Studies on the cultured yellowtail 
(*Seriola quinqueradiata*) 
burnt meat and its 
characteristics 

*Katsuyasu Tachibana*

*Faculty of Fisheries, Nagasaki University, Nagasaki, Japan*
Ecology and market features of yellowtail

- *Seriola quinqueradiata*
- Pelagic species
- Inhabits rocky shores
- Temperature: 7 - 29°C
- Late April-early May migrates to Kyushu for spawning
- High consumption in winter
- Important sashimi market

*1: Mushiake (2003)*
Aquaculture of yellowtail

- Started by 1960, capture based type aquaculture
- Since 1970 exceeds natural catches
- Expansion after 1980 (artificial diet)
- Progress on maturation and spawning

* Ministry of Agriculture, Forestry and Fisheries, Fishery and Aquaculture Production Statistics Year Book, 2003
Aquaculture systems for yellowtail

* Ministry of Agriculture, Forestry and Fisheries, Fishery and Aquaculture Production Statistics Year Book, 2003
Reports on fish burnt meat

• Turbit meat of tuna, possible causes, Nakamura et al., 1977.
• Denaturation of myofibrillar proteins as a cause of burnt meat in red meat fish (mackerel, yellowfin tuna, skipjack, sardine) and white meat fish (flounder, Alaska pollack) Konagaya & Konagaya, 1978.
• Raw tuna (big eye, yellowfin) rapid deterioration in Hawaii, Cramer et al., 1981.
• Jellied meat and yake niku, Konagaya, 1982.
• Ultrastructural study of postmortem changes in tuna, Davie & Sparksman, 1986.
• Etiology of burnt tuna, Watson et al., 1988.

↑Temperature + low muscle pH by stress → burnt meat
Fish samples

Cultured yellowtail: Body weight $928.0 \pm 210.7$ g
Fork length $38.1 \pm 3.7$ cm

Culture temperatures: 30°C (acclimated for 1 week)
13°C

Slaughter methods: Spinal cord destruction (SCD)
Suffocation in air (20 min) (SA)

Experimental groups: SCD 30°C (n= 4)
SA 30°C (n= 3)
SCD 13°C (n= 4)
SA 13°C (n= 4)
Method of spinal cord destruction for yellowtail
Storage and analysis

• Storage temperature: 32°C (water bath)
• Sampling time: 0h, 1h, 2h, 4h, 6h

Analysis

• Muscle color: L*, a*, b*
• Physical changes: expressible water, breaking strength
• Chemical changes: ATP related compounds, lactic acid, pH, Mf Ca^{+2} and Mg^{+2}-ATPase activities
• Microscopy: cross sections of ordinary muscle (H&E staining)
Ordinary muscle of normal and burnt meat of cultured yellowtail

<table>
<thead>
<tr>
<th>Normal meat</th>
<th>Burnt meat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expressible water 2 h: 13 %</td>
<td>Expressible water 2 h: 38 %</td>
</tr>
</tbody>
</table>
L* changes in cultured yellowtail ordinary muscle during storage at 32°C
Changes in $a^*$ and $b^*$ during storage at 32°C

![Graph showing changes in $a^*$ and $b^*$ over storage time at 30°C and 13°C.](image)
Changes in breaking strength during storage at 32°C
Changes in ATP content during storage at 32°C

![Graph showing the changes in ATP content over storage time at different temperatures. The graph includes lines for SCD and SA samples at 30°C and 13°C.]
Changes in lactic acid content and pH during storage at 32°C
Relationship between lactic acid content and pH

$y = -0.0160x + 7.09$

$r = -0.831$ (p < 0.001, n = 74)
Changes in myofibrillar Ca$^{+2}$ and Mg$^{+2}$ - ATPase activities during storage

Ca$^{+2}$-ATPase

Burnt model
Normal

Mg$^{+2}$-ATPase

Storage time (h)

Activity (µmol/min/mg)
Intercellular space of normal and burnt meat of yellowtail ordinary muscle

Normal

Burnt

100μm 100μm
Conclusions

• 30°C group, at 32°C storage:
  SA • • • burnt meat at 1 h
  SCD • • • burnt meat at 2 h

• 13°C group, at 32°C storage:
  SA • • • burnt meat after 4 h
  SCD • • • burnt meat was not observed

• The principal characteristics of burnt meat in cultured yellowtail observed at the early postmortem period were:
  ↑ L*, b*, expressible water, lactic acid contents, and the intercellular space
  ↓ ATP, pH, breaking strength and Mf (Ca^{2+} and Mg^{2+}) - ATPases activities

• Low temperatures and a non exhausting slaughter method could prevent the burnt meat problem in cultured yellowtail
General Conclusions

- The yellowtail burnt meat model system was developed as a research tool and it can be used to get deeper information on this problem.

- For yellowtail, an effective spinal cord destruction as slaughter method followed by an immediate specific selected storage is recommended.

- Fish handling is determinant for meat quality, more importantly in species for which the final market is raw consumption as sashimi.
Thank you!