Harvesting, handling practices and processing of bluefin tuna captured in the trap fishery: possible effects on the flesh quality

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OVERVIEW: HISTORY OF TUNA COMMERCE

The international commerce of BFT dates back to the 5th century B.C.

Phoenicians established a number of colonies along the Mediterranean coast in the vicinity of saltpans

OVERVIEW: HISTORY OF TUNA COMMERCE

The eating of tuna has been closely connected with the advancement of conservation methods:

- *Garum* (from the Greek word *garos*) derived from flesh, blood and viscera
- Salt, for processing tuna and prepare Dry tuna
- Olive oil, for Tuna in oil conservation
- Freezing

OVERVIEW: market considerations

- The tuna commerce was improved considerably with the development of rapid transportation, packaging and chilling i to the demands of foreign market

OVERVIEW: market considerations

THE HIGHEST DEMAND FOR TUNA IS FOR RAW CONSUMPTION IN THE FORM OF SUSHI AND SASHIMI

INSPECTION OF QUALITY OF PRODUCT IS EXTREMELY IMPORTANT

HIGHER QUALITY PRODUCTS ATTRACT HIGHER PRICES AND THESE MEANS HIGHER RETURNS TO MANAGERS, AND PAYMENTS FOR THE CREW

THE CONCEPT OF QUALITY FISH OR FRESH FISH

What buyers Look for ?

EMPYRICAL FACTORS
translucence, transparency, tissue texture, smell, fat content

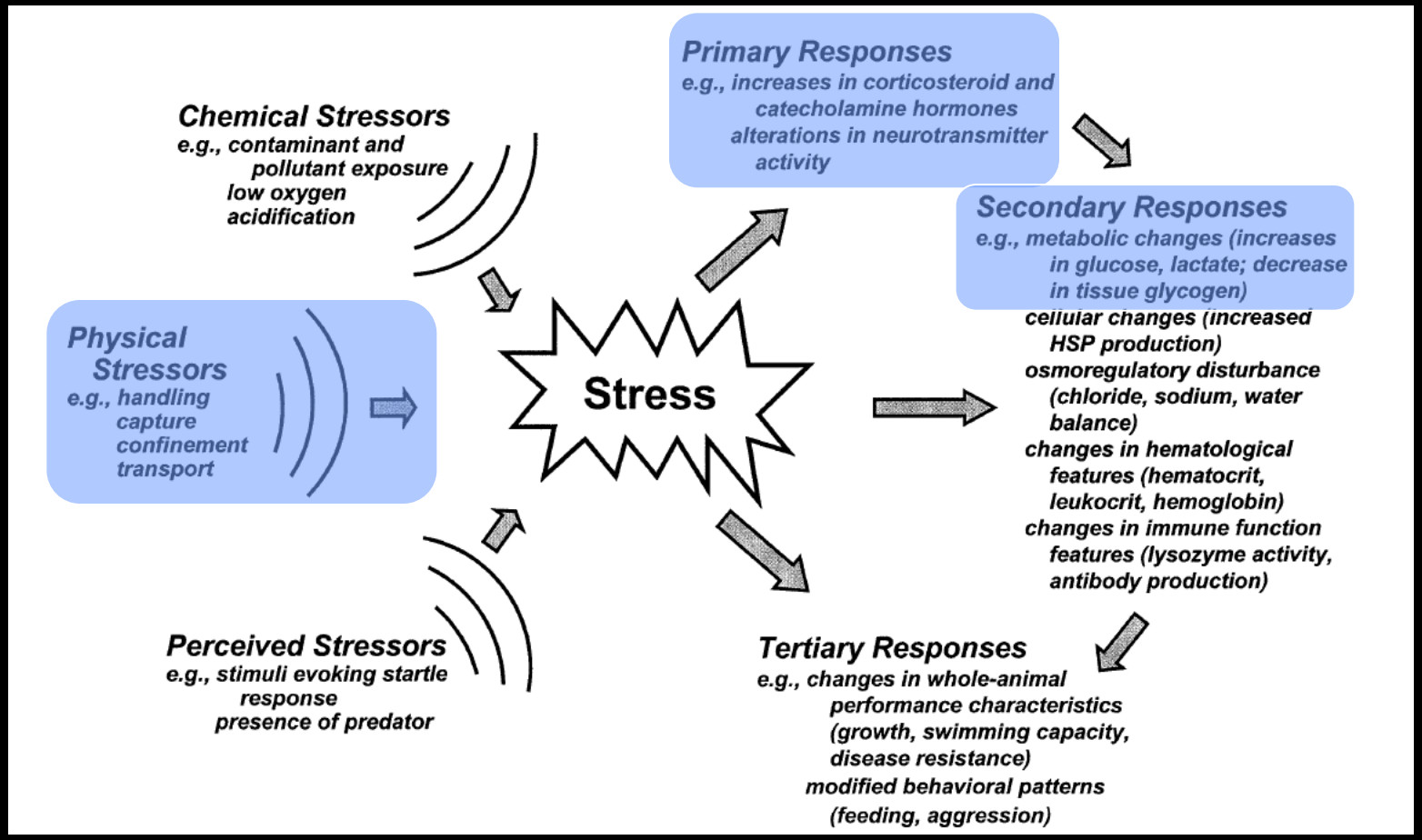
THE CONCEPT OF QUALITY FISH OR FRESH FISH

Determinants of Fish Quality

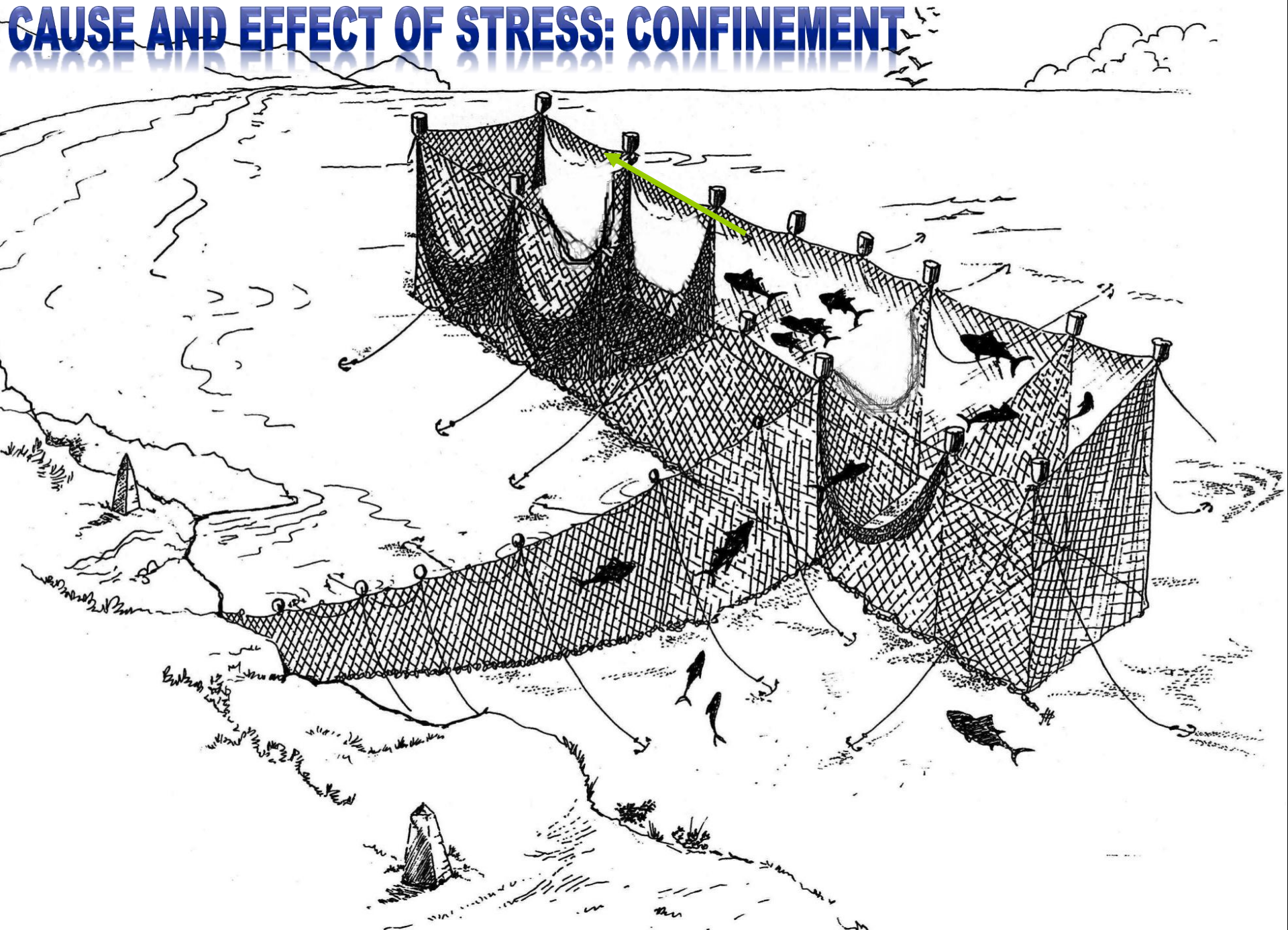
BIOLOGICAL FACTORS (not controlled by human)
- age, size, sexual maturity, parasites or disease , feeding

NON-BIOLOGICAL FACTORS (within the CREW control)
Fishing method, handling, chilling and storage techniques

CAUSE AND EFFECT OF STRESS IN FISH



CAUSE AND EFFECT OF STRESS: CONFINEMENT



CAUSE AND EFFECT OF STRESS: MATTANZA

CAUSE AND EFFECT OF STRESS:

GAFFING

CAUSE AND EFFECT OF STRESS

STORAGE & TRANSPORT

CAUSE AND EFFECT OF STRESS:

BLEEDING & EVISCERATION

CAUSE AND EFFECT OF STRESS:

CHILLING

Objectives

- Investigate the primary (neuroendocrine) and secondary (plasma changes) physiological response of bluefin tuna under stress –free and stress state

- Identify relationships between stressors and color variability of muscle

- Study the color variability of muscle tissue under the effects of air exposure over time

- Study the color variability of muscle tissue over time during defrosting

Results can be useful for:

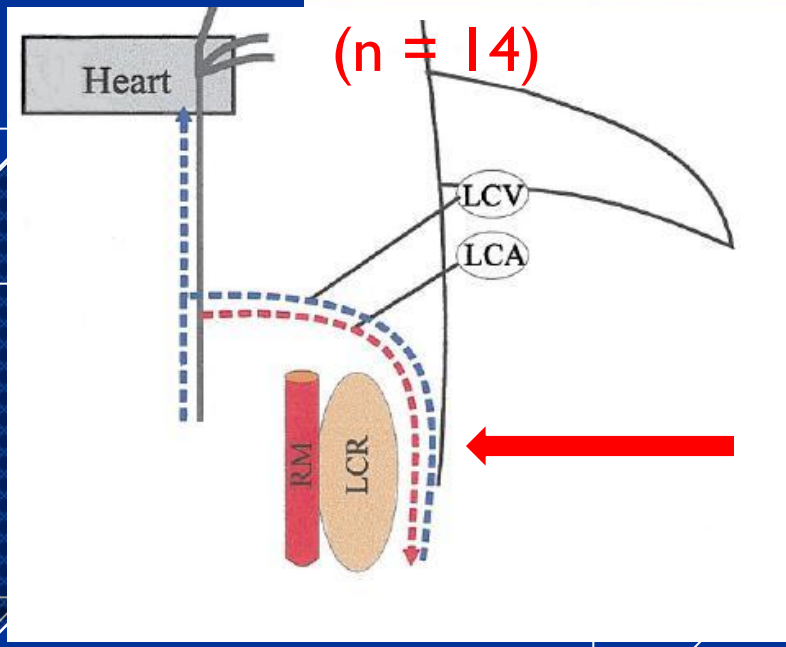
Trap Managers, Fishermen, Wholesaler ...

FIRST ISSUE

How is the physiological response of bluefin tuna

- before the fishing phase (no-stress condition) and
- after the fishing (stress condition) ?

EXPERIMENTAL DESIGN: blood sampling

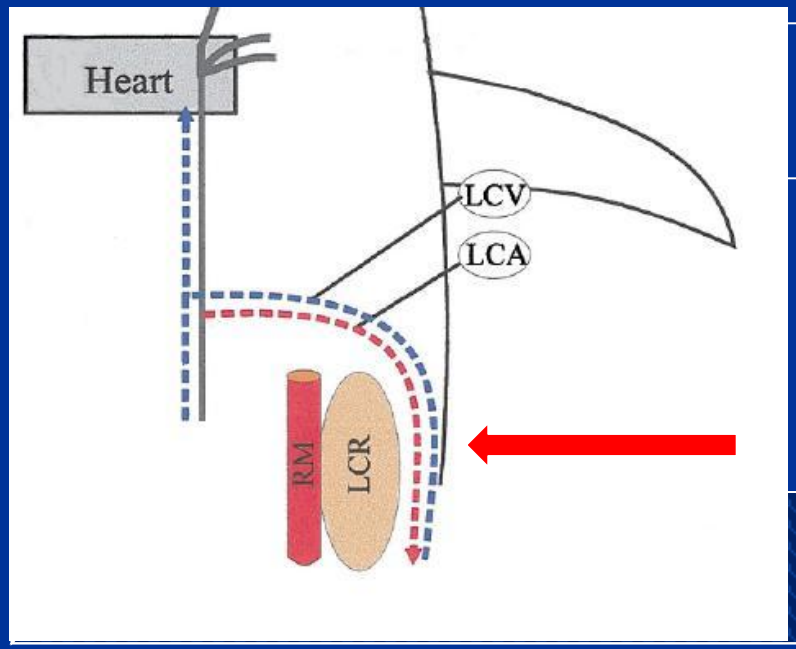


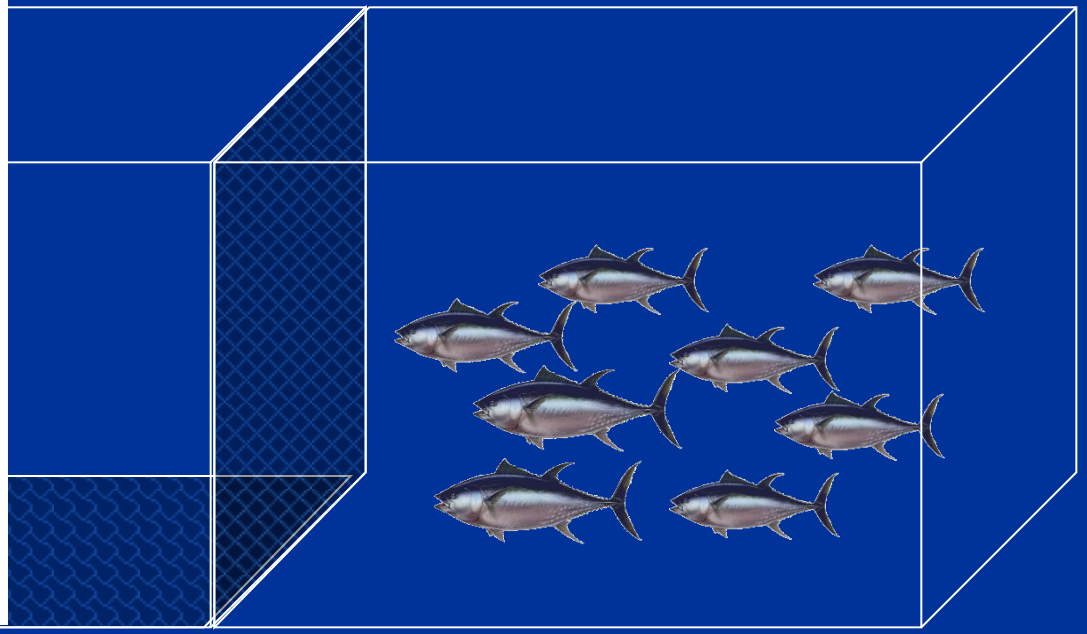
Death chamber

The west chamber

EXPERIMENTAL DESIGN: blood sampling

Stress state (the Lift or Mattanza; n = 14)





Death chamber

The west chamber

ANALYSIS OF BLOOD SAMPLES

- Cortisol (ng/ml) was determined using a diagnostic ELISA immunoenzymatic kit (DRG® Cortisol ELISA).
- Lactate (µmol/ml) was determined using a diagnostic kit (BM-Lactate, Roche Diagnostics)
- Glucose (mg/dL) by the chemistry analyzer MINDRAY-BS 120 (Mindray Medical International Ltd).

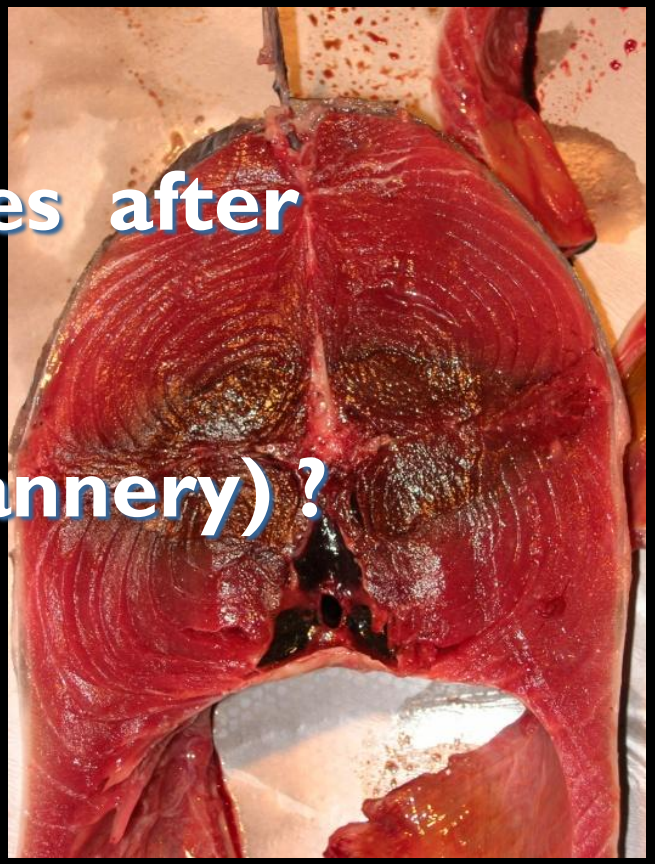
ANALYSIS OF DATA

- Data were analyzed using descriptive statistics plotting box and whiskers plots (mean ± S.D.)

- Student's *t*-test ($\alpha = 0.05$) considering the experimental condition "No-stress Vs. Stress" conditions.

SECOND ISSUE

- Does colour of muscle changes Before Vs. After fishing ?
- Does colour of muscle changes after landing ?
- … and after defrosting (for cannery) ?



AFTER THE MATTANZA ...

1. Transfer

2. Landing

3. Inspection

4. Evisceration

5. Chilling

6. Freezing-Defrosting (for cannery)

EXPERIMENTAL DESIGN: muscle sampling

FRESH SAMPLES (n = 48)

Time 1 (90')

Time 2 (180')

Time 3 (240')

EXPERIMENTAL DESIGN: muscle sampling

DEFROSTED SAMPLES (n = 16)

Time 1 (90')

Time 2 (180')

Time 3 (240')

ANALYSIS OF MUSCLE: methods

Tuna – Box (self-made using FOREX®)
Two fluorescent lights of 12W with a 5.000K color temperature
High resolution Digital Camera (12M pixel)

Alternative: Konica-Minolta Handle spectrophotometer K400

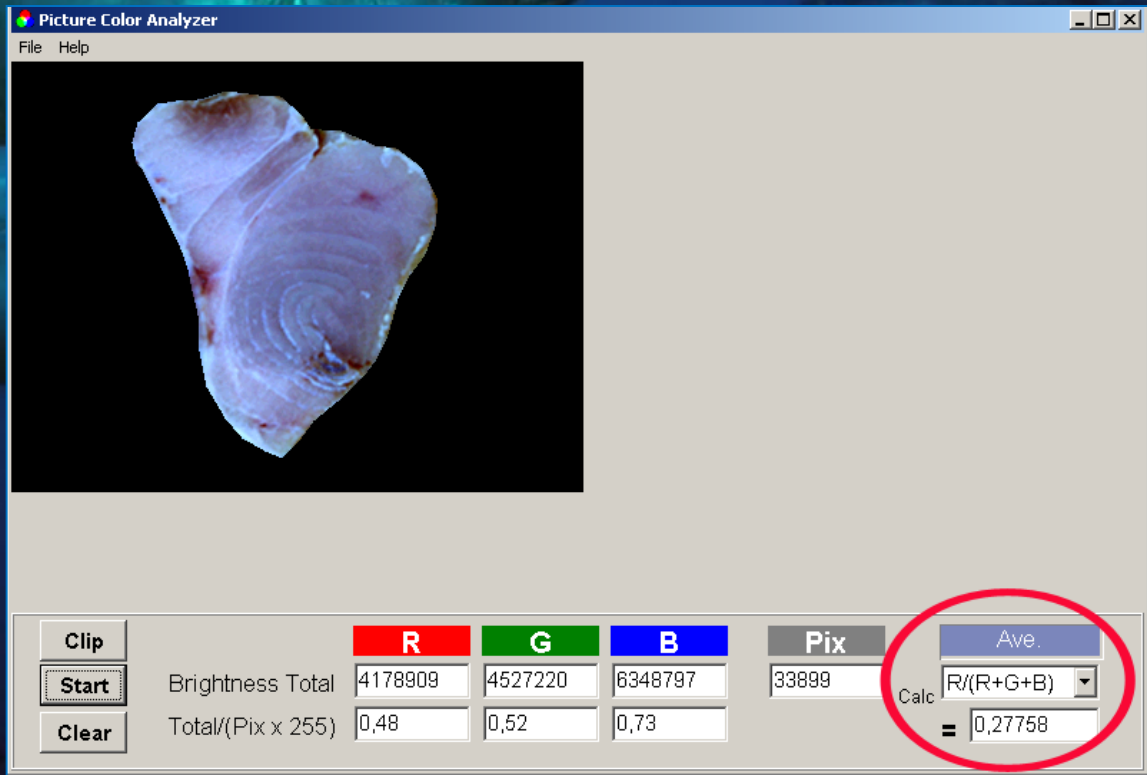
ANALYSIS OF MUSCLE: methods

High resolution pictures (~500K JPEG format)

Pictures were standardized (white balance)

ANALYSIS OF MUSCLE: methods

-Tracing of ROI (region of interest) of slices by Picture Color Analyzer (Otaka, 2002)
-Calculation the number of pixels for three monochromatic channels, RGB
-Percentage value of the surface was calculated using: total area/(pixel*255) considering a scale from 0 = white and 255 = black.
-Percentages of R, G, B on the overall pixels is:
Rp=R/(R+G+B); Gp=G/(R+G+B), Bp=B/(R+G+B),



Color Space: RGB
(**R**ed, **G**reen, **B**lue)

ANALYSIS OF DATA: methods

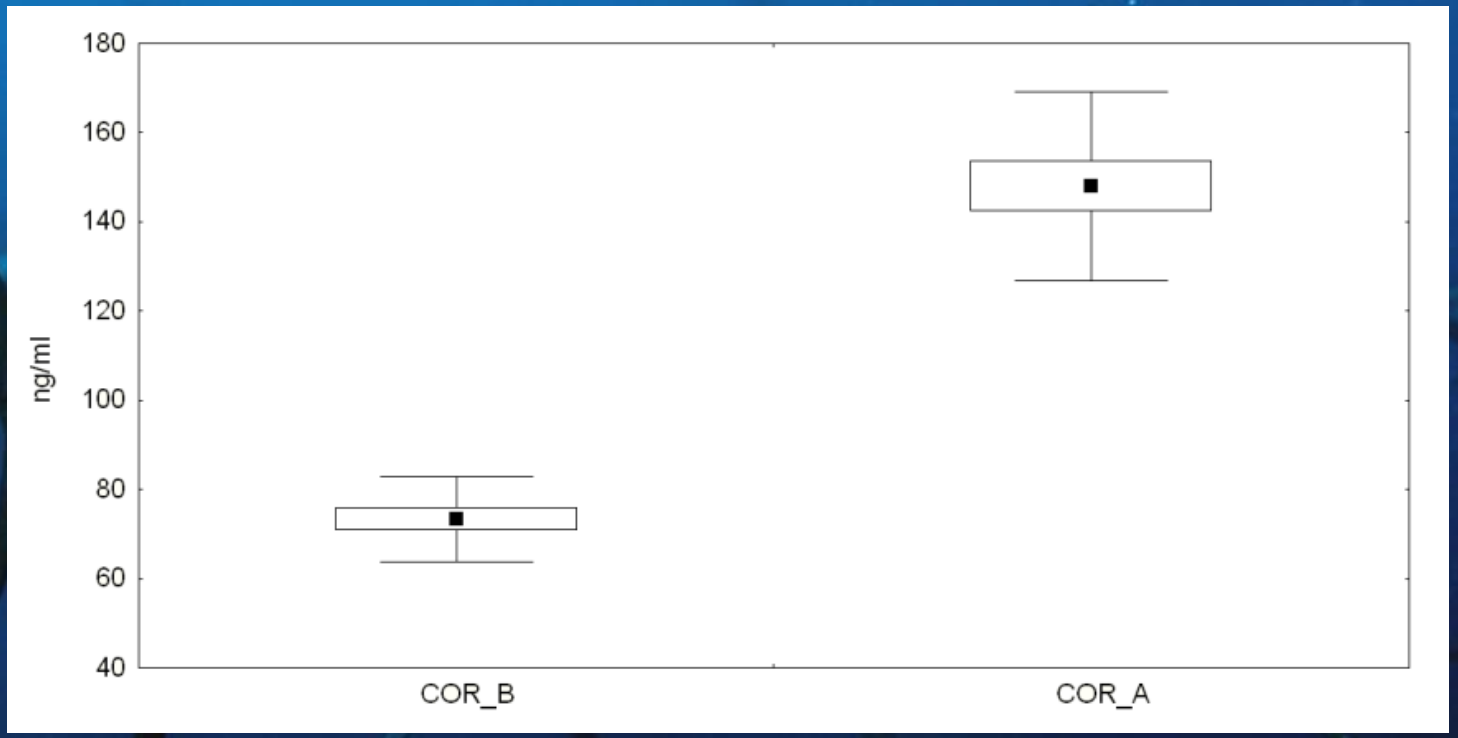
ANOVA was performed to test the hypothesis that the variability of percentage of channels Rp, Gp, Bp differed over the three time intervals (90' – 180' – 240') for *Fresh* and *Frozen* experiments.

Two-way ANOVA ($\alpha = 0.05$) was applied to test for differences *Fresh* Vs. *Frozen* experiments

Data were processed using Brodgar v2.6.6 (Highland Statistic Ltd. UK).


RESULTS

FIRST ISSUE: blood stressors accumulation



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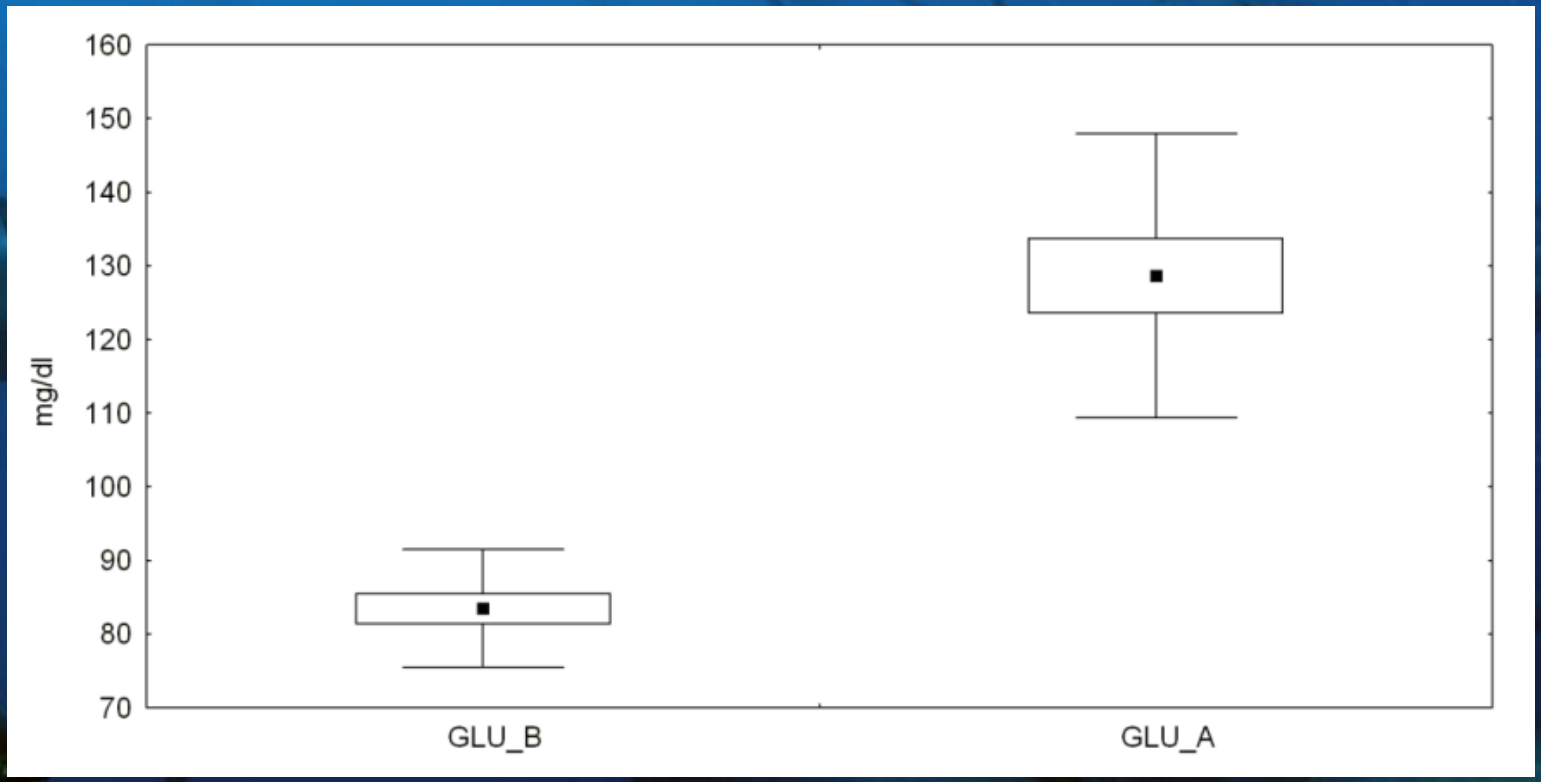

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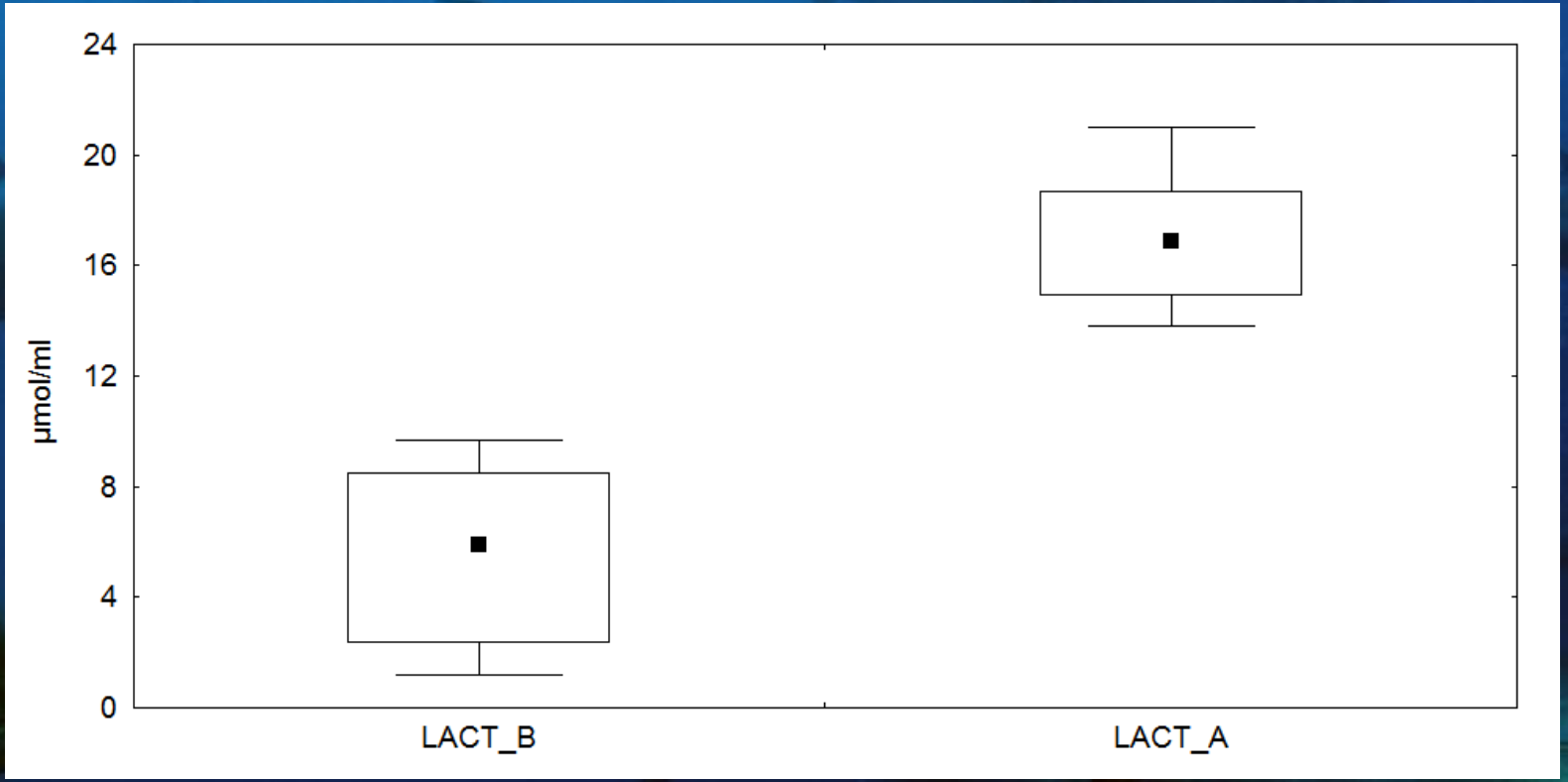


FIRST ISSUE: blood stressors accumulation

	Before				After			
	mean	sd	min	max	mean	sd	min	max
Cortisol (ng/ml)	73.3	9.5	60.0	85	148.0	21.2	106.0	196.6
Lactate (µmol/ml)	5.7	2.9	1.2	9.7	17.0	2.2	13.8	21
Glucose (mg/dL)	83.5	8.0	78.0	97.9	128.6	19.3	102.0	168

Student's t-test showed significant differences for all pairwise comparisons

Cortisol: Before Vs. After;

Glucose: Before Vs. After;

Lactate: Before Vs.After

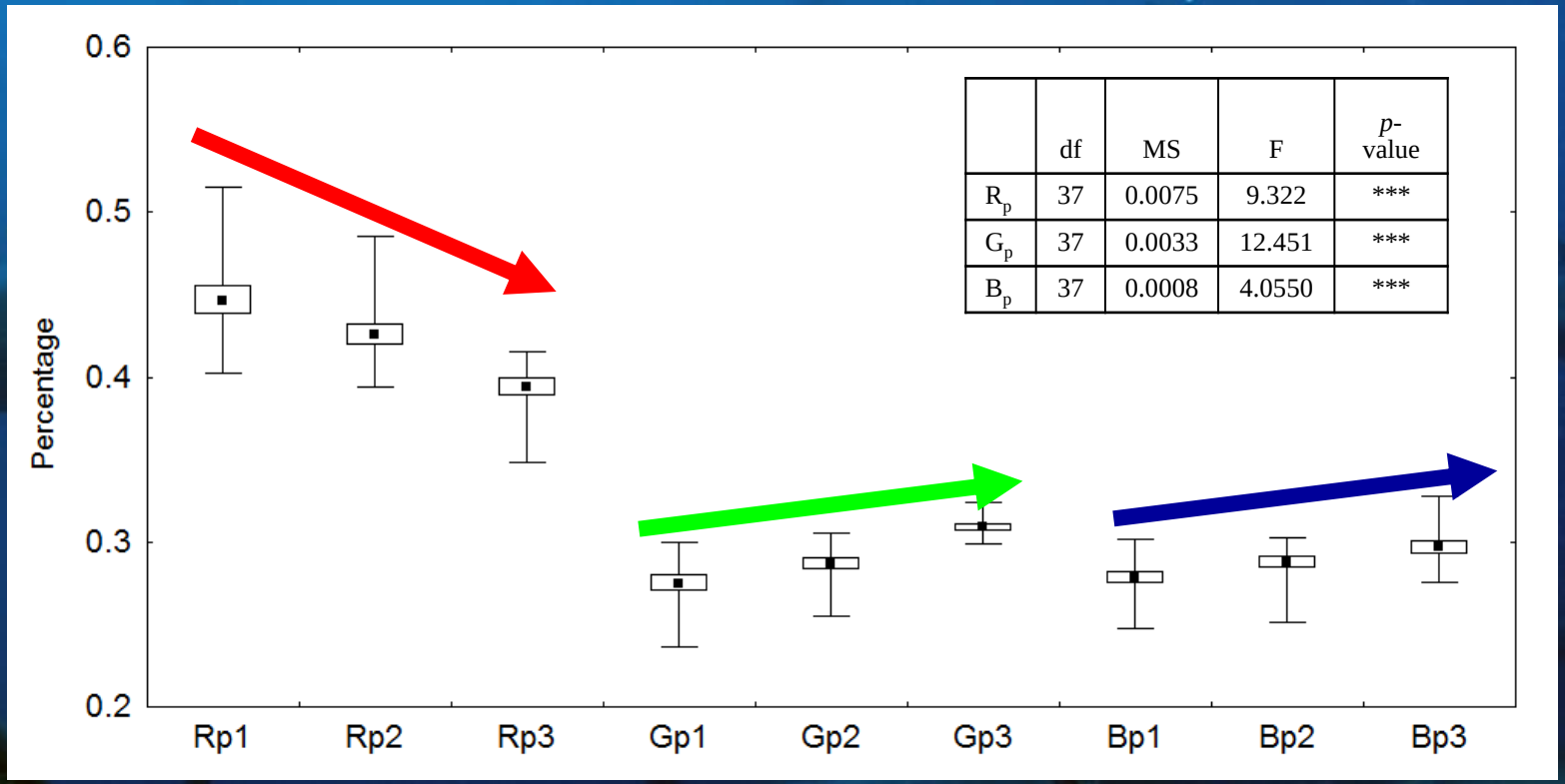

SECOND ISSUE
Colour changes in muscle

SECOND ISSUE: colour changes in muscle

There is no-significant difference of flesh color Before/After stress state of Mattanza

SECOND ISSUE: colour changes in muscle

FRESH TUNA



	df	MS	F	*p*-value
R_p	37	0.0075	9.322	***
G_p	37	0.0033	12.451	***
B_p	37	0.0008	4.0550	***

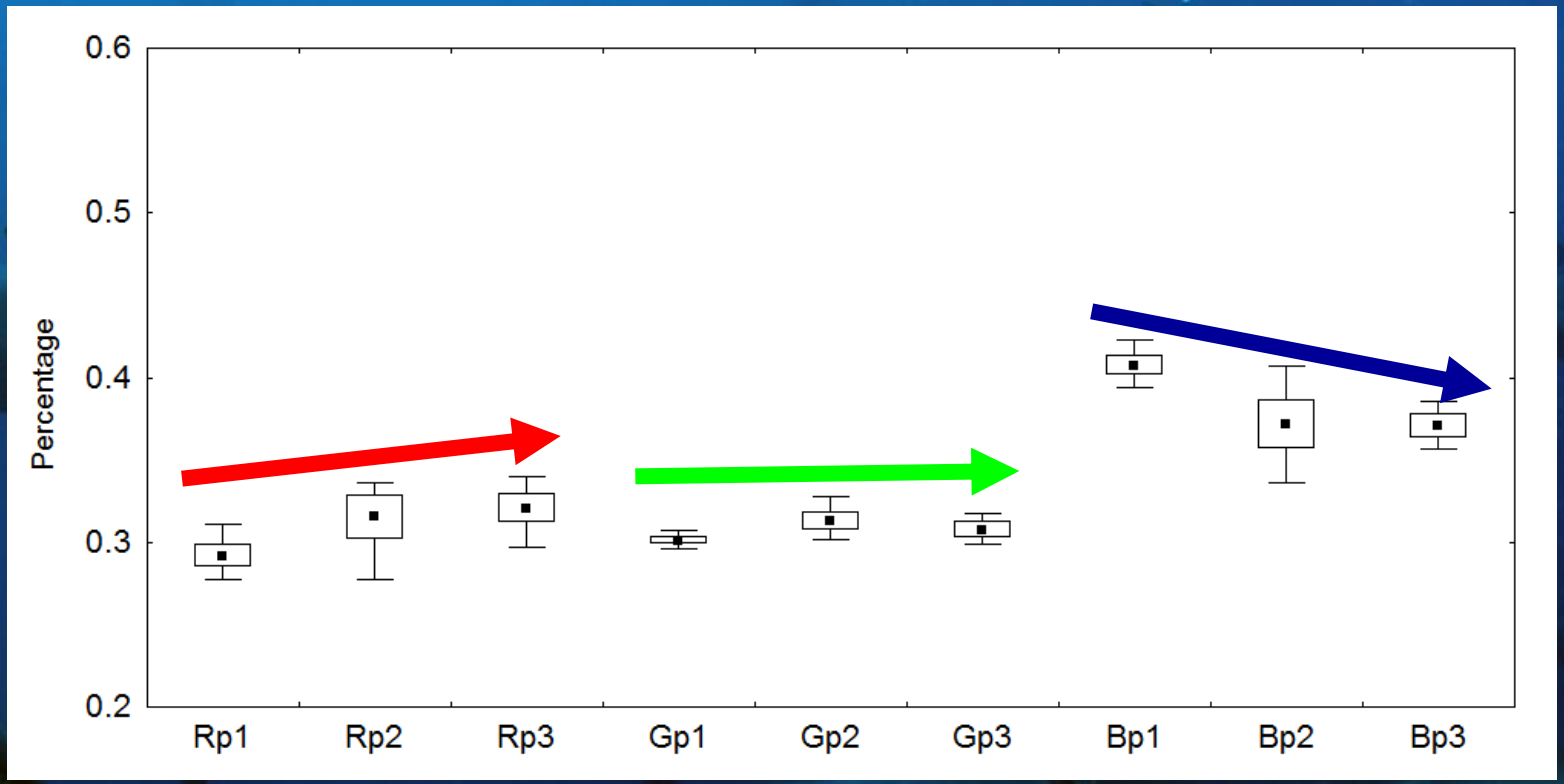
Drop of chanel RED

Enhance of chanel GREEN and BLUE

ANOVA ($P < 0.05$)

SECOND ISSUE: blood stressors accumulation

DEFROSTED TUNA



Enhance of RED, steady GREEN, decrease BLUE

ANOVA no-significant (P > 0.05)

Equivalent Colour Scale (ECS)

FRESH TUNA

T 1	T 2	T 3
CARDINALE MOLTO PALLIDO	ROSSO MOLTO PALLIDO	GRIGIO
R = 1 1 4 G = 7 1 B = 7 1	R = 1 1 2 G = 7 6 B = 7 6	R = 9 9 G = 7 9 B = 7 6

Equivalent Colour Scale (ECS)

FRESH TUNA

(keep at environmental temperature)

T 1	T 2	T 3	T 4
GRIGIO	GRIGIO	GRIGIO	GRIGIO
R = 7 9 G = 7 9 B = 1 0 4	R = 8 1 G = 8 4 B = 9 6	R = 8 1 G = 8 4 B = 9 9	R = 7 6 G = 8 9 B = 9 6

T 5	T 6	T 7
GRIGIO	GRIGIO	GRIGIO
R = 7 9 G = 8 6 B = 9 6	R = 7 6 G = 8 6 B = 9 9	R = 7 3 G = 8 6 B = 9 9

Equivalent Colour Scale (ECS)

DEFROSTED TUNA

(keep at environmental temperature)

T 1	T 2	T 3	T 4
INDACO MOLTO PALLIDO	GRIGIO	GRIGIO	GRIGIO
R = 7 3 G = 7 9 B = 1 0 2	R = 8 4 G = 7 9 B = 9 6	R = 8 6 G = 7 9 B = 6 9	R = 9 4 G = 7 9 B = 8 6

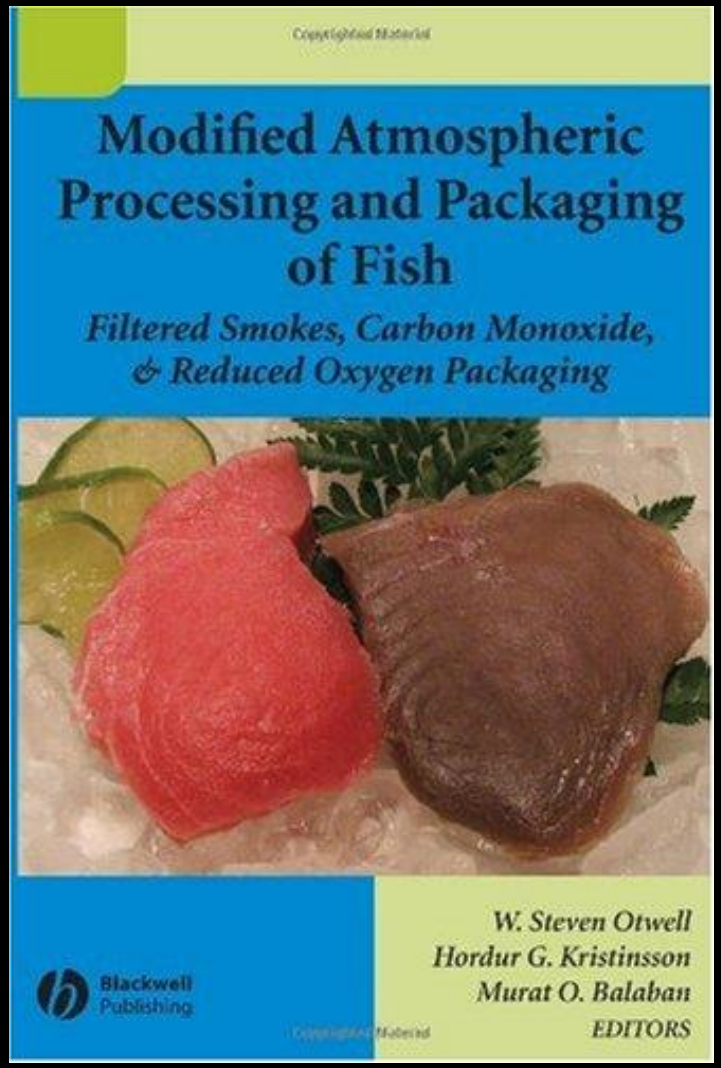
T 5	T 6	T 7
GRIGIO	ROSSO MOLTO PALLIDO	GRANATA MOLTO PALLIDO
R = 9 6 G = 7 9 B = 8 4	R = 1 0 7 G = 8 1 B = 7 3	R = 1 0 7 G = 8 6 B = 6 6

Equivalent Colour Scale (ECS)

- This Labeling is “no-subjective”
- Could be useful in the qualitative inspection of tuna
- It is useful to verify freshness (Time)
- To avoid food scams (which generate diverse values of RGB)

Malpractices: red-color

GASSING FLASH WITH CARBON MONOXIDE



CONCLUSION

Bluefin tuna is a high quality species and much prized

CONCLUSION

Good Fishing Practices = Higher Quality

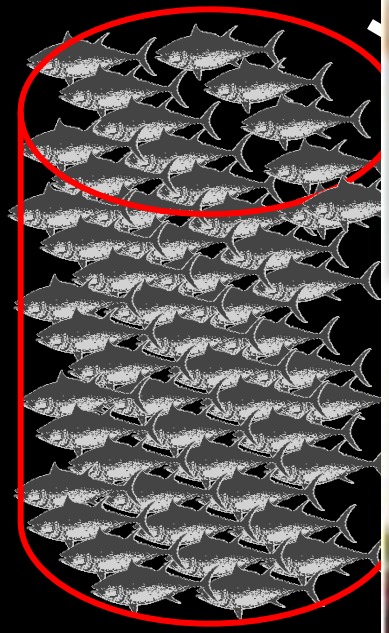
1) reduction of the level of hyperactivity of tunas before the mattanza;

2) bleeding the specimens instantly and chilling them rapidly on-board

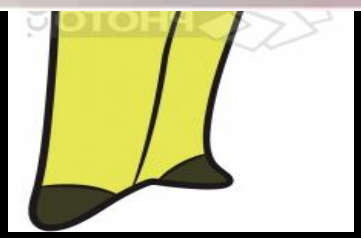
3) reducing transfer time from the trap site to the factory

4) adopting relative quality rank-colouring for labelling specimens is a useful tool for fresh market.

Management: QUOTA



QUALITY



EXPEDIENT STRATGIES

HIGHER QUALITY PRODUCTS ATTRACT HIGHER PRICES AND THESE MEANS HIGHER RETURNS TO MANAGERS, AND PAYMENTS FOR THE CREW

THIS IS AN EXPEDIENT STRATEGY IN THIS "NICHE" TUNA FISHERY TO MITIGATE THE EFFECTS OF QUOTA REDUCTION

Acknowledgements

- Consociazione Tonnare Sarde & Ligure Sarda Spa. (Isola Piana and Portoscuso Traps, Italy)
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