Tilapia quality and safety in global markets

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Overview

- Global perspective
- Problems with off-flavor
- Sex reverse hormones
- Antibiotics
- Carbon monoxide
- Quality control in processing
- HACCP, ISO and NGO certifications
- New products
Tilapia aquaculture

- Second most important farmed fish after the carps
- Most widely grown of any farmed fish
- Asian countries are major producers and consumers
World Tilapia Production of 2,381,237 mt in 2006
World Tilapia Production of 2,381,237 mt in 2006

- China
- Egypt
- Philippines
- Mexico
- Thailand
- Taiwan
- Brasil
- Indonesia
- Colombia
- Cuba
- Ecuador
- Vietnam
- Others

metric tons per year
Tilapia the “Green” farmed fish

- Herbivore / omnivore, low trophic level feeder
- Algae, bacteria, and detritus (bioflocs) are important food sources
- Prepared feeds are mostly grains and ag by-products
- Promoted by aid agencies and NGO’s

Dr. M. Gupta awarded World Food Prize for promotion of tilapia aquaculture, June 10, 2005

- Disease resistant and tolerant of poor water quality. Antibiotics and chemicals are not needed for commercial farming.
Global production of tilapia

Year

Metric tons

Aquaculture
Fishery
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US Tilapia consumption (imports and domestic)

229,000 mt of live weight (equivalent) - 2004
306,410 mt of live weight (equivalent) – 2005
368,295 mt of live weight (equivalent) – 2006
US Consumption of tilapia from domestic and imported sources

Tilapia (000's of kg of live weight)

- Domestic
- Imports
23,101 mt fresh fillets, 74,381 mt frozen fillets, 60,772 mt whole frozen (2006)
Value of Tilapia product forms imported to the U.S.

- Fillet Fresh
- Fillet Frozen
- Whole Frozen

- $297,413,000 (2004)
- $392,978,298 (2005)
- $482,742,515 (2006)
Europe is following US trend of adopting tilapia as replacement for traditional fishes.
Tilapia (June 2007, Tesco, UK)

$18 US per kg whole fish!!!!
Off-flavor

- Off-flavor due to geosmin and MIB
- Many farms in Asia and Latin America utilize green water production systems
- Frequently have cyanobacterial blooms
- Testing for off-flavor before harvest, on arrival to processor, during processing
Depuration systems

- Reduce feeding for several days in production unit and increase water flow
- Dedicated depuration system (tanks or raceways). Clean water for two or three days sufficient for majority removal of off-flavor compounds
Hormones for sex reversal

- Methyltestosterone used for sex-reversal during first 21 days of feeding
- Dosage of 60mg/kg of feed
- Non-detectable level 90 days after cessation of sex-reverse diet, harvest still 4-6 months later
- US-FDA INAD, approved for use during application process
- In developing countries concern for female workers handling the hormone while making feed
The YY male technology

- Combines hormonal feminization of male fry, XY females are crossed to normal (XY) males producing $\frac{1}{4}$ XX and $\frac{1}{2}$ XY and $\frac{1}{4}$ YY
- Use progeny testing to determine YY males
- YY males sire only male (XY) progeny from crosses with normal (XX) females
- All male progeny (actually $\geq 95\%$ male) are known as genetically male tilapia (GMT®)
The YY male technology

 THEN

 NOW

 Normal crosses produce equal proportion of males and females

 YY males produce only male progeny (GMT®)
Use of antibiotics and resistance

- Streptococcus is primary bacterial pathogen in tilapia culture. Mostly in intensive, especially recirculating, production systems
- Vibrio bacteria have also been reported from marine and brackish water cultures
- Medicated feeds have been used commercially
- Some antibiotic resistance reported in Brazil
Reducing antibiotic use

Several vaccines have been developed for Strep

Farmers in many countries have been warned against using antibiotics in tilapia aquaculture

Reduced densities and improved water quality invariably ameliorate the problem
Imports are mostly fresh and frozen fillets

- Processing and hand trimming of fillets

- Buyers are requesting fresh or fresh appearance even in frozen product
Many fillets are treated with carbon monoxide (CO, also called liquid smoke)

- CO infuses into fillet and reacts with myoglobin
- Fillet maintains fresh appearance for longer period
- Little health risk, beyond disguising spoilage

- First method was to fill bags with CO and fillets for 10 minutes before freezing
Carbon monoxide - CO

- Especially common at Chinese processors
- Initially CO infusion in bags, then moved to cabinets, now retort vessels
Carbon monoxide (CO)

- Rapidly improving the technique, and providing safety to workers
- Must be labeled as an additive in US and EU
Parasites

- Tilapia sometimes get heavy infestations of external parasites, which can affect growth rates. Very rare to get any internal parasites or serve as host for any human parasites.
- Reports of fish contaminated with malachite green or methylene blue used to treat external parasites.
Pollutants and Contamination

- In Peru and India, tilapia have been reared in effluent from sewage treatment plants.
- Tilapia can survive in very poor quality (polluted) water. (Sewage and industrial)
- No reports of contamination, but should be checked.
Demands on farmers and processors

- Demands for more food safety, high quality, “organic” or “green” tilapia products.
  - No off-flavor
  - Reduce or eliminate use of methyltestosterone hormone.
  - No antibiotics, malachite green or other chemicals
  - Reduce or eliminate use of CO

- Improved processing quality
- More value-added tilapia products
- More demand for all forms, especially frozen meals
- Rapidly increasing demand from Europe
ISO 9100 and ISO 22000

- ISO 9100 provides for certification of Hazard Analysis at Critical Control Points
- Covers product safety, plant and food hygiene, economic integrity, and product quality.
- ISO 22000, food safety management system, applies to all kinds of food processors linked to CODEX Alimentarius
HACCP

- Hazard Analysis at Critical Control Points
- Planning procedure for documenting good production and processing practices
- Participants operate under approved plan with audits at random frequency
- Focus is on documentation of proper activities at important stages rather than stationing a permanent inspector at farm or processing plant.
- Greater focus on critical processing steps.
- More cost effective
HACCP

Examples:

- Document feed source and use, farm water quality, testing for off-flavor
- Document source, arrival time, temperature and condition of fish as they arrive at process plant
- Provide footbaths, hand washes and protective clothing for processing workers, document usage by having employees sign daily log
- Measure and record bacterial numbers on fillets during quality control
NGO certifications

- NaturLand
- World Wildlife Fund
- Aquaculture Certification Council

Each reviewing sustainability of aquaculture practices and providing a certification and marketing logo.
Improved quality control:
Required for US, EU, and Japan markets

- Samples checked for bacterial and chemical contamination
- Follow HACCP procedures and EU guidelines
- Many plants are using ozone dips to reduce surface bacteria
Why did tilapia avoid the import alert placed on Chinese farmed seafoods???

- Hardy fish that rarely need antibiotics or chemicals
- Proactive training of farmers and processors
- Importers demanding “clean” product
- Consumers expecting “green” fish
Improvements in packaging
IQF Fillets in re-sealable packages
Ingredients: 100% Pure pasteurized orange juice and MEG-3®* (fish oil and fish gelatin). Contains tilapia, sardine and anchovy.

*Ingredient not found in regular orange juice.
Conclusions

- Concerns for off-flavor
- Some customers will not accept hormone treated. Could be a safety issue for hatchery workers
- Minimal use of antibiotics, and vaccines should further reduce that
- Carbon monoxide is the most controversial quality issue
Conclusions

- ISO and HACCP and NGO certifications
- More demands for food safety, quality assurance, improved packaging, and environmental safeguards (with little if any increase in price)
- Farmers and processors will need to meet these demands by increasing efficiency, not price
Eighth International Symposium on Tilapia in Aquaculture
12-14 October, 2008
Cairo International Conference Center
Global Tilapia Market Trends

Prices have been constant, only fresh fillets have increased slightly, will not see increases with inflation.
Current Global Market Trends

- Increase in demand for all forms of tilapia
- Demand increase will be greatest for frozen fillets
- Demand increase will be significant for fresh fillets
- High profit margin for prepared meals assembled and packaged in developing countries
Global Aquaculture Tilapia Sales

- For year 2000 = US $1,744,045,000
  (FAO FishStat 2007)

- 2005 sales = $2,457,312,000
  (FAO FishStat 2007)

- 2010 sales > $5,000,000,000
Tilapia Leather
Flowers made from Tilapia scales
Pathways in the use of tilapia as biomanipulator in shrimp farms

- Promotion of *Chlorella* dominance
- Feeding on organic waste
- Bioturbation of sediment
- Production of natural antimicrobials

**Improved sediment quality**
**Improved water quality**
**Suppression of growth of* V. harveyi***
Future global tilapia aquaculture
World Tilapia Production of 2,381,237 mt in 2006