As. J. Food Ag-Ind. **2010**, 3(03), 328-334

OPEN ACCESS

Asian Journal of Food and Agro-Industry

ISSN 1906-3040
Available online at www.ajofai.info

Research Article

Pesticide and antibiotic residues in freshwater aquaculture fish: Chemical risk assessment from farm to table

Ibrahim Abu Bakar*[1], Mohd Khan Ayub[2], Ayob Muhd Yatim[2] and Norrakiah Abdullah Sani[2]

[1]Nutrition Department, Kulliyyah of Allied Health Sciences, International Islamic University Malaysia (IIUM), Bandar Indera Mahkota, 25200 Kuantan, Malaysia.

[2] School of Chemical Sciences and Food Technology, Faculty of Science and Technology, National University of Malaysia, 43650 UKM Bangi, Malaysia.

*Author to whom correspondence should be addressed, email: iab@iiu.edu.my

---

Abstract

The qualitative chemical risk assessments of freshwater aquaculture fish from farms, markets and food premises have been carried out in six main production districts in Malaysia. Three species of fish were involved in this study [red *tilapia* (*Oreachromis sp*. red hybrids), *keli* (*Clarias spp*.) and *patin* (*Pangasius sutchii*)]. About 240 fresh fish (90 red *tilapia*, 60 *keli* and 90 *patin*) were randomly collected direct from their farms (earth ponds, floating net cages and ex-mining pools). Another 240 fish with the same ratios as farm fish samples were also randomly collected from various markets (wet markets, local markets called ‘pasar tani’ and night markets). The same number of samples with the same ratio of ready-to-eat fish from food premises (restaurants, food stalls and night market food stalls) were also collected. The fish were analyzed for chemical hazards, including pesticide residues and antibiotic residues. All data were then statistically analyzed. The results revealed that there were low chemical hazards in fresh water aquaculture fish. Pesticide and antibiotic residues were only detected in 2.9% and 5.8% of farm fish samples respectively.

Keywords: food safety, Malaysia.

Introduction

The aquaculture industry in Malaysia is growing rapidly, especially the production of freshwater aquaculture fish. The Department of Fisheries Malaysia [1] reported the production of farming aquaculture products in 2007 was about 270,000 tonnes compared to 197,000 tonnes in 2003. The increase is about 37% within 5 years and the average production increase per year from 1998 to 2007 (10 years) was about 7.5%. It seem that consumers in Malaysia have began to accept aquaculture fish as an alternative to sea fish since the production of sea fish was depleted [2, 3, 4].

Freshwater fish are the main aquaculture products in Malaysia beside brackish water fish [1, 5]. Red *tilapia* (*Oreachromis sp*. red hybrids), *keli* (*Clarias spp*.) and *patin* (*Pangasius sutchii*) are among the most popular aquaculture fish produced by farmers. For many years, farmers in Malaysia have cultured freshwater fish in earthen ponds, floating net cages in rivers and ex-mining pools [5, 6]. After harvesting, the fresh fish normally will be sold at local markets and cooked aquaculture fish are among popular dishes at food premises in Malaysia.

The uses of pesticides and antibiotics in fish farming are common practices to avoid the overgrowth of herbal plants and fish diseases beside promoting the fast growth of the fish [7, 8]. Generally chemical residues used at farm level can be accumulated in fish and could cause chronic health effects to consumers [9, 10]. They have the potential to gradually accumulate in the body and cause certain organ or system malfunction. There have been many studies about the effect of chemical residues in fish on consumers [11, 12, 13]. Among the health problems caused by chemical residues are cancer, nerve problems and immunological problems.

Chemical risk assessment of aquaculture products in Malaysia has been conducted by several researchers such as Mat [14] and Subramaniam [15], however, their studies did not include freshwater aquaculture fish, especially the popular red *tilapia*, *patin* and *keli*. Chemical risk assessment of the whole range of freshwater aquaculture fish from farm to table has never been studied in Malaysia. The objective of this study was to assess the level of pesticide and antibiotic residues in freshwater aquaculture fish in main production districts in Malaysia whether at farms, markets or food premises.

Materials and Methods

Fish sampling

About 240 freshwater aquaculture fish (90 red *tilapia*, 60 *keli* and 90 *patin*) were stratified randomly sampled from earthen ponds, river net cages and ex-mining pools at six main production districts in Malaysia. Another 240 freshwater aquaculture fish from markets were also sampled according to district, type of fish, farming system and type of market. Fish sampling at food premises involved ready to eat freshwater aquaculture fish where about 240 (90 red *tilapia*, 60 *keli* and 90 *patin*) were sampled according to district, farming system and type of food premises. All fish sampling activities at farms, markets and food premises were in accordance with the methods suggested by Jabatan Kesihatan Pahang [16] and were conducted from January to June 2007.

Analysis of pesticide residue

Qualitative analysis of pesticide residues was conducted using rapid test kit Agri-screen ticket AT-25 (Neogen, USA). Agri-screen ticket has two poles and each pole has an absorbent disk. One of the ticket's poles was dipped in the sample liquid and the ticket was then bent to keep both absorbent disks adhering together. The absorbent disks will change their colour to blue if the sample contained enough cholinesterase enzymes. If the sample contained enough amount of pesticide, it will inactivate the cholinesterase enzyme and the absorbent disks will retain their white colour. The blue colour indicated that there was no pesticide residue detected in the sample. About 20 g of fish flesh samples were weighed in Erlenmeyer flask. The sample was minced first using glass rod before distilled water was added to the flask. The sample was left diluting for several minutes before it was filtered using paper filter. The prepared liquid which contained cholinesterase enzyme in glass ampule was then put in the sample liquid. The glass ampule was broken by glass rod and the cholinesterase enzyme was left reacting with the sample for about 3 minutes. One of the agree-screen ticket poles was then put in the sample and the ticket was then bent to keep both tickets' poles sticking together. If the absorbent disks changed their colour to blue, it indicated no pesticide residue in the sample. If the absorbent disks retained their white colour, it indicated the sample was detected to contain pesticide residue and it was considered as high risk. The method of pesticide residue analysis has been explained by Anon 1 [17].

Analysis of antibiotic residue

Analysis of antibiotic residues was also conducted as qualitative analysis using rapid microbial test kit (Euroclone, Italy). The analysis was based on the growth prevention of *Bacillus stearothermophilus* on microbial plates when the sample contained antibiotics. The analysis method was explained by Anon 2 [18]. About 0.75 g of fish flesh was weighed in Erlenmeyer flask and 3 ml of liquid buffer (provided by manufacture) was added to the sample. The sample was then stirred for 5 seconds and kept it in the oven at 37^{o}C for 2 hours. About 50 µl of the sample was pipetted into the well of a microplate. The microplate was then kept in the orbital shaker at 65^{o}C for 3 hours. The micropipette was then dried and kept cool for 1-2 seconds. The well's colour will change to blue if there was *B. stearothermophilus* growth. This indicated no antibiotic residue in the sample and the sample was considered as low risk. If the well's colour remained yellow it indicated *B. stearothermophilus* was not growing and there was antibiotic residue in the sample. The sample was considered as high risk.

Results and Discussion

Analysis of freshwater aquaculture fish from farms

Figure 1 shows the result of analysis of pesticide and antibiotic residues in all samples. There were only 7 (2.9%) samples of freshwater aquaculture fish from farms detected as being contaminated with pesticide residues and only 14 (5.8%) samples were detected as being contaminated with antibiotic residues. These results showed that the risk of pesticide and antibiotic residues in freshwater aquacultured fish at farm level was low. It also indicated that farmers succesfully follow the recommended procedures for using pesticide and antibiotics at the fish farms and control the contamination by pesticide in cultured fish.

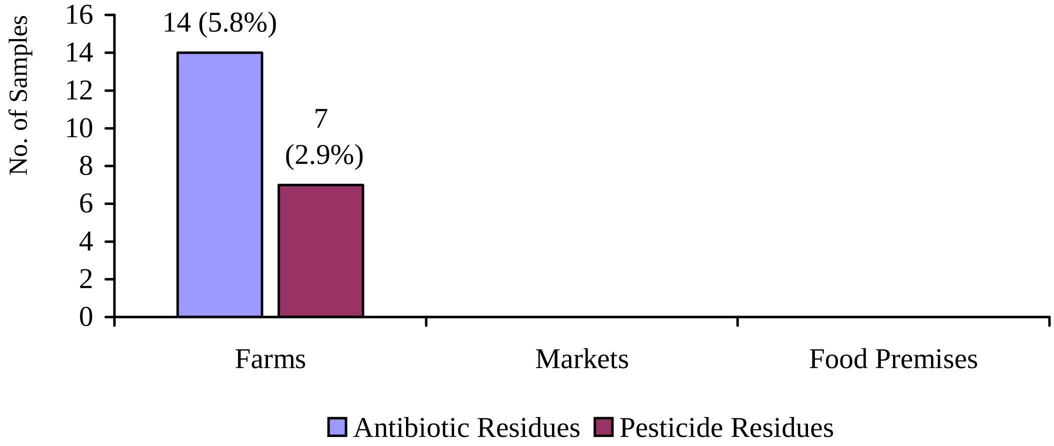

Figure 1. Comparision of Amount (%) of Freshwater Aquaculture Fish which were Detected to be Contaminated with Antibiotic and Pesticide Residues at Farms, Markets and Food Premises.

Pesticide residues were only detected in fish samples from earthen ponds (Table 1), not in floating net cages and ex-mining pools. The farmers might not need to use pesticides in floating net cages and ex-mining pools farming systems, or the pesticide might be more readily dissipated by running water in rivers or by the high volume of water found in ex-mining pools. The existance of pesticide residues in farm fish may come from many sources such as extensive use of pesticide by farmers to overcome the herbal plants in the ponds and also indirectly come from running water from the conventional farms nearby [13, 19].

Table 1 also shows that antibiotic residues were only detected in fish samples from earthen ponds and floating net cages. There were no antibiotic residues in samples from ex-mining pools. The same situation might have occurred where the farmers succesfully followed the procedures for using antibiotics in ex-mining pool farming systems, or the antibiotic was totally disolved by the high volume of water in ex-mining pools. The farmers might also not use antibiotics for ex-mining pool farming systems. The existance of antibiotic residues in fish from earthen ponds and floating net cages may indirectly come from the fish feed and the farmers also might not strictly follow the right procedure for harvesting the fish [20, 21].

Analysis of freshwater aquaculture fish from markets and food premises

Figure 1 also showed that there were no pesticide and antibiotic residues in all 240 (100%) of samples taken from markets and food premises. This situation suggests that there is very low risk of antibiotic and pesticide residues in freshwater aquaculture fish which are sold at markets in Malaysia either at wet markets, ‘pasar tani’ or night markets. Ready to eat aquaculture fish at food premises (either at restaurants, food stalls or night market food stalls) also have very low risk of antibiotic and pesticide residues. The small amount of pesticide and antibiotic residues which may exist in fish at the farm level may be totally disolved by the time they arrive at markets or by the cooking process at food premises.

Table 1. Distribution of Freshwater Aquaculture Fish Samples which were Detected as being Contaminated with Antibiotic and Pesticide Residues according to Type of Farming, District and Type of Fish.

Type of Farming	District	Type of Fish	Fish samples detected to be contaminated with antibiotic residues	Fish samples detected to be contaminated with pesticide residues
Earth ponds	Kuantan	Red *Tilapia*	3	2
		Keli	3	1
		Patin	-	1
	Pekan	Red *Tilapia*	-	1
		Keli	1	1
		Patin	4	1
Floating net cages in rivers	Temerloh	Red *Tilapia*	-	-
		Keli	1	-
		Patin	1	-
	Jerantut	Red *Tilapia*	-	-
		Keli	1	-
		Patin	-	-
Ex-mining pools	Hulu Langat	Red *Tilapia*	-	-
		Keli	-	-
		Patin	-	-
	Kinta	Red *Tilapia*	-	-
		Keli	-	-
		Patin	-	-
Total			14	7

Chemical risk assesment from farm to table

The comparison amount (%) of pesticide and antibiotic residues in freshwater aquaculture fish samples at three different sampling points is also shown in Figure 1. It shows that the contamination by pesticide and antibiotic residues only occurs at the farm level, not at markets or food premises. The combination of chemical risks in freshwater aquaculture fish is shown in Table 2. All aquaculture fish at farms, markets and food premises have low levels of chemical residues. This demonstrated that the freshwater aquaculture fish i.e red *tilapia*, *keli* and *patin* from Malaysia which were sampled at the particular time were safe for human consumption.

Table 2. Combination of Chemical Risks in Freshwater Aquaculture Fish at Farms, Markets and Food Premises.

Analysis of Chemical Residues	Level of Chemical Residues		
	Samples from Farms	Samples from Markets	Samples from Food Premises
Antibiotic Residues	Low	Low or not exist	Low or not exist
Pesticide Residues	Low	Low or not exist	Low or not exist
Chemical Risk	Low	Low	Low

The study of chemical contamination for the entire food chain, i.e from farm to table is vital to verify the safety of the food for human consumption [22, 23]. Lammerding also suggested that a total chemical risk assessment should be conducted for the food where all possible contaminations should be studied [23]. There are still many chemical contaminations associated with aquaculture, especially heavy metal contamination as explained by Tibbetts [24] and it is suggested that this should be the topic of futher study.

Acknowledgments

The authors would like to acknowledge the assistance provided by food health inspectors at different district health offices in Pahang state for collecting the samples and also to staff at different laboratories at the National University of Malaysia and Mentakab food lab for helping in performing the analyses for this study.

References

1. Department of Fisheries Malaysia (2009). *Perangkaan Perikanan Tahunan 2007.* (On-line) http://www.dof.gov.my (1 April 2009).

2. FAO (2008). Concern over situation of high-seas fish species: strengthening fisheries management in international waters - a major challenge. *FAO Newsroom* (On-line) http://www.fao.org/newsroom (5 March 2007).

3. FAO (2009). International seafood trade: challenges and opportunities. *FAO Fisheries and Aquaculture Proceedings* No. 13. 121p.

4. IFPRI (2003). *Fish to 2020: supply and demand in changing global markets*. International Food Policy Research Institute, Washington DC, USA.

5. Jabatan Perikanan Malaysia (2004). *Skim Pensijilan Ladang Akuakultur Malaysia (SPLAM).* (in Malay).

6. Jabatan Perikanan Malaysia (2002). *Garispanduan pembangunan perikanan di Malaysia.*(in Malay).

7. Huet, M. (1995). *Buku teks mengkultur ikan: pembiakan dan pemeliharaan ikan*. (ed.) Faizah Shaharom, Hassan Hj. Mohd Daud & Siti Khalijah Daud. Kuala Lumpur : Dewan Bahasa dan Pustaka (in Malay).

8. Alderman, D.J. & Hastings, T.S. (1998). Antibiotic use in aquaculture: development of antibiotic resistance – potential for consumer health risks. **Journal of Food Science and Technology**, 33(2): 139-155.

9. Hans, H.H., Reilly, A. & Karim Ben Embarek, P. (2000). Prevention and control of hazards in seafood. **Food Control**, 11: 149-156.

10. Holmstrom, K., Gruslund, S., Wahlstrom, A., Somlak, P., Bengtsson, B.E. & Kautsky, N. 2003. Antibiotic use in shrimp farming and implications for environmental impacts and human health. **International Journal of Food Science and Technology**, 38(3): 255-266.

11. Garrett, E.S., Jahncke, M.L. & Lima dos Santos, C.A.M. (1997). Public, animal and environment health implications of aquaculture. **Emerging Infectious Disease**, 3(4): 453-457.

12. Gorbach, S.L. (2001). Antimicrobial Use in Animal Feed – Time to Stop. **New England Journal of Medicine**, 345(16): 1-3.

13. Reilly, A. and Kaeferstein, F. (1999). Food safety and products from aquaculture. **Journal of Applied Microbiology**, 85(28): 249-257.

14. Mat, I. (1994). Arsenic and trace metals in commercially important bivalves, *Anadara granosa* and *Paphia undulate*. **Bulletin of Environmental Contamination and Toxicology**, 52(6): 833-839.

15. Subramaniam, K. (1999). *Grouper Aquaculture Development in Malaysia*. (On-line) http://www.enaca.org/grouper/research/hatchery.

16. Jabatan Kesihatan Pahang (1997). *Kawalan Mutu Makanan: Persampelan dan Analisis Mutu Makanan.* (in Malay).

17. Anon 1. (no date). *Agri-screen ticket: pesticide detection program*. USA: Neogene Corporation.

18. Anon 2. (no date). *Total Drug Residues Screening Kit*. Italy: Euroclone.

19. Amaraneni, S.R. (2002). Persistence of pesticides in water, sediment and fish from fish farms in Kolleru Lake India. **Journal of Food Science and Technology,** 82(8): 918-923.

20. Jabatan Perikanan Malaysia (no date). *Projek Ternakan Ikan Tilapia dalam Kolam/Tangki Konkrit secara Komersial.* (in Malay).

21. Parker, R. (2002). *Aquaculture Science*. 2nd edition. USA : Delmer.

22. Lammerding, A.M. (2002). *Risk Analysis: Approaches for Managing Food Safety*. Paper at 'ICMSF Training Workshop on the Application of Science and Technology in Risk Analysis for Food in ASEAN Countries, Kuala Lumpur, Malaysia, 7-10 October.

23. Slorach, S.A. (2002). *Integrated approaches to the management of food safety throughout the food chain*. Paper at FAO/WHO Global Forum of Food Safety Regulators. Morocco.

24. Tibbetts, J. (2001). Aquaculture: satisfying the global appetite. **Environmental Health Perspectives,** 109(7): 318-323.