of resultant model was 3644 and the same was used to predict the future values of import of fresh and chill stored fish. Quadratic trend model with auto regressive moving average model (ARMA-1,1) was fitted to the time series data (Montgomery *et al.*, 2008) on frozen fish with less root mean square error value of 1398. This fitted model was then used to predict the future values of import of frozen fish. The 95% lower and upper confidence limit for forecasted values of fish import to India is given in Table 1.

Based on the predicted values, the quantity of fresh and chill stored fish import to India will continue to produce a non-decreasing trend for fresh and chill stored fish, whereas, the quantity of frozen fish import to India will continue to produce exponential trend.

References

Department of Animal Husbandry, Dairying & Fisheries (2017) - Annual Report. Ministry of Agriculture & Farmers Welfare, Government of India. http://dahd.nic.in/ sites/default/ files/Annual%20Report%202016-17.pdf

https://comtrade.un.org/

Joshy, C.G., Balakrishna, N. and Ravishankar, C.N. (2017) – Non-parametric regression estimation of growth rate of India's fish production and export. *Fish. Techol.* (54): 128-136.

Montgomery, D.C., Jennings, C.L. and Kulahci, M. (2008) - Introduction to time series analysis and forecasting. John Wiley & Sons, Inc. New Jersey.

# Antibiotic resistance pattern in heterotrophic bacteria isolated from finfish cultured farms

Ahamed Basha K., Narsia K., Sivaraman G.K. and Prasad M.M.

ICAR-Central Institute of Fisheries Technology, Cochin

World fisheries production recorded 167.2 million tonnes in 2014 with total capture production was estimated to be 93.4 million tonnes and aquaculture production of 73.8 million tonnes (FAO. 2016). Diseases are proven to be one of the major constraints reported in the cultured fishes impeding both economic and social development in many developing countries. Initially, antibiotics are being administered in aquaculture as growth-promoting agents as well as therapeutic agents against bacterial infections. Indiscriminate use of antibiotics in aquaculture have been criticized widely for their negative impacts like accumulation of drugs in the fish as residues, development of antibiotic resistance in bacteria present in aquatic environment etc. (Anderson, 1992). Therefore, the present study was carried out to determine the extent of antibiotic resistance in heterotrophic bacteria isolated from four finfish farms fed with commercial feed. Water and sediment collected from ponds were serially diluted, spread on to Trypticase soy agar (TSA) and incubated at 30 °C for 24-48 h. A total of 56 species of bacteria were purified and characterized as described in 'Laboratory manual on microbiological examination of seafood' (Surendran *et al.*, 2013). Bacterial genera identified were *Micrococcus* spp. (21.42%), *Bacillus* spp. (17.85%), *Acinetobacter* spp. (12.5%), *Pseudomonas* spp. (12.5%), *Planococcus* spp. (10.71%), Enterobacteriacae (8.92%), *Arthrobacter* spp. (7.142%), *Vibrio* spp. (5.35%) and *Staphylococcus* spp. (3.57%). The antibiotic selection was made based on Gram reaction. A total 14 antibiotics were employed in this study (Table 1). Antibiotic resistance profile of these

Table 1. Antibiotics used against for gram positive and negative bacteria

| Sl. No. | Groups | Antibiotics |
|---|---|---|
| 1. | Pencillin group (Beta lactam) | Penicillin G, Ampicillin |
| 2. | Cephalosporins | Cefotaxime, Cefoxitin, Cefpodoxime |
| 3. | Aminoglycoside | Gentamicin, Kanamycin |
| 4. | Macrolides | Erythromycin |
| 5. | Tetracyclines | Tetracycline |
| 6. | Fluroquinolones | Nalidixic acid, Ciprofloxacin |
| 7. | Phenolics | Chloramphenicol |
| 8. | Nitrofurans | Nitrofurantoin |
| 9. | Folate pathway inhibitors | Sulfamethoxazole-trimethoprim (Co-trimoxazole) |

isolates were tested simultaneously using the standard agar disc diffusion method (CLSI, 2012) using Mueller-Hinton agar. All these isolates were grown overnight in Tryptic soya broth at 30 °C and adjusted to 0.5 McFarland Standard. Antibiotic resistance profile of these bacterial isolates is shown in Figure 1. The plates were incubated at 30 °C for 18-24 h. The diameters of inhibition zones were measured in millimetre, and interpreted in accordance to CLSI recommendations The bacterial isolates showed highest resistance towards ampicillin (82.1%,), followed by penicillin (55.3%) and nalidixic acid (23.21%). All the isolates were sensitive to gentamicin (100 %) followed by sulphamethaxazole-trimethoprim (98.3%) and ciprofloxacin (98.22%). Multidrug resistance (MDR) of bacterial isolates was

observed is 14.2%. The present study gave showed strong testimony supporting the prevalence of antibiotic resistance in aquafarms. The abuse of antibiotics is well known and strict enforcement should be regulated and government agencies and other leading organizations should conduct awareness programmes for aquaculturists on the antimicrobial stewardship and innovation therein. Stringent regulations are essential for the usage of antibiotics and continuous monitoring of antibiotic resistance should be mandatory for sustainable aquaculture production.

References

Anderson, D.P. (1992) - Immuno-stimulants, adjuvants and vaccine carrier in fish; application to aquaculture. *Annl. Rev. Fish Dis.* (2): 281-307.

Clinical and Laboratory Standards Institute (CLSI) (2012) - M110-S25. Performance Standards for Antimicrobial Susceptibility Testing; Twenty-Fifth Information Supplement.

FAO (2016) - The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all, Rome.

Surendran, P.K. (2013) - Laboratory techniques for microbiological examination of seafood, Fourth edition, ICAR-CIFT, Cochin
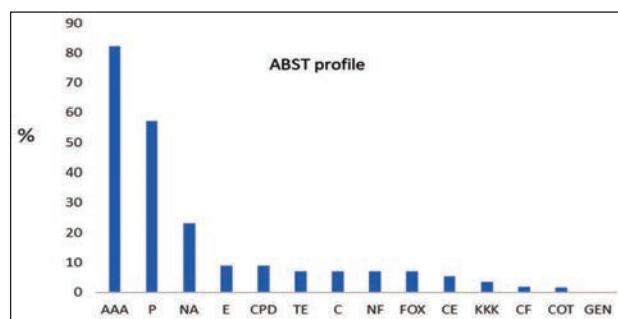


Fig. 1. Antibiotic resistance pattern of heterotrophic bacteria