Farmers' Knowledge and Strategies for Tilapia Disease Management in Cage Culture in Songkhram River

ความรู้และกลยุทธ์ของเกษตรกรในการจัดการโรคปลานิล ที่เลี้ยงในกระชังในแม่น้ำสงคราม

Patcharawalai Sriyasak[1*], Supannee Suwanpakdee[1] and Pornpimol Pimolrat[2]

พัชราวลัย ศรียะศักดิ์[1*] สุพันธ์ณี สุวรรณภักดี[1] และ พรพิมล พิมลรัตน์[2]

[1]*Department of Fisheries, Faculty of Natural Resources, Rajamangala University of Technology Isan Sakon Nakhon Campus, Sakon Nakhon 47160, Thailand*

[1]*สาขาวิชาประมง คณะทรัพยากรธรรมชาติ มหาวิทยาลัยเทคโนโลยีราชมงคลอีสาน วิทยาเขตสกลนคร จ. สกลนคร 47160*

[2]*Department of Coastal Aquaculture, Maejo University at Chumphon, Lamae, Chumphon 86170, Thailand*

[2]*สาขาวิชาการเพาะเลี้ยงสัตว์น้ำชายฝั่ง มหาวิทยาลัยแม่โจ้-ชุมพร จ. ชุมพร 86170*

**Corresponding author: Email: patcharawalai.sriyasal@gmail.com*

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บทคัดย่อ: การศึกษานี้เป็นการรวบรวมความรู้และกลยุทธ์ในการรับมือกับโรคปลานิลของเกษตรกร โดยทำการศึกษาในเกษตรกรผู้เลี้ยงปลานิลในกระชังในแม่น้ำสงคราม เก็บข้อมูลจากเกษตรกรจำนวน 148 ราย โดยใช้แบบสอบถาม ผลการศึกษาพบว่า เกษตรกรส่วนใหญ่ประสบปัญหาปลาเป็นโรคในช่วงที่ผ่านมา โรคปลาจะเกิดขึ้นบ่อยในช่วงเดือนเมษายนถึงมิถุนายน ซึ่งเป็นช่วงรอยต่อระหว่างฤดูร้อนและฤดูฝน เกษตรกรคิดว่าสาเหตุหลักที่ทำให้ปลาเกิดโรคเกิดจากคุณภาพน้ำ และ สภาพอากาศที่แปรปรวน การเกิดโรคที่พบบ่อย ได้แก่ ปรสิตภายนอก และ การติดเชื้อแบคทีเรีย ลักษณะอาการของโรคที่เกษตรกรพบบ่อยคือ ตาโปน วิธีการจัดการโรคปลาของเกษตรกร ได้แก่ การย้ายปลาที่เป็นโรคออกจากกระชัง การผสมวิตามินในอาหาร และการใช้ยาปฏิชีวนะ สำหรับวิธีการป้องกันปลาเป็นโรค เกษตรกรใช้วิธีหมั่นสังเกตปลาในกระชัง หมั่นทำความสะอาดกระชัง ใช้วิตามิน และหยุดเลี้ยงปลาในช่วงมีการระบาดของโรค นอกจากนี้ยังพบว่าเกษตรกรไม่ทราบสาเหตุที่แน่ชัดของการติดเชื้อ ดังนั้นเพื่อให้สามารถรับมือกับปัญหาโรคปลาได้ดีขึ้น เกษตรกรจึงควรส่งปลาเพื่อตรวจวินิจฉัยสาเหตุของการเกิดโรคที่แท้จริงเพื่อจะได้ทำการรักษาอย่างถูกวิธีต่อไป

คำสำคัญ: โรคปลา การเลี้ยงปลาในกระชัง การจัดการของเกษตรกร

Abstract: This study summarizes the current knowledge of fish farmers regarding their strategies to cope with Tilapia diseases. The study focuses on the river-based cage culture in Songkhram River. The data were collected from 148 fish farmers using structured questionnaires. The study found that most fish farmers struggled with fish disease problems in the past. The problems typically aggravated during April and June, which were the transitioning period from summer to wet season. They believed that the diseases were mainly caused by variation in water quality and weather. The common diseases were ectoparasite infestation and bacterial infection. The common clinical sign that these farmers observed was exophthalmia. With their limited knowledge of disease management, these farmers decided to remove infected fish from the cages, added vitamins in the feed, and applied antibiotics. The preventive practices included direct observation, a regularly cage cleaning, an application of vitamins, and stop fish activities during the disease outbreak period. However, they did not know the actual causes of diseases. In order to better cope with the problems, it is recommended that fish farmers should send the infected fish to the relevant agencies to diagnose the true causes of the diseases so that they can suggest appropriate treatments.

Keywords: Fish disease, fish cage culture, Fish farmer management

Introduction

Nile tilapia (*Oreochromis niloticus*) are significant economic fish in Thailand. They are widely cultured in all regions of the country because of their rapid growth, mild in taste and is inexpensive for the consumers. Cage-based aquaculture in rivers or other public water bodies is popular than aquaculture in ponds on private land. The river-base cage culture relatively provides higher potential fish yield. This contributes to the higher economic benefits and better utilization of natural water resources. It also provides the opportunity for the landless people to be able to access and engage in fish production (Lebel *et al*., 2013). Besides, it requires less manpower for cage movement and harvesting. It also needs a relatively lower initial investment since the body of water has already existed. Freshwater cage culture in northeast Thailand is well-known for high fish yield. In 2017, there were a total of 1,519 freshwater fish farms with a yield of 9,305 tons (Department of Fisheries, 2019). This generated a significant amount of income for fish farming households in the area. Unfortunately, many fish farmers have suffered some damages and losses from fish diseases. The diseases are typically caused by wastewater, weather variation, parasite infestation, and bacterial infection (Belton *et al*., 2009; Imjai *et al*., 2016; Srisapoome *et al*., 2016). Fish farmers have different management strategies for reducing risks. This study collected information on fish diseases and the management of fish farmers in the Songkhram River. The insights of their management strategies will be useful for fish disease management for tilapia cage culture in the future.

Materials and Methods

The population of this study involves 235 fish farmers in Sakon Nakhon and Nakhon Phanom provinces. These farmers reared fish in the floating cages in Songkhram River and registered with the provincial fisheries office. The sample of this study is 148 fish farmers, determined by the formula of Taro Yamane (Yamane, 1970) using a simple random sampling. The study site was in five districts (Figure 1) (Tha Uthen, Kham Ta Kla, Akat Amnuai, Si Songkhram and Na Thom; n=74, 30, 25, 11, 8 farms, respectively). The data were collected during April and December 2017.

This study collected data using a structured questionnaire. It consists of both open-ended questions and close-ended questions. Most questions covered the Nile tilapia rearing data, causes of fish diseases, the characteristic clinical signs of the diseases, and the details of the treatment and prevention methods. The daily air temperature and amount of rainfall data in the studied areas in 2017 were received from Sakon Nakhon and Nakhon Phanom Provincial Meteorological Office. This study employs statistical analysis and provides with descriptive statistics in percentage and mean with standard deviation.

Results

Characteristics of the sampled fish farmers

A little bit more than half (54.7%) of the fish farmers were male, with an average age of 49.1 ± 11.5 years. Most of them (71.6%) received a primary school diploma. Most of them (72.3%) had fish farming business as their secondary source of income in addition to rice farming. These farmers had on average 8.4 ± 5.2 years of experience in fish cage culture. Each of them owned 15.6 ± 33.9 cages on average. The most common cage size was 3 x 3 x 3 m with the fish stocking density of 32 fish/m^3. Fish fries were obtained from the private hatcheries (95.1%) with an average length of 5.48 ± 2.3 cm. The length of the rearing period was five months.

The weather data in the studied sites

The average air temperature in Sakon Nakhon and Nakhon Phanom during January and December 2017 was 26.5 °C. The highest average air temperature was in April (33.8 °C), while the lowest average air temperature was in December (16.6 °C) (Figure 2). The average amount of rainfall in the studied sites was highest (726.3 millimeters) in July and lowest (0.5 millimeters) in January (Figure 3) (Nakhon Phanom Provincial Meteorological Office, 2017; Sakon Nakhon Provincial Meteorological Office, 2017).

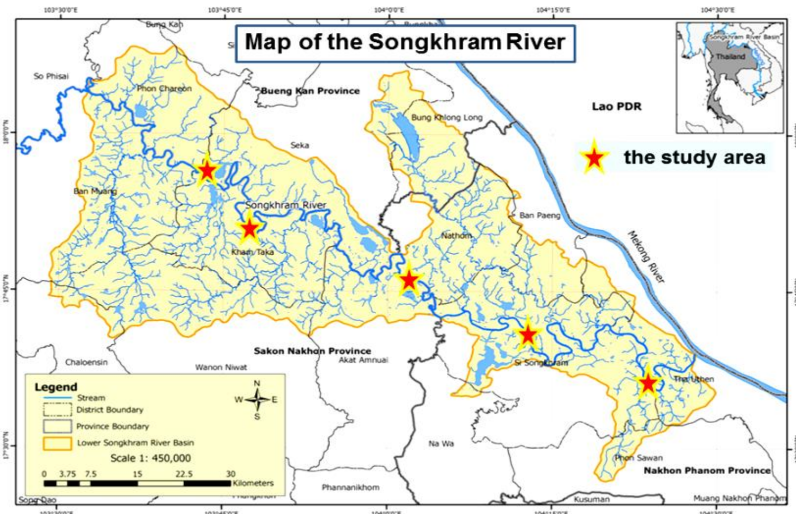

Figure 1. Map showing the study areas
(modified from WWW-Thailand, 2017)

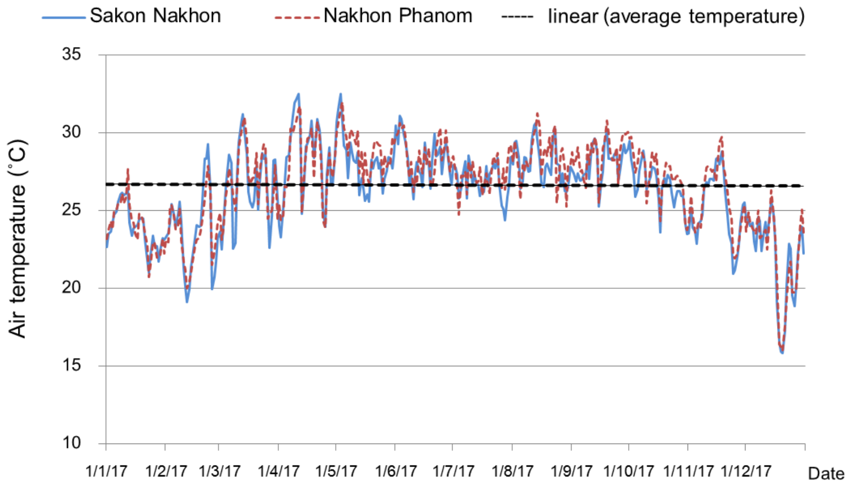

Figure 2. Air temperature in the studied sites between January and December 2017

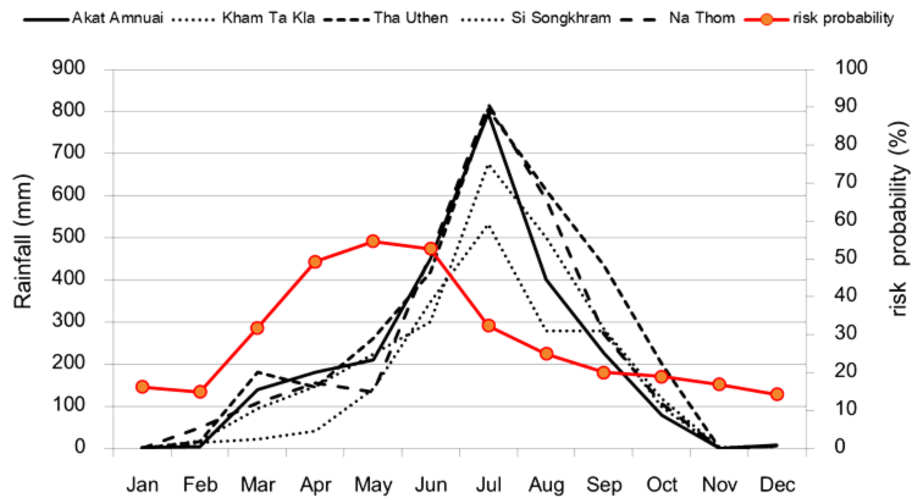

Figure 3. Amount of rainfall in the studied sites and the risk probability of fish diseases

Fish diseases data

Most farmers (92.6%) had faced fish disease problems in 2017. They reported that the risk of fish diseases was high in May (54.7%), June (52.7%) and April (49.3%). These periods are the transitioning period from summer to wet season (Figure 3). After fish were transferred to the floating cages around 82.2 ± 40.1 days on average, they got diseases. The average number of fish that died from the disease infection was 90.3 ± 197.1 fish/cage on average.

Most fish farmers (98.0%) believed that the sources of the fish diseases were from the new water column in the river, unsuitable water quality, chemicals from agriculture, disease outbreaks, and weather variables (Figure 4). Most of them thought that fish diseases were caused by ectoparasite infestation (66.9%), followed by bacterial infection (52.0%), fungi infection (33.8%), and virus infection (12.2%).

The prominent clinical signs observed by fish farmers were exophthalmia (97.3%), abnormal behaviors such as swimming erratically or loss of appetite, petechial hemorrhage, swelling, a lesion on the skin, abnormal gill colour, and fin rot (Figure 5). In addition, some farmers found an appearance of cotton wool on the body of the fish. This was caused by fungi infection.

Regarding the treatment and management strategies, most farmers removed infected fish from the cages (98.6%), added vitamins in the feed, reduced the feed, applied some antibiotics, treated with potassium permanganate ($KMnO_4$) and salt, and reduced stocking density (Figure 6). Herbs were also used for treatment as a substitution for antibiotics (39.9%). The traditional herbs included ginger, galangal, kaffir lime, lime, papaya, banana, garlic and shallot. Some farmers might use only one type of herb, while some might use a combination of those herbs.

In terms of preventive practices, most farmers used direct observation (97.3%), regularly cleaned the cages (92.6%), applied vitamins (95.3%), and stopped rearing fish during disease outbreak periods (52.7%). Moreover, the dead fish were buried (79.7%), processed to food (69.6%) and turn into fertilizer (48%).

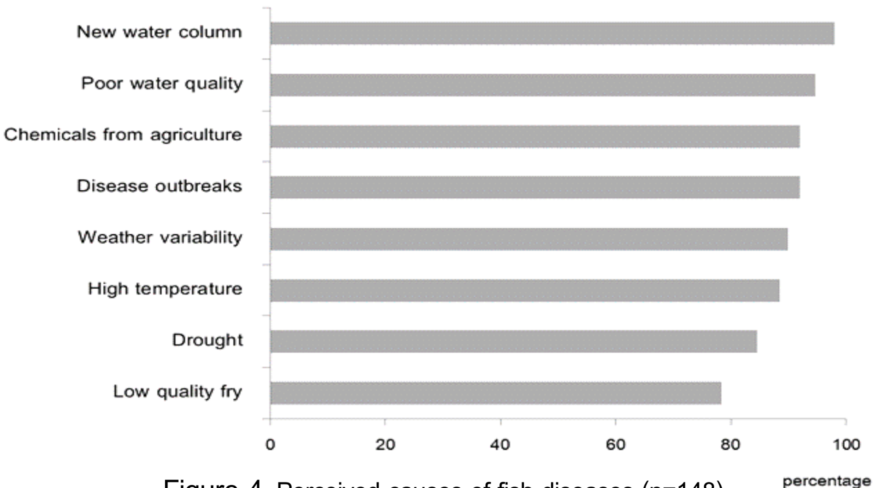

Figure 4. Perceived causes of fish diseases (n=148)

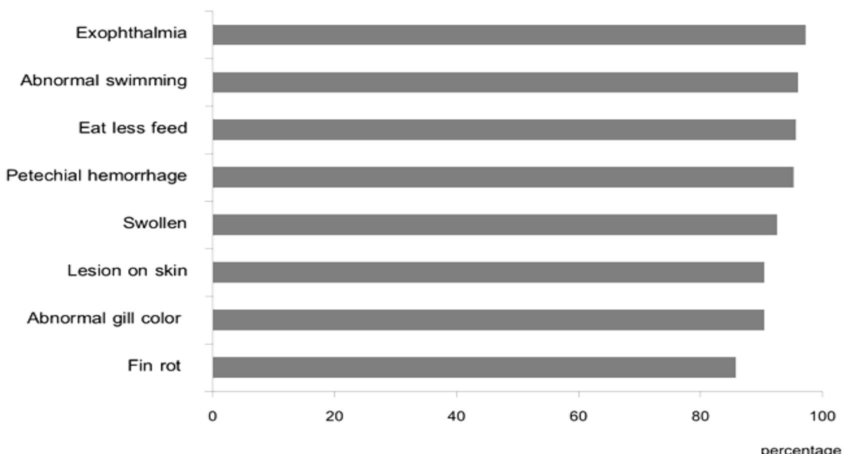

Figure 5. Clinical signs observed by fish farmers (n=148)

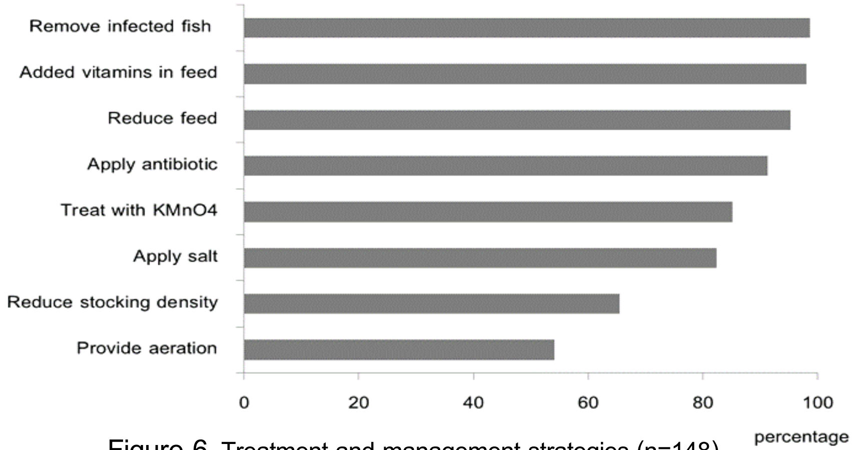

Figure 6. Treatment and management strategies (n=148)

Discussion

The inability to control water quality puts river-based cage culture at high risk. The disease outbreak in river-based cage culture is one risk that fish farmers cannot avoid (Rico *et al*., 2014). Many fish farmers faced with fish disease problems. It was difficult for them to diagnose the cause of the diseases themselves and they decided not to send infected fish to the Department of Fisheries or specialized agencies to diagnose. This was the reason why they never knew the true causes of the diseases.

Most farmers suffered some losses from the fish diseases from April to June which was the transitioning period from summer to wet season. During these periods, water parameters changed rapidly due to the new water column from rainfall. Consequently, this abrupt change damaged fish stocks in the floating cages (Srisapoome *et al*., 2016). The weather variations also affected water quality in the river. The affected water temperature, pH and dissolved oxygen (DO). These factors increased fish stress and eventually caused diseases (Hamed *et al*., 2018; Srisapoome *et al*., 2016; Svobodova *et al*., 2017). In addition, high flows in the wet season might push a fish against the net cage edges that caused lesions on fish skin and wound infection (Chitmanat *et al*., 2016). Similar results were observed by Baleta *et al*. (2019), who reported that primary causes of fish mortality in Magat Reservoir were fluctuating temperature (91.25%) and water quality (83.75%). The change in water quality was a disadvantage for fish cage culture in the river because farmers were unable to manage water parameters in the river. This was different from the fish culture in the earthen ponds that farmers could control or manage water quality in their ponds. Therefore, farmers, stakeholders and the government must be aware and find the effective procedures to solve this problem.

The clinical signs of fish diseases from ectoparasite observed by the farmers included abnormal swimming and the observable external parasites on fish gill or fish skin. The ectoparasite attached to fish skin was the cause of lesion and led to bacterial infection (Chitmanat *et al*., 2016; Srisapoome *et al*., 2016; Thongbamrung and Lertsuthichawan, 2014). The type of ectoparasite that was commonly found in fish cage culture is *Trichodina* spp. It was a very small protozoan that heavily infested on the gill and body surface.

Infected fish swam erratically, rubbed their body with the cage net, and lost their appetite. *Trichodina* spp. also caused a high mortality rate in fish fries (Chitmanat *et al*., 2016). In addition, ectoparasites that can infest in Nile tilapia are *Epistylis* sp., *Icthyophthirus* spp., monogenea (*Cichlidogyrus* sp.), *Argulus* sp., and *Alitropus* sp. (Chitmanat *et al*., 2016; Srisapoome *et al*., 2016; Sriwongpuk, 2009a).

The most common clinical signs of bacterial infection observed by farmers were bulging eyes, swirling swimming, skin hemorrhage, swelling, a lesion on the body, abnormal gill colour and fin rot. However, since farmers did not send the infected fish to diagnose, they could not identify the type of bacteria that caused the disease. Bacteria that typically cause disease outbreak in Nile tilapia are *Streptococcus* sp., *Flavobacterium columnare* and *Aeromonas hydrophila*.

The notable clinical signs of *Streptococcus* infection include spinning swimming or no balance swimming, darker or lighter body colour, exophthalmia, swollen abdomen, hemorrhage in an organ such as mouth, operculum, eye, fin and body (Chitmanat *et al*., 2016; National Bureau of Agricultural Commodity and Food Standards, 2010; Sriwongpuk, 2009b; Thanomsit and Saowakoon, 2017). The mortality rate resulted from streptococcosis is high when the water temperature is higher than 35 °C (Kayansamruaj *et al*., 2014; Mian *et al*., 2009).

Flavobacterium columnare causes acute and chronic infection in fish. The clinical signs of the columnaris disease are gill damage, gill inflammation, gill rot, lesion of body, fade skin colour, hemorrhage fin and fin rot. Some infected fish were found with the inflamed oral mucosa, caused by canker. This is known as the "cotton wool disease" or "mouth fungus" (Bernardet and Bowman, 2006; Pongnumpai and Chitmanat, 2017). The columnaris disease outbreaks are usually more severe when water temperature increases (Pulkkinen *et al*., 2010). Water quality is one of the main factors of outbreaks. Columnaris disease usually occurs when water temperature and other water parameters change rapidly after the rainfall. Decostere *et al.* (1999) reported that the amount of *Flavobacterium columnare* in fish gill was higher when organic matter and nitrite in the water were high.

Another bacterial disease is *Aeromonas hydrophila*. The clinical signs of infected fish are hemorrhagic septicemia, lethargy, loss of appetite, fin erosion, swollen abdominal and intestinal hemorrhage (Chitmanat, 2013). The environmental changes such as a low dissolved oxygen level, an increase of ammonia and nitrite, and an increase of water temperature lead to more outbreaks of *A. hydrophila* (Hamed *et al*., 2018).

For treatment and management strategies of fish diseases, most farmers removed infected fish out of the cages, mixed vitamins in the feed, reduced feeding and used antibiotics. A study of antibiotics and chemical uses in river-based cage culture in Thailand found that most fish farmers used antibiotics and chemicals, but farmers still had incorrect knowledge and less understanding about antibiotics and chemical uses (Rico *et al*., 2014; Srisapoome *et al*., 2016). Farmers learned to treat the fish diseases by themselves, but they did not know the types of antibiotics that they used. This may be because there was a lack of advice from government officials. Consequently, the treatments might not be appropriate for the diseases, leading to the ineffective of the treatments and eventually led to drug resistance in aquatic animals (Chitmanat *et al*., 2016; Khoi *et al*., 2008). Moreover, antibiotic residues also found inside fish and sediments around the floating cage area. This would affect the environment and the consumers in the long run (Rico *et al*., 2014). Therefore, the antibiotic uses for fish treatment are the important issues that all stakeholders should pay attention to ensure sustainable fish farming and consumer safety.

Conclusion

The study of tilapia disease management in floating cage culture in the Songkhram River found that the farmers had incorrect knowledge and understanding about disease management. Instead of treating the diseases by themselves, these farmers should send the infected fish to the government agencies or specialized units to diagnose the true causes of the diseases. This would allow them to be able to apply appropriate treatments for different types of bacteria. In addition, the fish farmer also confronted with the variations in water quality which they had no control over. Consequently, these farmers monitored fish regularly, reduced fish stocking density during the outbreak seasons and added vitamins in the feed to reduce the risk of damage.

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