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Assessment of the Trash-fish Diet for Snakehead Aquaculture in Vietnam: Species Composition and Chemical Characterisation

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Abstract

Traditional culture of snakehead (*Channa striata* (Bloch 1793) and *Channa micropeltes*, (Cuvier 1831), Channidae) in Vietnam have been based on capture of snakehead fingerlings from the wild and feeding them with chopped trash-fish also taken from the wild.. From August to October 2008, freshwater trash fish samples (3 kg composite samples) were collected from three fish distribution sites at Chau Doc, Thoai Son and Chau Thanh districts in An Giang province, in the Mekong Delta, Vietnam. The species composition was determined along with the size frequency, sources, and chemical composition of the freshwater trash-fish used for snakehead aquaculture. Thirty-three species of freshwater fish were identified in the freshwater trash-fish samples, 12 of which were juveniles of commercially important species. Marine trash-fish samples were also collected from the same distribution sites for analysis of chemical composition and product freshness. Chemical composition of freshwater trash-fish indicates their protein levels to be nutritionally adequate for snakehead aquaculture. Marine trash-fish showed high total volatile base nitrogen (TVB-N) values, compared to freshwater trash-fish, indicating that they are not fresh. The fish stocks of these freshwater trash-fish species should be assessed and the inland fishery should be managed properly, especially during the flood season.

Introduction

The Mekong River Basin hosts one of the most diverse freshwater faunas in the world. There are 1,200 recorded fish species and the number will increase as new species are discovered and classified (Sverdrup-Jensen 2002). Diversity is based on a wide range of permanent and seasonal habitats, which are the result of the Mekong Basin's complex geological history.

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Most fish species depend on different habitats at different stages of their life and at different seasons of the year (Sverdrup-Jensen 2002). During the flood season, most Mekong species take advantage of the floodplains for feeding, breeding and rearing their young (Sverdrup-Jensen 2002). In the Mekong Delta, the fisheries encompass a range of different gears and methods for targeting different species groups. In a multi-species fisheries environment such as the Mekong system, it is useful to distinguish different species groups based on different life history strategies. Baran et al. (2007) suggested a 20% increase in fish demand in the Lower Mekong Basin is likely over a 10-year period. Fishing is likely to increase due to population growth and ease of access and this may result in an increase in the overall catches. On the other hand, the increase will be accompanied by a continued decrease in many important commercial species in the catches (Sverdrup-Jensen 2002). However, the freshwater fishes are used not only for human consumption but also for aquaculture, especially the juvenile fishes are caught in flood seasons.

Aquaculture in Vietnam has been expanding rapidly. Pangasiid catfish were traditionally raised on diets based on trash-fish (also known as small-size fish or low-value fish) collected from the Mekong River. After the introduction and use of formulated diet over the last decade the catfish industry has grown rapidly. Traditional culture of snakehead *Channa striata* (Bloch 1731) and *Channa micropeltes* (Cuvier 1831), Channidae) in Vietnam have been based on capture of snakehead fingerlings from the wild and feeding them with chopped trash-fish taken from the wild (Hien et al. 2015). In neighbouring Cambodia, similar practices have led to the ban of snakehead culture, to avoid conflicts between fish farmers capturing trash-fish and fishermen who capture fish for human consumption (Poulsen et al. 2008).

The purpose of our study was to determine the species composition, size frequency and distribution of the low-value freshwater fishes used for aquaculture. The chemical composition of these fish was also examined to see their suitability as feed for snakehead. In order to conduct some of the feeding trials in a related project, it was necessary to investigate the chemical composition and quality of the trash-fish that would be used for feeding the experimental fish. Both fresh-water and marine trash fish are being used for aquaculture in Vietnam.

Materials and Methods

The study was carried out monthly during the flood season from August to October 2008. Freshwater trash-fish samples (3 kg composite samples) were collected from three fish distribution sites in Chau Doc, Thoai Son and Chau Thanh districts, An Giang province, the Mekong Delta, southern Vietnam (Fig. 1). Purveyors at the distribution sites caught freshwater trash-fish and stored them for 1-2 days before selling to snakehead farmers. The fish samples were identified by their scientific names, and the species composition, length frequency, seasonal occurrence and distribution were determined. Information on different kinds of trash-fish used for snakehead culture and sources of the trash fish was also collected by interviewing 67 farmers, of which 19 households cultured snakehead in ponds, 27 in hapas and 21 in cages.

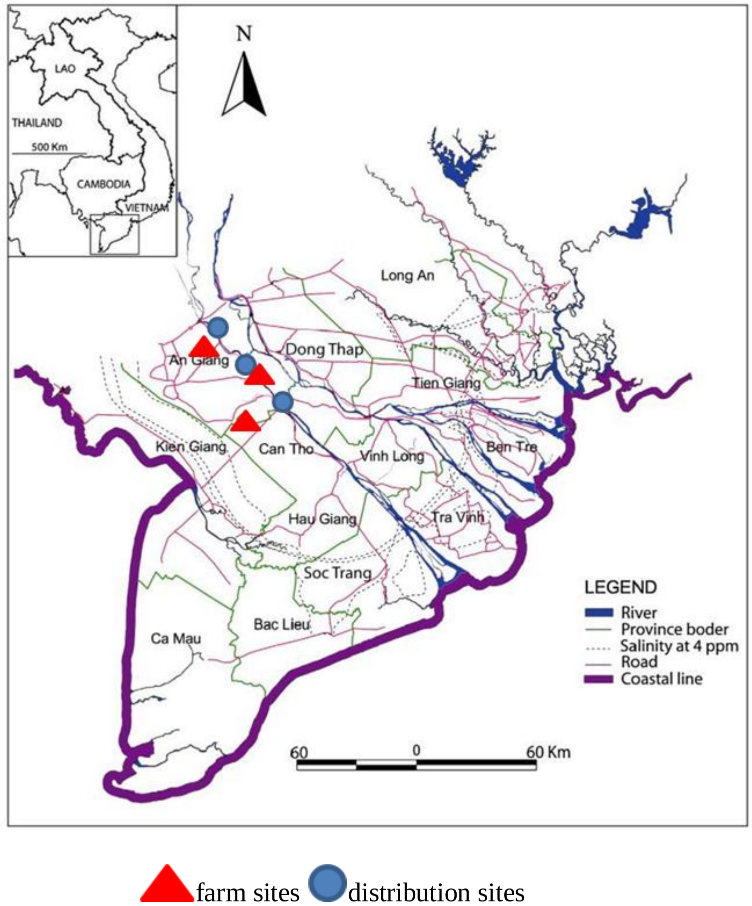

Fig. 1. Trash-fish and interview sites in the Lower Mekong Basin.

Marine trash fish samples (3 kg composite samples) were collected at distribution sites on the same day, then stored on ice and sent to the College of Aquaculture and Fisheries, Can Tho University for analysis on the following day of chemical composition (protein, lipid, moisture and ash) and total volatile base nitrogen (TVB-N) analysis of product freshness. The marine trash fish samples had been caught in the sea and transported to distribution sites with around 15- 30 days of storage on ice (Hien et al. 2006). The species composition of marine fish was identified in a previous study (Hien et al. 2006), so here we focused on freshwater fish species. Fresh-water trash fish samples were also collected at the distribution sites for the same analyses. To evaluate the freshness change during storage, three of each trash fish samples were also held on ice for 3 days at Can Tho University and analysed for TVB-N.

The common species of freshwater fish (*Henicorhynchus lobatus* Smith 1945, Cyprinidae; *Trichogaster microlepis* (Günther 1861), Osphronemidae; *Anabas testudineus* (Bloch 1792), Anabantidae; *Mystus mysticetus* Roberts 1992, Bagridae; and *Esomus metallicus* Ahl 1923, Cyprinidae) were analysed separately for chemical composition (moisture, crude protein-CP, crude lipid-CL and crude ash-CF) according to AOAC (2000). Loss on drying was determined by moisture content, protein (N x 6.25) by Kjeldahl method, lipid by Soxhlet method, and ash by combustion in a muffle furnace.

Results

Species composition

Thirty-three species of freshwater fish were identified in the trash-fish samples. The most common species are listed in Table 1 and Fig. 2. In total, the species belong to 20 families, of which the families Cyprinidae (24%), Bagridae (10%), Cobitidae (10%) and Osphronemidae (10%) are most heavily represented. The most common freshwater species were *H. lobatus* (19.6%), *T. microlepis* (12.6%) and *A. testudineus* (10.1%) (Fig.2). Details of monthly occurrence and length frequency distribution are described in the next section. Our observations from the marine trash-fish, not identified to species, showed that the common species are from the families Engraulidae, Leiognathidae, Scombridae, Carangidae and Clupeidae. The freshwater trash-fish are commonly used to feed fish maintained in hapas (96.3%) and the farmers can catch freshwater trash-fish by themselves (36.0%, n=25); meanwhile marine trash-fish are mostly used in ponds and cages for snakehead aquaculture and the farmers buy marine trash-fish from middlemen or fishermen who catch the trash-fish in coastal areas of the Mekong Delta (Tables 2 and 3).

Table 1. The minimum and maximum lengths of the most abundant freshwater trash-fish used for snakehead culture in three districts in An Giang province, Vietnam

Local Name	Scientific Name	L_{min} (mm)	L_{max} (mm)
Cá linh thùy	*Henicorhynchus lobatus* Smith 1945	30	107
Cá sặc điệp	*Trichogaster microlepis* (Günther 1861)	20	97
Cá rô đồng	*Anabas testudineus* (Bloch 1792)	13	105
Cá sặc bướm	*Trichogaster trichopterus* (Pallas 1770)	37	81
Cá dãnh	*Puntioplites proctozysron* (Bleeker 1865)	38	110
Cá chốt vạch	*Mystus mysticetus* Roberts 1992	20	91
Cá đỏ mang	*Systomus rubripinnis* (Valenciennes 1842)	17	85
Cá lòng tong sắt	*Esomus metallicus* Ahl 1923	20	79
Cá linh rìa	*Labiobarbus leptocheilus* (Valenciennes 1842)	60	105
Cá rô phi	*Oreochromis niloticus* (Linnaeus 1758)	41	115

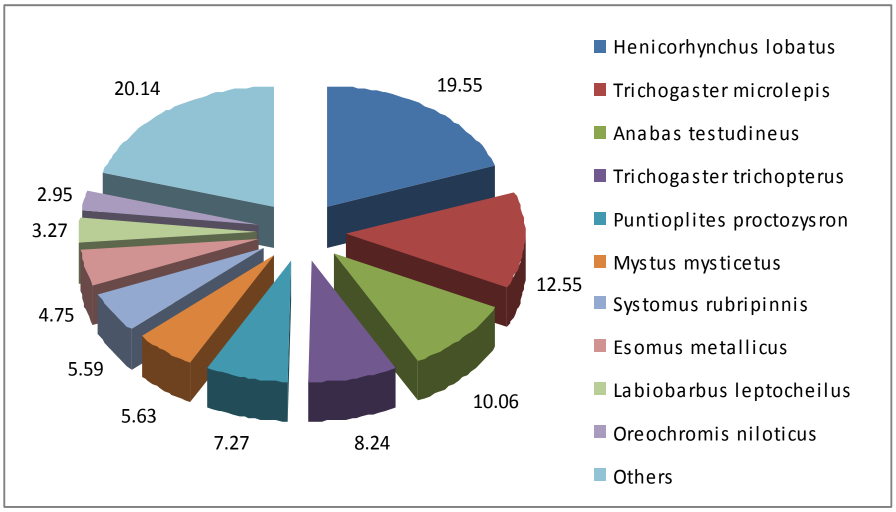

Fig. 2. The most common species of low-value fish used for snakehead culture in An Giang Province, Vietnam.

Table 2. Percentages of snakehead-farming households using different kinds of trash-fish for snakehead culture. Sample sizes (n) refer to the number of households using the type of production system indicated.

Type of feed	Pond n=19	Hapa n=27	Cage n=21
Freshwater trash fish	63.2%	96.3%	71.4%
Marine trash fish	100%	74.1%	90.5%
Channeled apple snail *Pomacea canaliculata* (Lamarck 1828)	5.3%	25.9%	-

Table 3. Percentages of trash fish sources used for snakehead culture. Sample sizes (n) refer to the number of households using the type of production system indicated.

Source of trash-fish	Pond (n = 9)	Hapa (n =25)	Cage (n =14)
Caught by farmers	-	36.0%	7.1%
Bought directly from fishermen	33.3%	56.0%	14.3%
Bought from middlemen	66.7%	8.0%	78.6%

Seasonal occurrence and length frequency distribution

Monthly occurrences of the most common freshwater species varied, as follows. In August, the most abundant species were *H. lobatus* (50.4%); *A. testudineus* (11.1%); *M. mysticetus* (8.7%) and *Barbonymus gonionotus* (Bleeker 1849), Cyprinidae (7.4%).

In September, the most abundant species were *Pangasius bocourti* Sauvage, 1880, Pangasiidae (22.3%); *Systomus rubripinnis* (Valenciennes 1842), Cyprinidae (19.2%); *Helicophagus waandersii* Bleeker 1858, Pangasiidae (11%); *Ompok bimaculatus* (Bloch 1794), Siluridae (8.4%); and *Brachirus panoides* (Bleeker 1851), Soleidae (7.9%). In October, the most abundant species were *Puntioplites proctozysron* (Bleeker 1865), Cyprinidae (47.5%); *Oreochromis niloticus* (Linnaeus 1758), Cichlidae (25.3%); and *Labeo chrysophekadion* (Bleeker 1849), Cyprinidae (10.3%).

Many commercial species were exploited at very small size or in the juvenile stage (Table 1) such as *A. testudineus* (TL_{min}= 13 mm) and *S. rubripinnis*, (TL_{min}= 17 mm). The length frequency analysis showed that *H. lobatus* was exploited mostly from 60- 75 mm in total length, while the other species were exploited with a larger range of total lengths.

Chemical composition

Chemical composition of the common freshwater species indicated that crude protein, crude lipid and crude ash of *A. testudineus* were the highest values, whereas those of *T. microlepis* were lowest for both protein and lipid (Table 4). Protein content of marine trash fish was higher, 17.0%, than that of freshwater trash fish (15.5%); by contrast, lipid content of marine trash fish (2.22%) was lower than that of freshwater fish (6.2%) (Table 5).

Table 4. Chemical composition of the most abundant low-value freshwater fishes (whole fish, %, wet matter basis) used as feed for snakehead culture in An Giang province, Vietnam.

Species	Moisture (%)	Crude protein (%)	Crude lipid (%)	Crude ash (%)
Corhynchus lobatus Smith 1945	76.5	14.4	5.68	2.98
Trichogaster microlepis (Günther 1861)	77.5	14.3	1.97	2.68
Anabas testudineus (Bloch 1792)	68.3	16.1	8.39	4.67
Mystus mysticetus Roberts 1992	74.3	14.5	6.23	2.48
Esomus metallicus Ahl 1923	71.6	14.8	8.07	2.68

Moreover, after 3 days of storage on ice, there was an increase in TVB-N value to 159±17.7 mg $N \cdot (100\ g)^{-1}$ in all samples collected from distribution sites. Fresh-water trash fish exhibited low TVB-N values of 15.7±0.51 mg $N \cdot (100\ g)^{-1}$ on the day of catching and sampling. The samples looked fresh at the time of analysis and fish were collected and analysed on the days when they were caught. There was an increase in TVB-N value after 3 days of storage to 43.5±1.1 mg $N \cdot (100\ g)^{-1}$.

Table 5. Comparative chemical compositions of combined-species marine and freshwater trash fish (whole fish, %, wet matter basis) used for snakehead culture in An Giang province, Vietnam

Type of fish	Moisture (%)	Crude ash(%)	Crude Protein (%)	Crude Lipid (%)
Marine trash fish	73.6±1.50	6.93±0.24	17.0±0.19	2.22±0.21
Fresh water trash fish	71.1±0.41	5.50±0.31	15.5±0.27	6.20±0.48

TVB-N values of marine trash-fish samples collected from distribution sites were 99.2 ± 12.0 mg N·(100g)$^{-1}$ (Fig. 3).

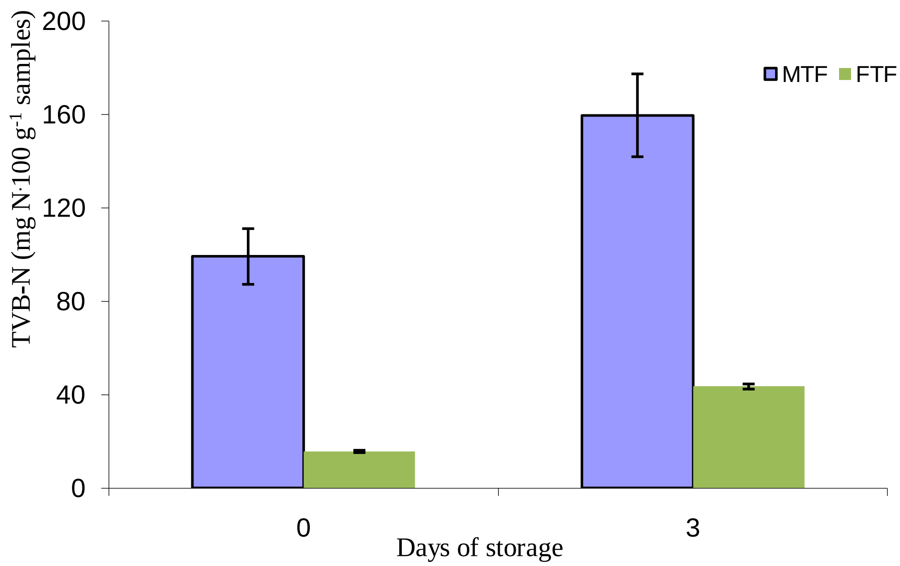

Fig 3. The freshness (TVB-N, mg N·100 g^{-1} samples) of marine trash-fish (MTF) samples and fresh water trash-fish (FTF) samples collected at distribution sites (n=3). Bars indicate standard errors.

Discussion

Our results indicate that aquaculture of snakehead based on feeding trash-fish in the Mekong Delta might have an impact on commercially important freshwater fish populations. Although fishers may think they are targeting commercially unimportant small species, they are actually catching juveniles of commercially important populations (*H. lobatus*, *T. microlepis* and *A. testudineus*) during the flood season. This may help to explain the decline in those fisheries resources in recent years. The aim of this study was to assess the freshwater trash-fish used in snakehead culture; thus, specific species composition and frequency of the marine trash-fish were not a focus of this study. However, results from our observations confirmed that marine trash-fish species were similar taxonomically to those used in striped catfish culture reported by (Hien et al. 2006), likely because the marine trash-fish in the region are distributed for both striped catfish and snakehead culture simultaneously.

Pike and Hardy (1997) presented evaluation standards for the freshness of fish and suggested that TVB-N value must be lower than 14 mg N·(100 g)$^{-1}$ for fish to be categorised as fresh, from 14 to 30 mg N·(100 g)$^{-1}$ to be considered moderately fresh, and values of over 50 mg N· (100 g)$^{-1}$ are categorised as stale. Our analysis showed that all of the marine trash fish samples were in stale condition according to classification of Pike and Hardy (1997). The likely reason that marine trash-fish samples showed high values of TVB-N is the long storage duration in transportation from the fishermen to the distribution sites which normally takes 15 days or more. According to classification of Pike and Hardy (1997) the fresh-water trash fish sampled by us were still fresh after 3 days of storage on ice. In fishmeal processing, TVB-N values in trash fish ranged from 22-143 mg N·(100 g)$^{-1}$ (Pike and Hardy, 1997). Based on a previous study done in Vietnam, random sampling of trash fish for TVB-N analysis (11 samples), indicated that marine trash fish used as feed for catfish were of bad quality with TVB-N values ranging from 84-148 mg N (100g)$^{-1}$ (Hien et al. 2006).

Chemical composition of the most abundant low-value freshwater fishes and combined-species marine and freshwater trash fish represent a nutritionally adequate diet for snakehead, which has a high protein requirement of up to 40% (Samantary and Mohanty 1997). Pelleted diets have been developed for snakehead (Hien et al. 2015), so farmers should be able to reduce their reliance on trash-fish in culture practices. Our recent surveys (unpublished data) indicate that over 1,000 snakehead farmers have already changed their feeding practices to using formulated feed. Information from the current study could be used as a guideline for fishers, farmers and government regulators in Cambodia, so that they can adopt practices that will allow the government to overturn the ban on snakehead culture in that country.

Conclusion

Thirty-three species of freshwater fish used as "trash fish" or low-value fish for aquaculture in An Giang province were identified, and the most abundant and common species is *H. lobatus*. Many of those fishes are commercially important species and some of them are target species for aquaculture in Vietnam, such as *A. testudineus*, *P. bocourti*, and *O. niloticus*. Therefore, those fish stocks should be assessed and the inland fishery should be managed properly, especially in flood season. Chemical composition of both marine and freshwater trash fish appears to be nutritionally adequate for snakehead aquaculture, except that the marine trash-fish are not fresh.

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