ANTIMICROBIAL USAGE IN AQUACULTURE

Review of AMU in aquaculture based on 1996 and 2009 FAO surveys on the use of chemicals and veterinary drugs in aquaculture and other more recent literature

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Aquatic AMR Workshop 1: 10-11 April 2017, Mangalore, India
Published Surveys in Scientific Literature

  - conducted face to face interview with set of questionnaires
  - antibiotics that were found being used in prawn farms and available in the market were oxytetracycline, chloramphenicol, erythromycin, nitrofurans, oxolinic, and sulfa drugs

  - conducted face to face interview with set of questionnaires
  - at least 13 different kinds of antibiotics was documented. The most commonly used group was fluoroquinolones, followed by tetracyclines and sulfonamides.

• Conducted in Bangladesh, China, Thailand and Vietnam for Macrobrachium, penaeid shrimps, tilapia and Pangasius catfish farms
• Methodology: Structured interviews with farm owners, managers or technicians of 252 farms
• 60 different veterinary medicinal ingredients (26 are antibiotics)
• Highest usage of antibiotics was in the Pangasius farms, but the total quantities of antibiotics applied, relative to production, were comparable or lower than those reported for other animal production commodities. Is this a cause for concern?
• Culture intensity influenced chemical use pattern
  • “chemicals” did not give a break down on whether they were antibiotics, probiotics, disinfectants, etc.
Use of Chemicals in Aquaculture in Asia

Proceedings of the Meeting on the Use of Chemicals in Aquaculture in Asia

JR Arthur
CR Lavilla-Pitogo
RP Udabashe
Editors

Towards safe and effective use of chemicals in coastal aquaculture

GESAMP REPORTS AND STUDIES No. 65
AQUACHEM
Use of Chemicals in Aquaculture in Asia (FAO, SEAFDEC, CIDA)

- May 1996
- 16 countries, at least 15 experts
- 17 presentations
- Country papers were based on face to face surveys and/or questionnaires
Use of Chemicals in Aquaculture in Asia (FAO, SEAFDEC, CIDA)

Problems identified
- Residues in fish; food safety
- Fate and persistence in the environment
- Development of AMR
- Weak implementation of regulations on sales and usage
- Lack of alternatives to antibiotics

Recommendations
- Farmers, producers and suppliers
- Government and organizations
- Research sector

<table>
<thead>
<tr>
<th>Country</th>
<th>Species/Species</th>
<th>Chemistries</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lao PDR</td>
<td>Limited to lime and fertilizers in freshwater systems</td>
<td>None reported</td>
<td>Phillips, 2000</td>
</tr>
<tr>
<td>Malaysia and Singapore</td>
<td>Shrimp and marine fish</td>
<td>Sulfonamides, Tetracyclines, Nitrofurans, Chloramphenicol, oxolinic acid, Virginiamycin, Dimetridazole, Metronidazole</td>
<td>Shariff, Nagaraj, Chua &amp; Wang, 2000</td>
</tr>
<tr>
<td>Nepal</td>
<td>Carp (EHS)</td>
<td>None reported</td>
<td>Phillips, 2000</td>
</tr>
<tr>
<td>Pakistan</td>
<td>Carp</td>
<td>Unknown antimiicrobials?</td>
<td>Phillips, 2000</td>
</tr>
<tr>
<td>Philippines</td>
<td>Penaeus monodon</td>
<td>OTC, Rifampicin, Bactrin Forte, Chloramphenicol, Furanzolidone, Prefuran, Erythromycin</td>
<td>Lacierda, de la Pena &amp; Lumanlan-Mayo, 2000</td>
</tr>
<tr>
<td></td>
<td>hatcheries</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P. monodon</td>
<td>OTC, Chloramphenicol, oxolinic acid, Furanzolidone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ponds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Shrimp</td>
<td>OTC, Furazolidone, Furanzolidone, Erthromycin</td>
<td>Wickrathawatana &amp; Siriwardena, 2000</td>
</tr>
<tr>
<td></td>
<td>broodstock</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shrimp larvae</td>
<td>OTC, Chloramphenicol, Erythromycin, Furans</td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td>Not specified</td>
<td>12 antibiotics</td>
<td>Liao, Guo &amp; Su, 2000</td>
</tr>
<tr>
<td>Thailand</td>
<td>Freshwater and marine species</td>
<td>OTC, Erythromycin, oxolinic acid, nitrofurans, sulphonamethoxine</td>
<td>Tonguthai, 2000</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Carp</td>
<td>Unspecified antibiotics</td>
<td>Phillips, 2000</td>
</tr>
<tr>
<td></td>
<td>Shrimp</td>
<td>OTC and “other” antibiotics</td>
<td></td>
</tr>
</tbody>
</table>
GESAMP - Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

PREPARATION OF THIS STUDY

This study has been prepared on the basis of the work of the GESAMP Working Group on Environmental Impacts of Coastal Aquaculture.

The Working Group met in Iloilo, Philippines, 22 - 28 May 1996. Its report was reviewed by the 27th session of GESAMP, Nairobi, 14 - 18 April 1997, and subsequently approved for publication in its present form.

The Working Group session was attended by the following experts: David J. Aldermann, Uwe Barg (Technical Secretary), Mali Boonyaratpalin, Erlinda Cruz-Lacierda, Valerie Inglis, Celia Lavilla-Pitogo and Ewen MacLean, Jurgene Primavera, Donald P. Weston (chair). A study was contributed by P. Sinhaseni, Malinee Limpoka and Ornrat Samitawat.

The intersessional work of the Working Group was jointly sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP) and the World Health Organization (WHO). The Secretariat was provided by FAO.
Section 2.5 of report: Antibacterial Agents

- **β-lactams** - benzyl penicillin, amoxycillin; not effective against vibriosis and motile aeromonads. The β-lactams are important in human medicine.

- **Nitrofurans** - group of synthetic antibacterials including furazolidone and nifurpirinol; potentially carcinogenic. This has led to their prohibition for use on food animals.

- **Macrolides** - The only macrolide used in fish farming is erythromycin. It is active against Gram-positive bacteria, but used in shrimp hatcheries in Southeast Asia.

- **“Phenicols”** - very broad-spectrum antibiotics including chloramphenicol, thiamphenicol, and florphenicol; important in human medicine as the treatment of typhoid. The major environmental hazard of chloramphenicol is its potential to increase drug resistance. Derivatives have been developed for veterinary use.
Section 2.5 of report: Antibacterial Agents (continuation)

• **4-Quinolones** - synthetic antibacterial agents that include nalidixic acid, oxolinic acid and flumequine. The second generation of more potent fluorinated derivatives includes enrofloxacin and sarafloxacin.

• **Rifampicin** - Limited use of this antibacterial has been reported for treatment of luminous vibriosis in shrimp culture in parts of Southeast Asia (Primavera, 1993).

• **Sulphonamides** - may be used alone but commonly used when potentiated with trimethoprim or ormetoprim. Romet® 30 is an example and one of only two aquaculture antibacterials licensed in the USA. Other preparations are Tribrissen and Co-trimoxazole.

• **Tetracyclines** – oxytetracycline (OTC), chlortetracycline, doxycycline. OTC is probably the most widely used antibiotic in aquaculture; effective against a wide variety of Gram-negative and Gram-positive bacteria.
Section 3 of report: Issues of Concern

- Persistence
- Residues in non-cultured organisms and in seafood
- Toxicity to non-target species
- Stimulation of resistance
- Health of farm workers
- Prophylactic use of antibiotics
- Quality assurance of chemicals used in aquaculture
- Need for data on quantities used
- Need for environmental fate and effects information
- Need for alternatives
FAO 2009 - Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

- Bondad-Reantaso, Arthur & Subasinghe, editors. 2012
- Outcome of FAO/AAHRI workshop in Bangkok (2009)
- 15 papers
  - Survey on the use of veterinary medicines in aquaculture
  - Country status presentations
    - China
    - Philippines = same participants today 😊
    - Thailand
    - Vietnam
- Workshop Outcomes
Survey structure and process
A survey questionnaire was developed with seven sections, briefly described below

- **Section 1:** Respondent profile (academic background and professional activity of the respondent)
- **Section 2:** Types of antimicrobials used for therapeutic purposes (antimicrobials used for treating disease (therapeutic application) in different host species groups)
- **Section 3:** Types of antimicrobials used for prophylactic purposes (antimicrobials used for prevention of diseases (prophylactic application) and the stages when they are applied (broodstock, hatchery and grow out)).
- **Section 4:** Application (percentage at the different stages of culture (broodstock, hatchery and grow out) and dosage and duration of antimicrobial treatments for prophylactic and therapeutic use)
- **Section 5:** Use of chemotherapeutants (type, mode of application and for which diseases, source and availability), as well as other veterinary products (i.e. anesthetics, sex control aids, spawning aids, etc.) used in aquaculture
- **Section 6:** Impact (perceived positive and negative impacts) and efficacy (possible reasons for failure)
- **Section 7:** Recommendations for actions to improve effectiveness and responsible use in aquaculture
Alday-Sanz, Corsin, Irde & Bondad-Reantaso, 2012

• Sent questionnaires to global contacts by email
• Organized in-country workshops participated in by industry stakeholders (farmers, feed millers, drug suppliers, retailers, etc.)
• Visited stores, farms and feed mills

Above information feed into the Bangkok 1999 meetings and were discussed in the workshop
FINDINGS:

- More treatment than prevention was the management strategy
- Oxytetracycline was the most reported product for treatment and prevention
- Commonly perceived reason for treatment failure were WRONG DIAGNOSIS
- There are very few approved drugs for aquaculture
- A way to reduce use of veterinary medicines is through training of farmers and fish health advisors on:
  - Health management and biosecurity
  - Diagnostics
  - Proper use of veterinary drugs
FAO 2009 – Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

CHINA: Yuan and Chen, 2012

### Antimicrobial agents used in Chinese aquaculture

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Target pathogen or disease</th>
<th>Dosage and application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxytetracycline</td>
<td>Enteritis, bacterial disease</td>
<td>4 % in fish feed for 3–5 days or 2–10 mg/kg fish weight for 3–7 days</td>
</tr>
<tr>
<td>Norfloxacin</td>
<td>Bacterial disease</td>
<td>Prevention: 100 g/60–100 kg feed, 1 time per day for 3–5 days; Treatment: 100 g/50–60 kg feed, 2 times per day for 5–7 days</td>
</tr>
<tr>
<td>Enrofloxacin</td>
<td>Bacterial disease</td>
<td>Treatment: 200 g/80 kg feed</td>
</tr>
<tr>
<td>Florfenicol</td>
<td>Broad spectrum antibiotic, bacterial infection</td>
<td>10–15 mg/kg fish weight for 3–5 days, once per day; 0.5 ppm for 3 days</td>
</tr>
<tr>
<td>Compound bacteriophage with western medicine and Chinese medicine</td>
<td>Bacterial, fungal and viral infections</td>
<td>1–2.5 g/kg feed for 3–5 days</td>
</tr>
<tr>
<td>Compound Norfloxaci</td>
<td>Bacterial infection, Mycoplasma infection</td>
<td>20 g/kg feed for 3 days, once per day</td>
</tr>
<tr>
<td>Quinocetone</td>
<td>Gastrointestinal diseases</td>
<td>40–50 ppm</td>
</tr>
<tr>
<td>Compound sulfamethoxazole</td>
<td>Bacterial infection</td>
<td>2–3 mg/kg fish weight for 3–5 days</td>
</tr>
<tr>
<td>Compound sulfadimidine</td>
<td>Redfin disease, red skin disease, lepiorrhosis, enteritis, etc.</td>
<td>1.5 g/kg fish weight for 6 days, twice per day</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>White head-mouth disease, gill rot disease, etc.</td>
<td>0.5 g/100 kg fish weight for 6 days; 1 ppm for 5 days</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>Infectious diseases of fish</td>
<td>0.2 ppm for 5 days</td>
</tr>
<tr>
<td>Oxolinic acid</td>
<td>Redfin, red skin disease</td>
<td>10–20 mg/kg fish weight for 4–7 days</td>
</tr>
<tr>
<td>Ivermectin</td>
<td>Parasites</td>
<td>Treatment: 20–30 ml/mu fish pond</td>
</tr>
<tr>
<td>Abamectin</td>
<td>Parasites</td>
<td>Treatment: 20–30 ml/mu fish pond</td>
</tr>
</tbody>
</table>

PHILIPPINES: Somga, Somga & Regidor, 2012
FAO 2009 – Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

Viet Nam: Mai, 2012

• Report is based on surveys in 2003 – 2004
• Information is based on consultative workshops with stakeholders
• Info also gathered by desktop review

• Results showed 223 antibiotics
  • Mostly imported
  • 62% of imported veterinary drugs were from Thailand
OIE Aquatic Manual
Section 6: Antimicrobial use in aquatic animals (2010-2013)

SECTION 6. ANTIMICROBIAL USE IN AQUATIC ANIMALS

Chapter 6.1. Introduction to the recommendations for controlling antimicrobial resistance
Chapter 6.2. Principles for responsible and prudent use of antimicrobial agents in aquatic animals
Chapter 6.3. Monitoring of the quantities and usage patterns of antimicrobial agents used in aquatic animals
Chapter 6.4. Development and harmonisation of national antimicrobial resistance surveillance and monitoring programmes for aquatic animals
Chapter 6.5. Risk analysis for antimicrobial resistance arising from the use of antimicrobial agents in aquatic animals

SECTION 7. WELFARE OF FARMED FISH

Chapter 7.1. Introduction to recommendations for the welfare of farmed fish
Chapter 7.2. Welfare of farmed fish during transport
Chapter 7.3. Welfare aspects of stunning and killing of farmed fish for human consumption
Chapter 7.4. Killing of farmed fish for disease control purposes

SECTION 8. DISEASES OF AMPHIBIANS

Chapter 8.1. Infection with Batrachochytrium dendrobatidis
Chapter 8.2. Infection with ranavirus

SECTION 9. DISEASES OF CRUSTACEANS
Templates used in the survey are in http://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/Survey_on_monitoring_antimicrobial_agents_Dec2016.pdf
Figure 7. Data source as reported by 89 Member Countries, 2010-2015

- WHOLESALERS & RETAILERS: 56
- IMPORTS: 42
- MARKETING AUTHORISATION HOLDERS: 33
- VETERINARIANS: 17
- PHARMACISTS: 16
- FEED MANUFACTURERS: 12
- MANUFACTURERS: 9
- FARMERS & OTHERS: 7

Data sources
OIE Survey - No Differentiation of Data by Animal Groups

Differentiation of the data reported by animal groups in 89 Member Countries, 2010-2015

Figure 29. Animal groups covered by the data in 17 Asian Member Countries

- 53% No differentiation between animal groups
- 47% Differentiation by animal groups
NOTES:

- first year of analysis

- a preliminary finding shows that national monitoring systems on the use of antimicrobial agents in aquatic food-producing animals are implemented only after national monitoring systems on the use of antimicrobial agents in terrestrial food-producing animals have been implemented to the highest level of specificity, by route of administration.
OIE Survey - Antimicrobial Classes Reported by 89 Member Countries

Figure 31. Proportion of reported antimicrobials classes by 17 Member Countries in Asia, 2010-2015

Figure 14. Proportion of reported antimicrobial classes by 89 Member Countries, 2010-2015
OIE Survey - CONCLUSIONS

- The information represents a remarkable first step in better understanding the global use of antimicrobial agents in animals.
- The data reported will become more precise with each passing year with more countries readying to put in place surveillance systems on the use of antimicrobial agents in animals.
- There is a need to provide additional support to Member Countries to improve their national monitoring systems.
- Detailed interpretation of the data also needs further development.
- The OIE database should allow countries to provide their information through an electronic portal.
Coursera Learning Resource: https://www.coursera.org/learn/antimicrobial-resistance

Thank you very much!