercial aqua health care products such as Liver guard, Ayur Guard and Pathogen clear imported by Uno Feeds from China were used as follows:

- (a) Liver Guard 10g/kg feed + Ayur Guard 5g/kg feed + Pathogen Clear 2g/kg feed, for 5 days followed by
- (b) Liver Guard 10g/kg feed + Ayur Guard 10g/kg feed + Stress Guard C 5g/kg feed, for 5 days followed by
- (c) Liver Guard 5g/kg feed + Ayur Guard 5g/kg feed + Stress Guard C 3g/kg feed, for 5 days.



Fig. 13: Healthcare products use in EUS treatment & top coating of feed before feeding

3. Treatment of pond water with povidone iodine (20%) or Bleaching powder (50% effective chlorine) along with Stress Guard C to ensure that the fish recover from stress and diseases.
4. Treatment of deteriorated pond bottom with Bottom Guard (oxidizes bottom sediments).
5. Control of Microcystis bloom through water exchange, chemicals treatment and probiotics application based upon fish health condition and pond condition.

Results of EUS therapeutic application in murrel farm

1. Infection levels & Mortality in fish

The stocking details at the Bhimavaram Uno farm for the 2018-19 Murrel farming crop as well as the infection and mortality details observed in the farm during EUS outbreak are detailed in tables 1 & 2 below:

Tank	Pond information	Stocking data	Sampling data
No. 6	Area - 1.5 Acre	Nos. stocked - 26,000	ABW - 202g/ pcs,
	Depth - 5 feet	ABW at stocking - 10g/pc	Sampling date - 23/02/2019
Date of Stocking - 01/11/2018			
No. 8	Area - 2.5 Acre	Nos. stocked - 36,000	ABW - 295g/ pcs,
	Depth - 6 feet	ABW at stocking - 8g/pc	Sampling date -23/02/2019
Date of stocking - 01/10/2018			

Table 1. Fish stocking information

Tank	Date	Infection rate (% fish group)	Daily mortality (pieces)	Health-care products applied
No. 6	23/02/2019	51%	50-70	LiverGuard AyurGuard PathogenClear StressGuardC BottomGuard
	04/03/2019	60%	100-150	
	20/03/2019	<3%	1-2	
No. 6	23/02/2019	27%	150-200	StressGuardC BottomGuard
	04/03/2019	20%	100-150	
	20/03/2019	<2%	2-3	

Table 2. Fish infection and Mortality

2. Changes in pond environmental parameters

Following repeated water exchange and effective treatment of the pond water and pond bottom, the thickness of bottom sludge was considerably reduced; from one foot during the beginning of the treatment to less than half feet upon completion of treatment protocol (Fig. 14). Similarly, there was also a significant reduction in *Microcystis* bloom in the ponds during the period (Fig. 15).



Fig. 14: One foot of sludge observed on 23/02/2019 reduced to 3 inches on 20/04/2019



Fig. 15: Microcystis bloom on 23/02/2019 which significantly reduced by 01/03/2019

3. Fish health condition

After continuing the above treatment for a period of one month, there was a cessation in mortalities and significant improvement in the fish health condition which includes the reversal of hepatic condition to normal reddish in colour from the yellowish colour

observed during infection (Fig. 16). Meanwhile, changes were also observed on the skin of the EUS affected fish with a considerable reduction in the ulcers and healing of the wounds (Fig. 17 & 18).



Fig. 16: Change in Fish liver condition from yellowish to the normal reddish



Fig. 17: Sampling in 04/03/2019, the wounds are healing



Fig. 18: Sampling on 20/03/2019, the wounds are healed

4. Fish growth & harvest data

As seen in the Fig. 19, above, the growth rate following EUS treatment was found to be significantly higher in both the ponds after the disease was brought under control, than before the treatment commenced.

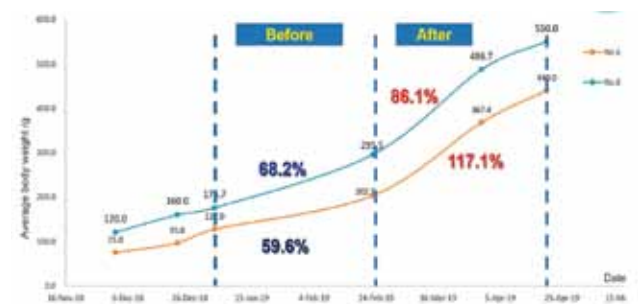


Fig. 19: Fish growth chart showing performance before and after EUS treatment

Item	Tank No.6	Tank No.8
Pond area	1.5 Acre, 5 feet	2.5 Acre, 6 feet
Stocking quantities	10g, 26,000	8g, 36,000
Stocking date	01/11/2018	01/10/2018
Harvest date	01/08/2019	31/08/2019
Harvest ABW (g/pc)	730	650
Fish yields (kg)	17,500	14,111
EUS outbreak time	Feb, 2019	Feb, 2019
EUS controlled	March, 2019	March, 2019
Final survival rate	90.1%	61.7%

Table 3. Fish survival & harvest data calculation

The harvest and survival data obtained from the ponds is shown in the Table 3 below. The 2018/2019 crop where Uno/Nutriera team were successful in overcoming EUS infection in Snakehead farm in Bhimavaram was by far the best and the most successful crop among the last few crops in terms of recovery rate and final survival rate.

Conclusion

Snakeheads have been repeatedly described as one of the most EUS susceptible fish species. Currently defined as a seasonal epizootic condition of complex infectious etiology characterized by the presence of invasive *Aphanomyces*, EUS is found to be associated with low and declining water temperatures and high rainfall. For example, during the winter of Andhra Pradesh, water temperature can be as low as 18-23°C, which is the prevailing temperature of EUS outbreaks, but not at 28-32°C during the monsoon or summer season locally. It was reported that by using immunostimulants for the enhancement of non-specific immunity to counter disease outbreaks and it is increased hematological parameters of *A. hydrophila* infected *C. punctatus*.

Meanwhile, the farming environment get eutrophication and pond bottom deterioration would lead to proliferation of the pathogens, like bacteria, fungus, parasites, which can easily bring about the EUS outbreaks among sub-health fish. So, according to the practical experiences in last few crops of murrel

farming, prevention of diseases outbreak is much more important and required, we have to pay more attention to the farming environment management and fish immunity enhancement. Once we found the symptoms of EUS in earlier stage we must take the measures immediately.

As the consequence of the artificial breeding and special feed nutrition techniques for snakehead fish, *Channa Striata* has been researched and developed in India by few industry players. More players will join the murrel commercial farming within 2-3 years, but which is a high investment, high risk and with a high return farming species, and easy to suffer from Epizootic Ulcerative Syndrome.

During the fish farming practices, prevention of diseases plays a more important role than the treatment.

References are available upon request from the corresponding author

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