Antibiotic residuals in some farmed rainbow trout (*Oncorhynchus mykiss*) of market size in Iran

M Soltani¹, E Pirali¹, A Rasoli², S. Shafiei¹, S. Kakoolaki³ and Gh Shams²

¹Department of Aquatic Animal Health, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran
²Department of Pharmacology, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran
³Iranian Fisheries Research Organization, Tehran, Iran

Received: January 2014          Accepted: May 2014

Abstract

To assess the hygienic conditions of market rainbow trout (*Oncorhynchus mykiss*), the residuals of three antibiotics consisting of oxytetracycline (OTC), enrofloxacin (EN) and erythromycin (ET) were measured in the muscles of freshly caught fish obtained from 17 trout farming in Charmahal-va-Bakhteyari (CVB) province using high performance liquid chromatography. Totally 266 fish samples were randomly obtained and 798 muscle samples were used for detection of the above antibiotics. The obtained results showed that OTC was detected in one fish farm (5.8%) having a residual of 0.75 to 7.13 μg g⁻¹. EN was detected in 6 fish farms (35%) with a residual of 0.5- 0.73 μg g⁻¹. Also, the lowest and highest residuals of ET were 23.38 and 181.38 μg g⁻¹, respectively in 5 fish farms (29.4%). The obtained results showed that the residual of these antibiotics in trout muscles of some fish farms were higher than the acceptable levels and therefore, requires a serious attention of both the environment and the consumer health care. Also, the detection limit of 0.05 μg g⁻¹ used for these antibiotics shows that application of high performance liquid chromatography method used here in this study is a useful tool for a routine screening of these antibiotics in trout farming.

Key words: antibiotic residual, trout, erythromycin, enrofloxacin, oxytetracycline.

Introduction

Increasing demands upon human societies for animal protein, especially with the origin of aquatic-source have led to the development of aquaculture sector worldwide (Sapkota, Sapkota, Kucharski, Burke, McKenzie, Walker & Lawrence 2008). Evidences show that the uncontrolled use of chemicals such as antibiotics can cause serious problems in the environment as well as humans as the main consumers of aquaculture productions. This adverse effect is more noticeable in the immunocompromised people such as diabetics and infants. Use of food containing antibiotic residuals can also cause allergies, cancers, birth defects and drug resistance to the diseases in humans. The residuals of antibiotics in food products can also cause development of drug resistance in potential pathogenic bacteria in the digestive tracts of animals, including human and fish (Hernández-Serrano 2005). Even creating drug resistance in non-pathogenic bacteria can lead to more drug-resistant causing a development of such resistant genes in to pathogenic bacteria in humans and other animals (FDA. 2009b; Miranda, Tello & Keen 2013).

The widespread use of antibiotics in the aquaculture industry for treatment of bacterial diseases caused by *Aeromonas hydrophila*, *Aeromonas salmonicida*, *Pasteurella piscicida*, *Edwardsiella ictaluri*, *Vibrio anguillarum*, *Yersinia ruckeri*, *Streptococcus iniae*, *Lactococcus garvieae* and *Renibacterium salmoninarum* has raised a serious concern for the consumers (Cabello 2006; Park, Hwang, Hong & Kwon 2012). Since some bacterial diseases including streptococcosis/lactococcosis and yersiniosis have been dramatically increased in farmed rain-
bow trout (Oncorhynchus mykiss) in Iran (Soltani, Jamshidi & Sharifpour 2005), the use of some anti-
biotics have been remarkably increased by the trout farmers recently. This increase in the chemotherapy 
has caused a serious publich health concern. Therefore, the aim of this study was to assess the resid-
uals of 3 commonly used antibiotics in rainbow trout of market size from 17 farmed trout in Char-
mahal-va-Bakhteyari (CVB) province the leading state of Iran in trout production in freshwater.

Materials and Methods

A number of 266 carcasses of rainbow trout weighing 300-400 g were randomly sampled from the trout suppliers. The samples were originally ob-
tained from 17 trout farms (15-20 samples each farm) in CVB province. The main target markets of these fish suppliers are Isfahan and Tehran cit-
ties. At the time of sampling some historical details including name and location of trout farmers were 
obtained to follow the previous antibiotic treatment at the culturing stage. Therefore, some historical 
details of these trout farms including previous his-
tory of streptococcosis/lactococcosis (the common disease in the region) and antibiotic used are show-
in Table 1. Fish samples were transported to the laboratory on ice. About 15 g of lateral muscles of each fish sample was aseptically obtained and im-
mediately transferred to -196°C until used within 3 weeks post-sampling.

Extraction of fish muscle samples for OTC

Muscle samples were first homogenized and a 5±0.01 g was then mixed in a sterile polypropylene container containing 15 mL of sterile phosphate buffered solution (PBS) (0.02 mol, pH = 2.25) plus 50% (W/V)aceticacid (Merck) prepared in pure distilled water. The homogenizing process was re-
peated three times with homogenizer each time 30 s prior to centrifugation at 3000 rpm for 20 min. The supernatants were collected in to a sterile contain-
er. The extraction procedure was repeated for the rest of muscle sample. The final supernatant was 
passed through the cartridge activated with passing 4 mL of methanol (Merck) and 4 mL of buffer. The

<table>
<thead>
<tr>
<th>No of fish farm</th>
<th>Name of fish farm</th>
<th>No of fish samples (g)</th>
<th>History of previous antibiotic therapy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CH_ME</td>
<td>20 (350)</td>
<td>ET, FP</td>
</tr>
<tr>
<td>2</td>
<td>CH_MD</td>
<td>20(300)</td>
<td>EN, FP</td>
</tr>
<tr>
<td>3</td>
<td>CH_AB</td>
<td>15(400)</td>
<td>ET, FP</td>
</tr>
<tr>
<td>4</td>
<td>CHTN</td>
<td>15(300)</td>
<td>EN, FP, ET</td>
</tr>
<tr>
<td>5</td>
<td>CHAN</td>
<td>15(380)</td>
<td>ET</td>
</tr>
<tr>
<td>6</td>
<td>S1DB</td>
<td>16 (350)</td>
<td>EN</td>
</tr>
<tr>
<td>7</td>
<td>SH_ZI</td>
<td>15 (400)</td>
<td>EN, FP</td>
</tr>
<tr>
<td>8</td>
<td>SH_DA</td>
<td>15(340)</td>
<td>EN, FP</td>
</tr>
<tr>
<td>9</td>
<td>S2_SHB</td>
<td>15(400)</td>
<td>EN, FP</td>
</tr>
<tr>
<td>10</td>
<td>S2_HE</td>
<td>15(350)</td>
<td>EN, FP</td>
</tr>
<tr>
<td>11</td>
<td>G_FE</td>
<td>15(400)</td>
<td>FP</td>
</tr>
<tr>
<td>12</td>
<td>SA_TSH</td>
<td>15(350)</td>
<td>ET</td>
</tr>
<tr>
<td>13</td>
<td>SAMHI</td>
<td>15(350)</td>
<td>EN</td>
</tr>
<tr>
<td>14</td>
<td>SA_AR</td>
<td>15(300)</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>SA_MF</td>
<td>15(100)</td>
<td>OTC</td>
</tr>
<tr>
<td>16</td>
<td>SA_YA</td>
<td>15(200)</td>
<td>-</td>
</tr>
</tbody>
</table>

OTC was washed out from the cartridge using 7 mL methanol and dried up by nitrogen at 40°C. The samples were then filtered using Milipor filter and were maintained at -20°C. Positive control samples were included in using trout muscle samples containing pure OTC (Sigma) at known concentration. The OTC content was then measured using HPLC system (Salte & Liestøl 1983; Esposito, Fabrizi, Lucchetti, Marvasi, Coni & Guandalini 2007).

Extraction of fish muscle samples for EN

Muscle samples were first homogenized and a 5±0.01 g was then mixed in a polypropylene con-
tainer containing 1.5 mL of sterile PBS (0.02, mol, pH=9.1). After15 min, a volume of 5 mL acetone-
nitrile (Merck) was added, mixed well and the sam-
ple was then placed in the ultrasonic as an energy source. The homogenizing samples were cen-
trifuged at 3000 rpm for 10 min. The supernatants were then collected in to a sterile container and the organic phase was evaporated by nitrogen at 40°C. The extraction procedure was repeated for the rest
of muscle sample. The final supernatant was passed through the cartridge activated with passing 4 mL of methanol and 4 mL of PBS EN was washed out from the cartridge using 5 mL methanol containing 2% hydrochloric acid (Merck) and dried up by nitrogen at 40°C. The samples were then filtered using Milipor filter and were maintained at -20°C until subjecting to HPLC system. Positive control samples were considered using trout muscle samples containing pure ET (Sigma) (Lucchetti, Fabrizi, Esposito, Guandalini, Di Pasquale & Coni 2005).

According to the ratio of signal to noise (5/1), the maximum amount for each OTC and EN was calculated at 50 ng per one g of tissue, and the recovery of the method was then calculated to be 74.4% for both test and standard samples. In all experiments, initially the calibration and standardization of methods were performed prior to examine the test samples.

### Results

A calibration curve in trout muscle free of the antibiotics is shown in Fig. 1-3. Minimum detectable for all three antibiotics was 0.05 μg g⁻¹ trout muscle. The residuals of OTC were detectable in range 0.07-7.13 μg g⁻¹ in 6 muscle samples in one
The residuals of EN were detectable in range 0.05-0.90 μg g⁻¹ in 75 muscle samples obtained from 6 fish farms (Table 2). The detectable values were 0.19-0.29 μg g⁻¹ for farm 4 (15 samples), 0.07-0.09 μg g⁻¹ for farm 6 (9 samples), 0.05-0.80 μg g⁻¹ for farm 7 (15 fish samples), 0.5-0.8 μg g⁻¹ for farm 8 (8 fish samples), 0.05-0.09 μg g⁻¹ for farm 9 (11 samples) and 0.05-0.08 μg g⁻¹ for farm 10 (Table 2). Also, the residuals of ET were detectable in range 23.38-181.38 μg g⁻¹ in 69 muscle samples obtained from 5 fish farms (Table 2). The detectable values were 60.82-132.5 μg g⁻¹ (20 samples) in farm 1, 23.38-35.22 μg g⁻¹ (13 samples) for farm 3, 100.54-154.21 μg g⁻¹ (15 samples) for farm 4, 51.21-89.32 μg g⁻¹ (15 samples) for farm 5 and 100.02-181.38 μg g⁻¹ (14 samples) for farm 12 (8 samples).

Discussion

Results of this study show that the residuals of OTC, EN and ET measured by HPLC in 798 muscle samples of cultured trout obtained from 17 fish farms were detectable. Generally a number of 151 (19%) muscle samples were positive for the residuals of these antibiotics. Maximum detectable levels for EN, ET and OTC were 0.9, 1.52 and 0.74 μg g⁻¹ muscle sample. The recommended levels of maximum residual limits (MRL) reported by the Codex, EU and FDA for these antibiotics are 100, 200 and 200 μg g⁻¹ fish tissues, respectively (Council of the European Communities, Council Regulation 2377/90/EC 1990; European Commission, Council Directive 96/23/EC 1996; FDA 2009a,b,c). Although in this study the residual levels of these antibiotics are below MRLs, two issues may arise from these data. Firstly, the fish samples were obtained randomly from the fish farms, although an attempt was undertaken to select the fish farm with a previous history of antibiotic therapy. Secondly, the fish samples used in this study had not been specified for their exact period of chemotherapy prior to the sample collection. Thus, in such circumstances there is a possibility for collecting the untreated fish samples and/or collecting the fish samples which were treated a long time ago e.g. above 2 months before being sampled resulting in undetectable residuals of these antibiotics in their muscle tissues. Also, by comparing the maximum detectable range of the residuals of these three antibiotics, one might show that the use
of ET was more common than OTC and EN in the examined trout farms. Because the maximum values for ET was 181 μg g⁻¹ muscle where as for OTC and EN was 0.8-0.9 μg g⁻¹ muscle. Perhaps, one of the most common reasons for using ET in these trout farms was its application as an antibiotic of choice for treatment of streptococcosis/lactococcosis that is the most common and serious bacterial diseases in the region. Moreover, the findings of this study revealed that the use of EN in trout farming is increasing as its residuals were detectable in approximately 29% of the examined fish farms. However, the amount of an antibiotic residual in the tissues of fish is influenced by several factors including type of antibiotic, duration time for storage of tissues/sample, temperature of storage period, type of tissue, fish species, route of drug administration and some environmental factors such as water quality parameters especially water temperature of the pond fish. Recently, these concerns have led to the standardization of measurement methods of residual drugs in the tissues of aquatic animals, which should be considered for scientific and official authorities (Canada-Canada & Munoz de laPena 2009). In this regard, some official authorities such as the Europe Union (EU), World Food Organization, (FAO) World Health Organization (WHO), American Drug Administration (FDA) (FDA. 2009a,b,c), Canada Food and Drug Inspection Administration (CFIA), and the Australian Bureau of veterinary drugs and pesticides (AD-VMA) were going to develop guidelines, including the Maximum Residual Limits (MRL), antibiotics used in aquaculture, especially in edible and breeding fish. The outstanding point here is that there are significant differences between countries and the afore-mentioned references far as the defined MRL for some antibioticosis concerned. For instance, FP fish consumption is only given by the EU (Commission Decision 2003/181/EC of 13 March 2003, Council Directive 96/23/EC of 29 April 1996). In some countries such as Chile, the amount of MRL FLQ in tissues of rainbow trout estimated 500 μg kg⁻¹ (Hernández-Serrano 2005). Also, the MRL values for tetracycline in fish in the countries of Europe Union (EU) such as Canada, Australia and America, were expressed 100, 200, 2000 μg kg⁻¹ of tissue respectively (Council of the European Communities, Council Regulation 2377/90/EC1990; European Commission, Council Directive 96/23/EC 1996; European Commission, Commission Decision 2003/181/EC 2003; FDA 2009a,b,c). These differences and prohibited use of some antibiotics and chemical agents in aquaculture have led to the equalization of the methods, especially in terms of sensitivity, quantification, maximum residual limits, and types of drugs. In conclusion, result of this study shows that some trout farmers in Iran are currently using different antibiotics including OTC, ET and EN in their own trout farms. The main reason for such antibiotic application is mainly due to the morbidity and mortality by both *Streptococcus iniae* and *Lactococcus garvieae*. Therefore, use of other protective measures such as vaccination is highly recommended.

**Acknowledgements**

This work financially supported by ministries of science, research and technology, and ministry of agriculture, Iran and research council of university of Tehran and center of excellence of aquatic animal health, university of Tehran.

**References**


باقی مانده آنتی بیوتنیک در برخی مزرعه قزل آلا سایز بازاری ایران

مهدی سلطانی، اсаمالیر علی برعلی، علی رسولی، شیخ شفیعی، شاپور کاکولی، علام رضایی

۱- گروه بهداشت و بیماری‌های آبیان، دانشکده دامپزشکی دانشگاه تهران
۲- گروه موفقیت دانشکده دامپزشکی دانشگاه تهران
۳- موسسه تحقیقات شیلات ایران

چکیده

به منظور ارزیابی بهداشتی ماهی قزل آلا سایز بازاری، باقی مانده سه آنتی بیوتنیک شامل آکسی تراساکلین، اترولوکسین و ارینروماتیک در عضلات ماهیان نازه سید شده از ۱۷ مزرعه پرورش ماهی در استان چهارمحال و بختیاری به صورت تصادفی از ماهیان ۱۷ مزرعه تهیه و تعداد ۳۸۷ نمونه عضله آنها مورد تست قرار گرفت. نتایج حاصله نشان داد که آکسی تراساکلین در ماهیان یک مزرعه (۸/۸) و به میزان ۵/۳۷-۷/۱۳ میکروگرم در غلظت قابل سنجش بود. همچنین اترولوکسین در ماهیان ۵ مزرعه (۷/۳۷-۹/۲۸) میکروگرم در غلظت قابل سنجش بود. در گذشته میکروگرم در غلظت قابل سنجش بود. در نتایج این داده‌ها نشان می‌دهد که باقی مانده استرولوکسین و آکسی تراساکلین بالاتر از حد مجاز بوده ولذا سنجد مرتب باقی مانده این داروها در مزارع ماهیان امروزی ضروری است. به علاوه با توجه به حداقل میزان سنجد این آنتی بیوتنیک‌ها در این مطالعه (۴/۵۰۰ میکروگرم در هر گرم نمونه) استفاده از این روش کرکوموتورگرافی ممکن است با روش مفیدی برای سنجد باقی مانده آنتی بیوتنیک‌ها در مزارع ماهیان باشد.

واژه‌های کلیدی: باقی مانده آنتی بیوتنیک، قزل آلا ارینروماتیک، آکسی تراساکلین، اترولوکسین

*مویسنده مسئول: 
msoltani@ut.ac.ir