



# Greater amberjack Workshop

## Grow out

### Feeding and Husbandry



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**IEO**

**Athens, Greece, 18 September 2018**

# Two important parameters

## Feeding strategy

## Stocking Density

- Both parameters have important impact on production costs
- Their effects could depend on fish size



WP21

Grow out Husbandry Greater amberjack

**Task 21.2.2** Definition of feeding pattern for 5 g and 200 g juveniles

**Task 21.3.2** Definition of stocking density for 5 g and 150 g juveniles

**Growth, condition and welfare of fish**

- Specific growth rate and fish condition (K)
- Feed intake
- Hematological and biochemical parameters
- Immunological and oxidative stress studies
- Morphological

# Feeding strategy

**Objective:** The optimization of feeding methods for greater amberjack grow out

## Facilities and rearing conditions:

### 5 g Fish (FCPCT)

- Tanks of 500 l during 120 days
- Fish number and weight (mean±SD): 600 fish (12.01±1.5 g)
- Flow-through system.
- Natural Photoperiod and Temperature: 9 h of light 22.1±1.4°C.
- Oxygen level: 7.5±0.6 mg l<sup>-1</sup>.
- Feeding strategies:

Feeding rate (% B.W./day)	Feeding frequency (meals d <sup>-1</sup> )	Treatment
App. satiation	3	T1-S3
App. satiation	1	T2-S1
3.5	3	T3-3.5/3
3.5	4	T4-3.5/4
3.5	1	T5-3.5/1
2.5	3	T6-2.5-3
2.5	4	T7-2.5-4
2.5	1	T8-2.5/1

### 200 g Fish (IEO)

- Tanks of 1 and 4 m<sup>3</sup> during 120 days
- Fish number and weight (mean±SD): 180 fish (262.1±55.5 g)
- Renewal rate: 30 and 70 l min<sup>-1</sup> for 1 and 4 m<sup>3</sup> tanks (180 and 100 % h<sup>-1</sup>, respectively) .
- Natural Photoperiod and Temperature: 18.8±0.4°C (↓ from 19.4°C to 18.1°C)
- Oxygen level: > 90%.

- Feeding strategies: 1 (08:00 h), 2 (08:00, 18:30h), 3 (08:00, 13:30, 18:30h) and 7 (08:00, 10:00, 12:00, 13:30, 15:00, 17:00, 18:30 h) meals day<sup>-1</sup>.



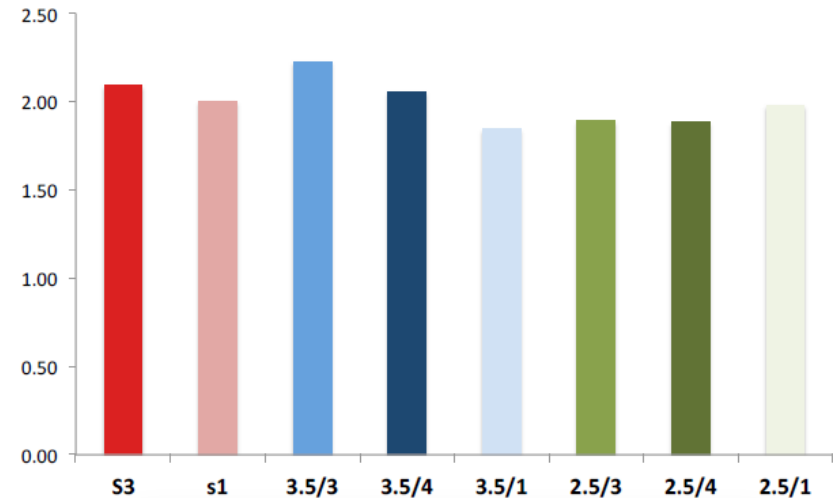
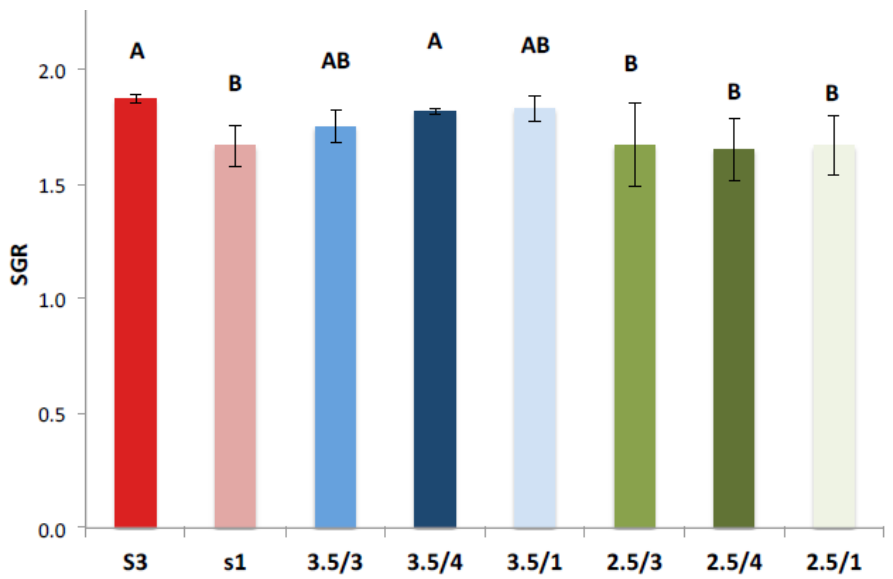
## Task 21.2.2 Feeding pattern for 5 g juveniles

### ■ Specific growth rate (SGR)

- 3 meals d<sup>-1</sup> apparent satiety and 4 meals d<sup>-1</sup> at 3.5% higher SGR
- 1 meal d<sup>-1</sup> apparent satiety and any frequency at 2.5% lower SGR

### ■ Condition factor

- Condition index (K) was not affected by dietary treatment and only occurred a less weight gain

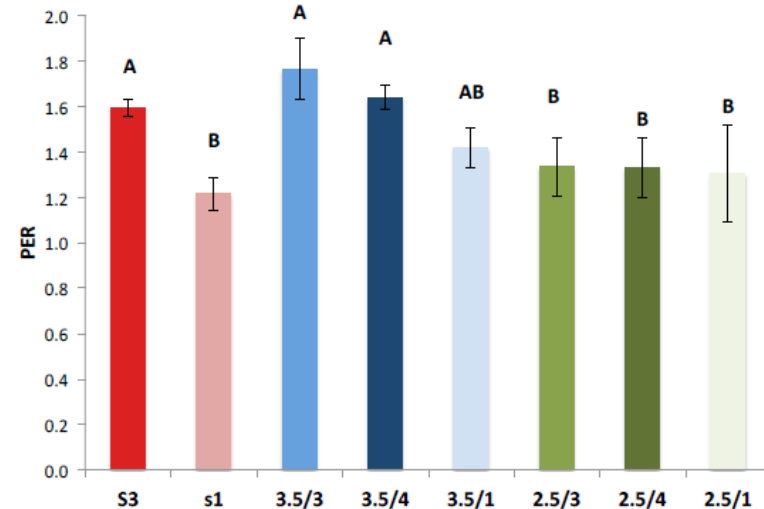
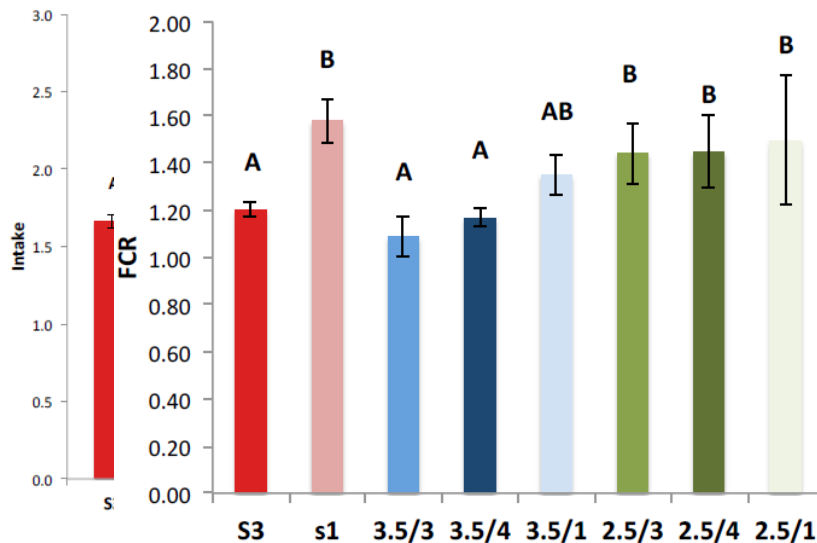




## Task 21.2.2 Feeding pattern for 5 g juveniles

### ■ Feed intake and FCR

- 1 meals d<sup>-1</sup> at apparent satiety higher feed intake and worst FCR
- 3 meals d<sup>-1</sup> at apparent satiety and 3 or 4 meals d<sup>-1</sup> at higher ration (3.5%) better FCR

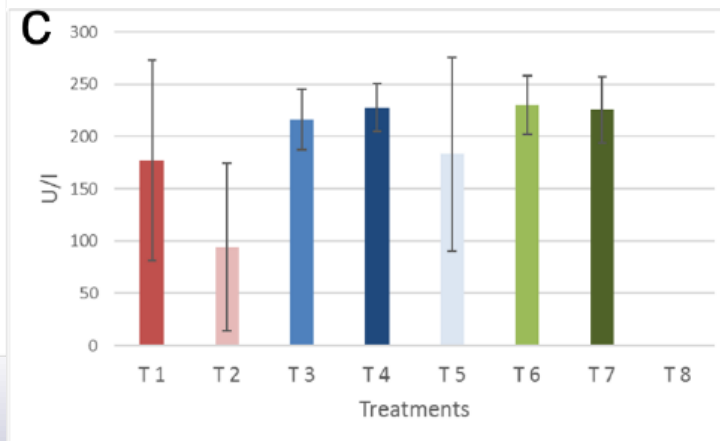
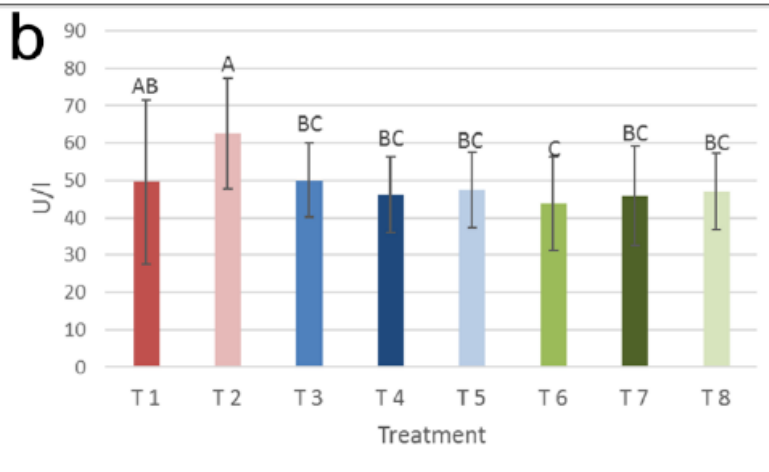
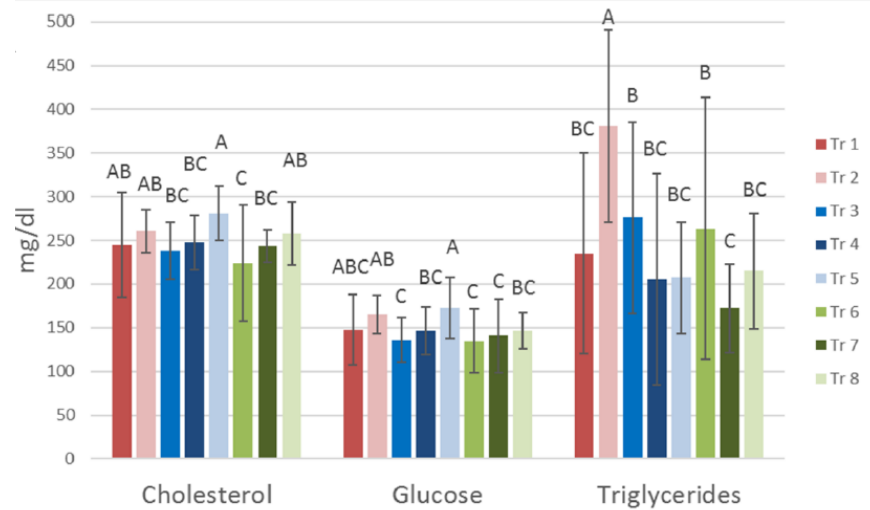


- The protein efficient ratio (PER) was positively affected by the higher ration (3.5%) and frequencies (3 and 4 meals d<sup>-1</sup>).

## Task 21.2.2 Feeding pattern for 5 g juveniles

### ■ Blood biochemical parameters

- Fish fed 1 meal d<sup>-1</sup> at 3.5% higher cholesterol and glucose levels.
- Fish fed 4 meals d<sup>-1</sup> at 2.5% presented the lowest triglycerides level.



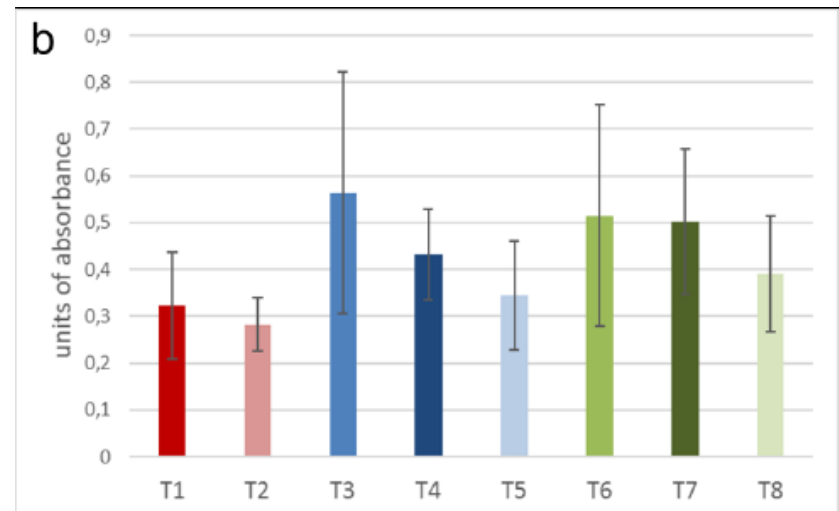
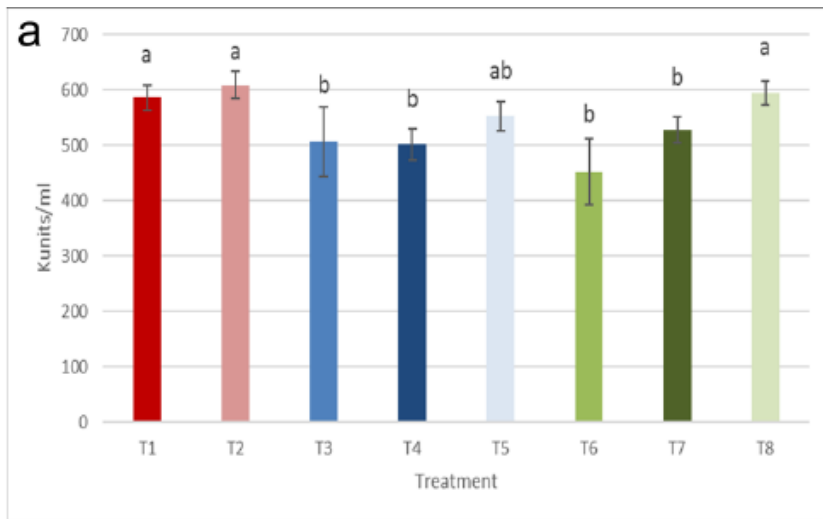
### ■ Enzymatic activity

- Fish fed at apparent satiety 1 or 3 meals d<sup>-1</sup> presented the higher alkaline phosphatase activity (ALP). No differences among dietary treatments were found for lipase activity.

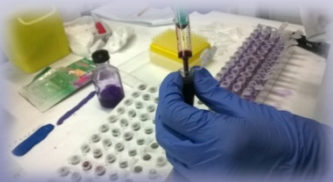
## Task 21.2.2 Feeding pattern for 5 g juveniles

### ■ Immunological parameters

- 1 and 3 meals  $d^{-1}$  at apparent satiety and 1 meal  $d^{-1}$  at 2.5% and 3.5% higher lysozyme activity.
- No differences among dietary treatments were found for peroxidase activity.



Any feeding ration supplied at 1 time per day caused a greater lysozyme activity. The apparent satiety, at any feeding frequency, increased the lysozyme activity.



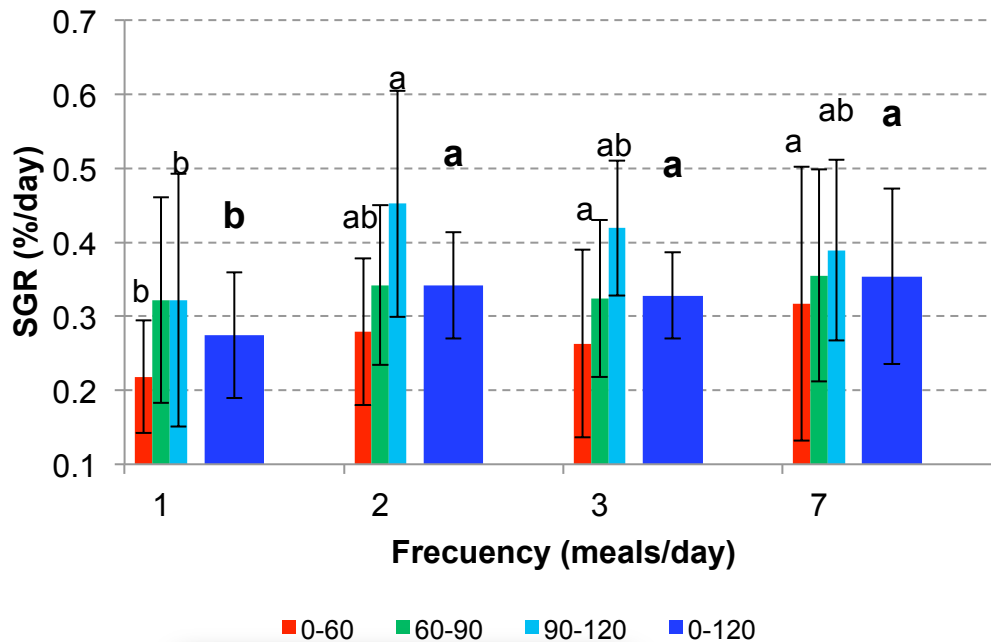
# Task 21.2.2 Feeding pattern for 200 g juveniles

## ■ Specific growth rate (SGR)

- 1 meal d<sup>-1</sup> lower SGR in overall period (120 days)

## ■ Condition factor, HSI and VSI

- 1 meal d<sup>-1</sup> lower Condition factor (CF) and Hepatosomatic Index (HSI) at 120 days.

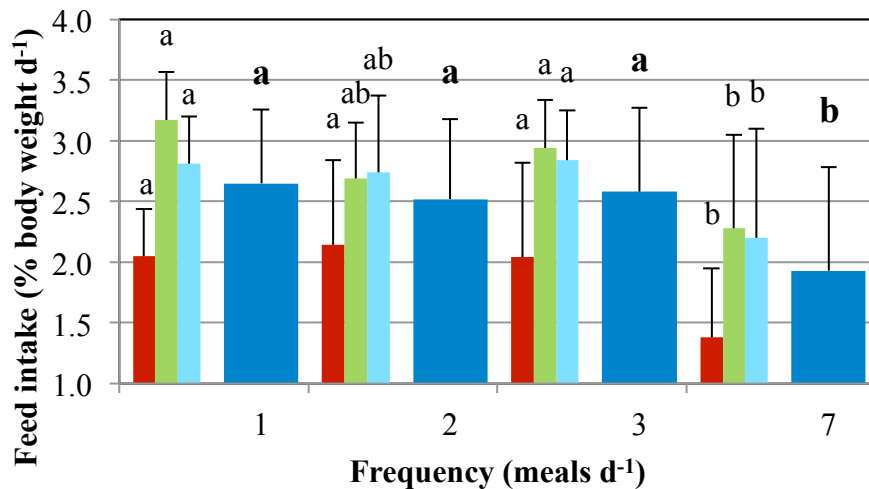


Frequency	1 meal d <sup>-1</sup>		2 meals d <sup>-1</sup>		3 meals d <sup>-1</sup>		7 meals d <sup>-1</sup>	
	mean	sd	mean	sd	mean	sd	mean	sd
CF 0	2.116 ± 0.134		2.130 ± 0.125		2.094 ± 0.109		2.145 ± 0.120	
CF 60	1.919 ± 0.089		1.911 ± 0.149		1.917 ± 0.124		1.945 ± 0.156	
CF 90	1.920 ± 0.106		1.933 ± 0.124		1.909 ± 0.114		1.961 ± 0.129	
CF 120	1.826 ± 0.111	b	1.889 ± 0.134	ab	1.834 ± 0.092	ab	1.905 ± 0.130	a
HSI 120	0.491 ± 0.043	b	0.677 ± 0.221	ab	0.726 ± 0.067	a	0.687 ± 0.131	ab
VSI 120	3.198 ± 0.565		3.346 ± 0.951		3.204 ± 0.275		3.136 ± 0.469	

# Task 21.2.2 Feeding pattern for 200 g juveniles

## ■ Feed intake

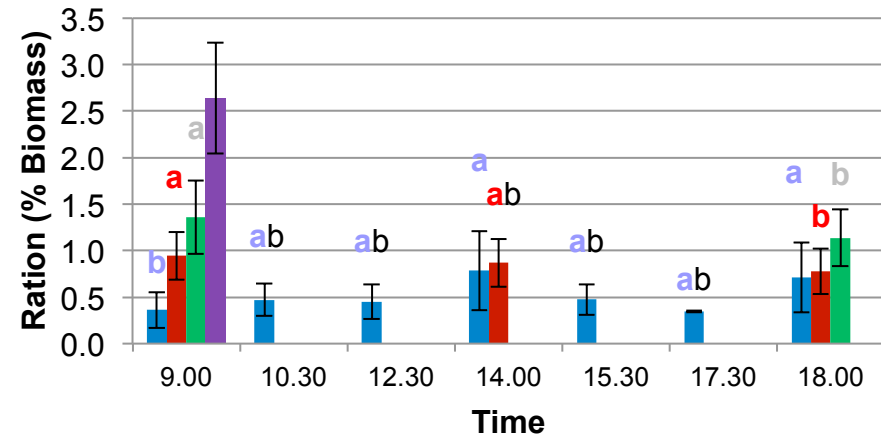
- 7 meals d<sup>-1</sup> significantly lower in overall period (0-120 days)



■ 0-60 days ■ 60-90 days ■ 90-120 days ■ Total period (0-120 days)

## ■ Daily feeding rhythms

- 7 meals d<sup>-1</sup> higher intake at 14:00 and 18:00 h. In the other groups, intake was higher at first meal.



■ 7 meals d<sup>-1</sup> ■ 3 meals d<sup>-1</sup> ■ 2 meals d<sup>-1</sup> ■ 1 meal d<sup>-1</sup>

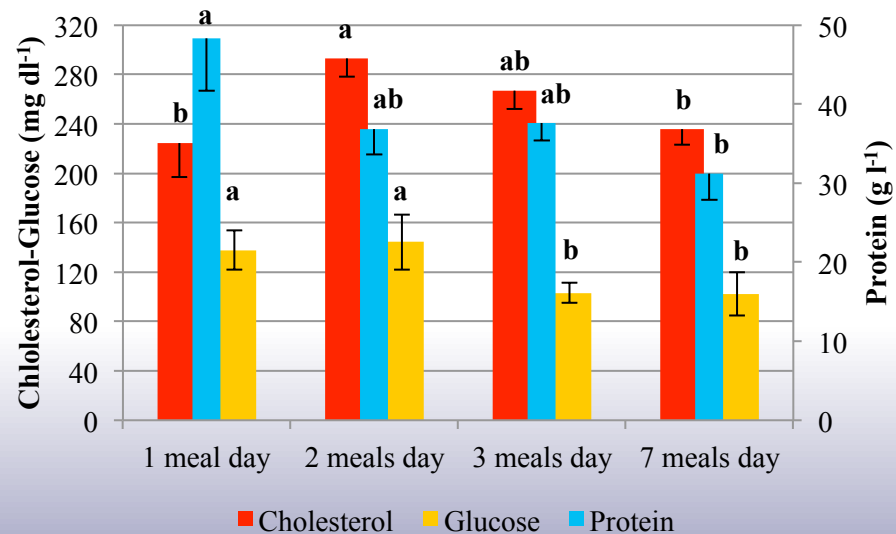
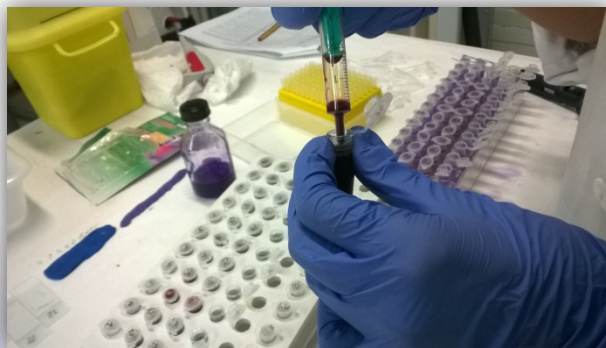


# Task 21.2.2 Feeding pattern for 200 g juveniles

## ■ Hematological and biochemical parameters

- Significant differences were not found between groups fed with different frequencies. Only protein, cholesterol and glucose were slightly higher in the 2 meals d<sup>-1</sup> group.

120 days	1 meal/day	2 meals/day	3 meals/day	7 meals/day
Erythrocytes	171.77 ±3.56	257.06 ±24.49	251.47 ±23.57	235.85 ±35.45
Leucocytes	119.41 ±52.66	99.74 ±22.64	92.62 ±58.56	62.15 ±1.91
Hematocrit	38.01 ±5.55	39.21 ±0.71	34.98 ±3.37	38.6 ±0.27
Triglycerides	107.65 ±21.67	114.74 ±43.91	114.16 ±29.10	77.75 ±34.04
Cholesterol	224.76 ±27.83 b	292.76 ±14.56 a	266.61 ±14.57 ab	235.39 ±12.28 b
Protein	48.3 ±6.63 a	36.88 ±3.25 a	37.60 ±2.24 ab	31.22 ±3.35 b
Glucose	137.68 ±16.00 a	144.24 ±22.32 a	102.95 ±8.18 b	102.42 ±17.59 b

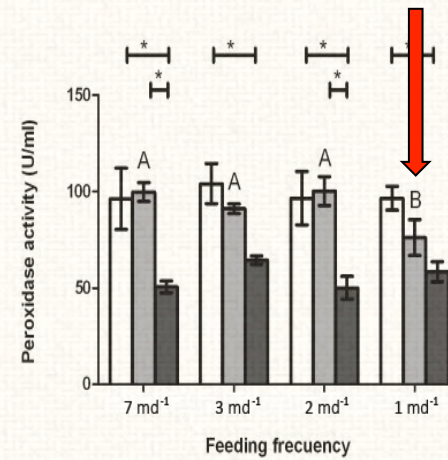
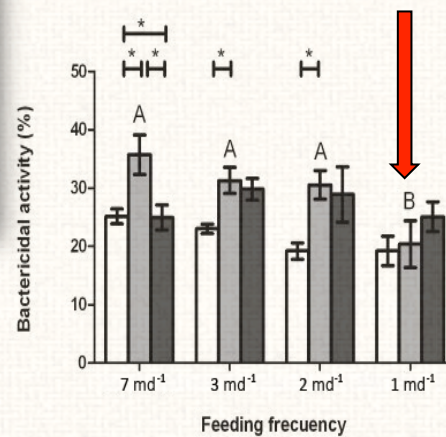
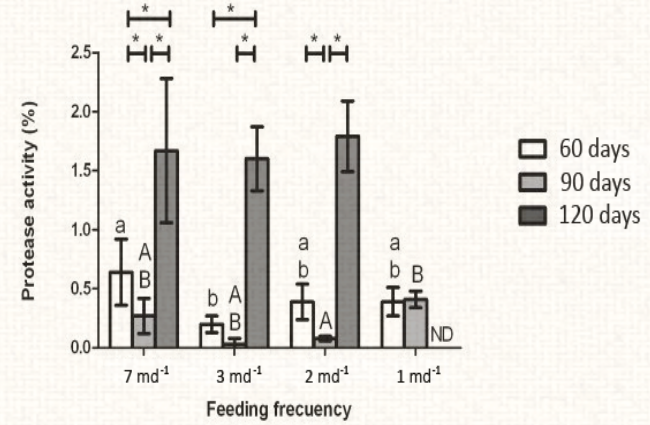
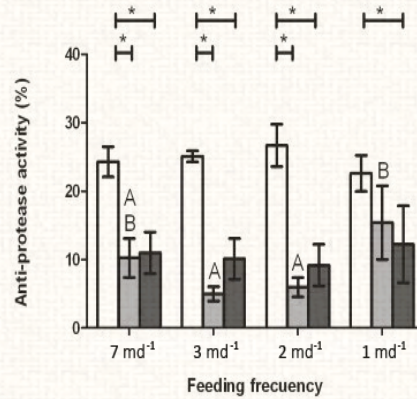




# Task 21.2.2 Feeding pattern for 200 g juveniles

## ■ Immunological parameters

- 1 meal d<sup>-1</sup> lower bactericidal and peroxidase activities after 90 days.



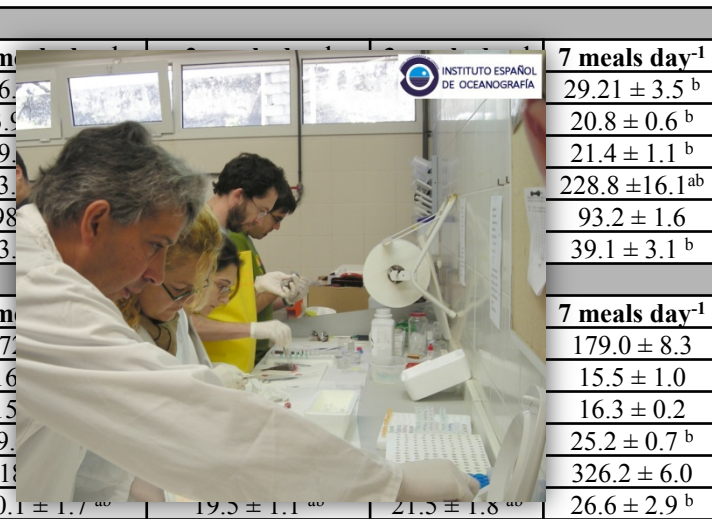


# Task 21.2.2 Feeding pattern for 200 g juveniles

## ■ Oxidative stress enzymes

- Feeding frequency affected significantly to several enzymes in different tissues.
- Catalase activity was lower in 1 meal day<sup>-1</sup> group in liver and FRAP (Ferric Reducing Antioxidant Power) in muscle.

Liver					Gill				
	1 meals day <sup>-1</sup>	2 meals day <sup>-1</sup>	3 meals day <sup>-1</sup>	7 meals day <sup>-1</sup>		1 meals day <sup>-1</sup>	2 meals day <sup>-1</sup>	3 meals day <sup>-1</sup>	7 meals day <sup>-1</sup>
FRAP <sup>1</sup>	213.5 ± 9.8	191.5 ± 13.3	188.6 ± 16.3	182.4 ± 6.1	FRAP <sup>1</sup>	46.5 ± 1.7 <sup>abc</sup>	46.5 ± 1.7 <sup>abc</sup>	46.5 ± 1.7 <sup>abc</sup>	46.5 ± 1.7 <sup>abc</sup>
CAT <sup>1</sup>	55.4 ± 4.7 <sup>a</sup>	106.6 ± 6.4 <sup>b</sup>	122.8 ± 14.3 <sup>b</sup>	110.9 ± 3.8 <sup>b</sup>	CAT <sup>1</sup>	13.5 ± 0.5 <sup>a</sup>	13.5 ± 0.5 <sup>a</sup>	13.5 ± 0.5 <sup>a</sup>	13.5 ± 0.5 <sup>a</sup>
SOD <sup>1</sup>	725.7 ± 39.7 <sup>ab</sup>	909.8 ± 44.3 <sup>a</sup>	599.0 ± 48.4 <sup>b</sup>	770.0 ± 38.6 <sup>ab</sup>	SOD <sup>1</sup>	19.5 ± 0.5 <sup>abc</sup>	19.5 ± 0.5 <sup>abc</sup>	19.5 ± 0.5 <sup>abc</sup>	19.5 ± 0.5 <sup>abc</sup>
GPx <sup>2</sup>	34.1 ± 2.7 <sup>ab</sup>	40.6 ± 2.3 <sup>b</sup>	38.0 ± 2.2 <sup>b</sup>	33.2 ± 0.5 <sup>ab</sup>	GPx <sup>2</sup>	213.5 ± 9.8 <sup>abc</sup>	213.5 ± 9.8 <sup>abc</sup>	213.5 ± 9.8 <sup>abc</sup>	213.5 ± 9.8 <sup>abc</sup>
GR <sup>2</sup>	78.1 ± 2.9	79.8 ± 3.6	80.6 ± 5.6	79.5 ± 3.6	GR <sup>2</sup>	98.5 ± 3.6 <sup>abc</sup>	98.5 ± 3.6 <sup>abc</sup>	98.5 ± 3.6 <sup>abc</sup>	98.5 ± 3.6 <sup>abc</sup>
GST <sup>2</sup>	84.3 ± 4.1 <sup>bc</sup>	90.1 ± 4.0 <sup>c</sup>	68.5 ± 3.9 <sup>ab</sup>	73.8 ± 3.9 <sup>abc</sup>	GST <sup>2</sup>	43.5 ± 1.8 <sup>abc</sup>	43.5 ± 1.8 <sup>abc</sup>	43.5 ± 1.8 <sup>abc</sup>	43.5 ± 1.8 <sup>abc</sup>
Muscle					Brain				
	1 meals day <sup>-1</sup>	2 meals day <sup>-1</sup>	3 meals day <sup>-1</sup>	7 meals day <sup>-1</sup>		1 meals day <sup>-1</sup>	2 meals day <sup>-1</sup>	3 meals day <sup>-1</sup>	7 meals day <sup>-1</sup>
FRAP <sup>1</sup>	58.6 ± 3.3 <sup>c</sup>	23.0 ± 2.6 <sup>b</sup>	15.7 ± 3.0 <sup>b</sup>	25.8 ± 2.0 <sup>b</sup>	FRAP <sup>1</sup>	17.5 ± 0.5 <sup>abc</sup>	17.5 ± 0.5 <sup>abc</sup>	17.5 ± 0.5 <sup>abc</sup>	17.5 ± 0.5 <sup>abc</sup>
CAT <sup>1</sup>	16.5 ± 0.5 <sup>a</sup>	16.5 ± 0.5 <sup>a</sup>	16.5 ± 0.5 <sup>a</sup>	16.5 ± 0.5 <sup>a</sup>	CAT <sup>1</sup>	16.5 ± 0.5 <sup>a</sup>	16.5 ± 0.5 <sup>a</sup>	16.5 ± 0.5 <sup>a</sup>	16.5 ± 0.5 <sup>a</sup>
SOD <sup>1</sup>	13.0 ± 0.5 <sup>b</sup>	13.3 ± 0.4 <sup>b</sup>	13.8 ± 0.3 <sup>b</sup>	12.7 ± 0.5 <sup>b</sup>	SOD <sup>1</sup>	15.5 ± 1.0 <sup>abc</sup>	15.5 ± 1.0 <sup>abc</sup>	15.5 ± 1.0 <sup>abc</sup>	15.5 ± 1.0 <sup>abc</sup>
GPx <sup>2</sup>	11.3 ± 1.2 <sup>c</sup>	16.8 ± 1.1 <sup>b</sup>	16.6 ± 0.5 <sup>b</sup>	14.2 ± 0.9 <sup>bc</sup>	GPx <sup>2</sup>	19.5 ± 0.5 <sup>abc</sup>	19.5 ± 0.5 <sup>abc</sup>	19.5 ± 0.5 <sup>abc</sup>	19.5 ± 0.5 <sup>abc</sup>
GR <sup>2</sup>	127.5 ± 3.1 <sup>b</sup>	150.0 ± 6.6 <sup>a</sup>	141.7 ± 3.3 <sup>ab</sup>	135.8 ± 5.2 <sup>ab</sup>	GR <sup>2</sup>	31.5 ± 1.8 <sup>abc</sup>	31.5 ± 1.8 <sup>abc</sup>	31.5 ± 1.8 <sup>abc</sup>	31.5 ± 1.8 <sup>abc</sup>
GST <sup>2</sup>	3.3 ± 0.3 <sup>c</sup>	2.9 ± 0.4 <sup>bc</sup>	3.3 ± 0.4 <sup>bc</sup>	5.5 ± 0.6 <sup>b</sup>	GST <sup>2</sup>	20.1 ± 1.7 <sup>abc</sup>	19.5 ± 1.1 <sup>abc</sup>	21.5 ± 1.8 <sup>abc</sup>	26.6 ± 2.9 <sup>b</sup>



## ***Conclusions***

### **For 5 g fish:**

- The amount of feed determines better growth and feed utilization, with 3.5% biomass per day showing equal growth than those fish fed on apparent satiation, but distribution of this amount of diet must be done at least in more than 1 intake per day.
- Results of blood biochemical parameters suggest lipid metabolism imbalance in fish fed 1 intake per day.
- The worst results in growth and feed conversion were obtained in fish fed 1 time per day. Other frequencies assayed showed better results and similar between them.

### **For 200 g fish:**

- The best results in growth and feed conversion rates have been obtained when the fish were fed at more than 1 meal per day.
- The absence of changes in the hematological and biochemical parameters suggests that greater amberjack juveniles were able to adapt to the different feeding frequencies under the particular culture conditions.
- Immunological parameters reveal differences in the immune status among fish fed at different feeding frequencies that could influence the health status of fish.

# Stocking density

**Objective: The optimization of stocking density for greater amberjack grow out**

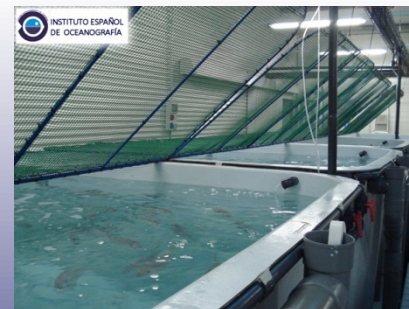
## Facilities and rearing conditions (IEO):

### 5 g Fish

- Tanks of 500 l during 120 days
- Initial weight (mean  $\pm$ SD):  $27.0 \pm 8.3$  g.
- Renewal:  $30 \text{ l min}^{-1}$  (350 % tank volume).
- Feeding: 6 times day (first 2 month) and 4 times day (last 2 month)
- Natural Photoperiod and Temperature:  $24.1 \pm 1.1^\circ\text{C}$  ↓ from  $25.4^\circ\text{C}$  to  $20.7^\circ\text{C}$
- Oxygen level:  $87.9 \pm 0.5\%$  (93.9-79.8 %)
- Three Initial density ( $\text{kg m}^{-3}$ ):  $0.17 \pm 0.02$ ,  $0.28 \pm 0.01$  and  $0.46 \pm 0.07$  for Low (LD), Medium (MD) and High (HD) densities, respectively.

### 150 g Fish

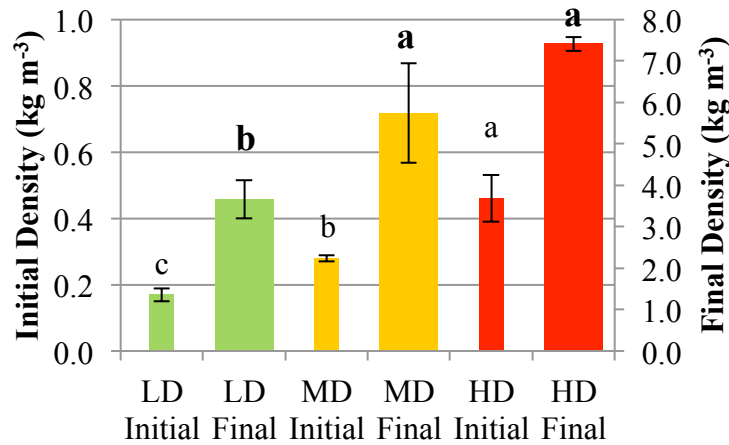
- Tanks of  $4 \text{ m}^3$  during 120 days
- Initial weight (mean  $\pm$ SD):  $175.7 \pm 56.4$  g
- Renewal:  $70 \text{ l min}^{-1}$  (100 % tank volume).
- Feeding: 3 times day (8:00. 14:00 and 18:00)
- Natural Photoperiod and Temperature:  $21.8 \pm 1.3^\circ\text{C}$  ↑ from  $19.0^\circ\text{C}$  to  $22.9^\circ\text{C}$
- Oxygen level:  $> 90\%$
- Fourth Initial density ( $\text{kg m}^{-3}$ ): 1.3, 1.7, 2.4 and  $3.2 \text{ kg m}^3$  for Low (LD), Medium Low (MLD), Medium High (MHD) and High (HD) densities, respectively.



# Task 21.2.2 Stocking density for 5 g juveniles

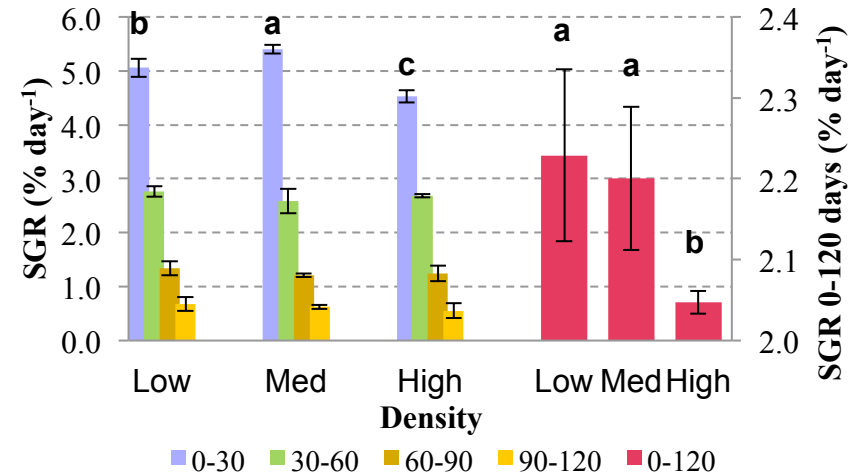
## Stocking density

■ Density increased 3.5, 5.5 and 7.0 kg m<sup>-3</sup> for LD, MD and HD, respectively.

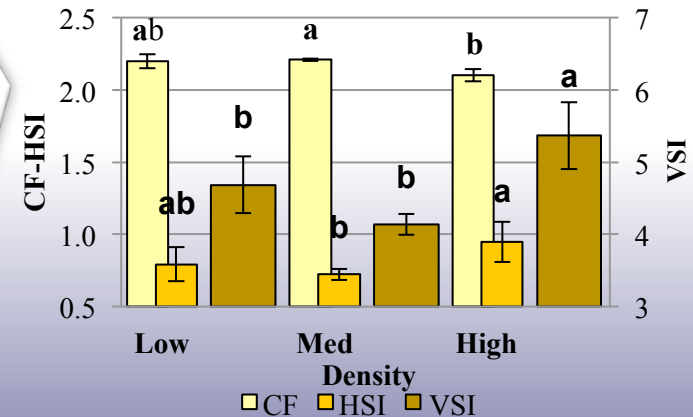


## Specific growth rate (SGR) and Condition

■ HD showed lower SGR (and deviation) and CF and higher HIS and VSI.



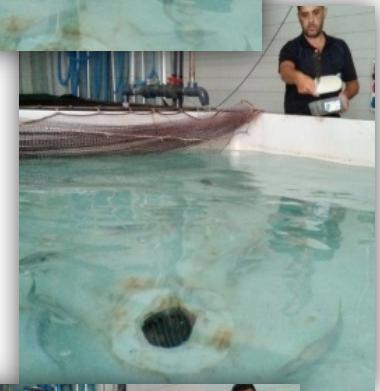
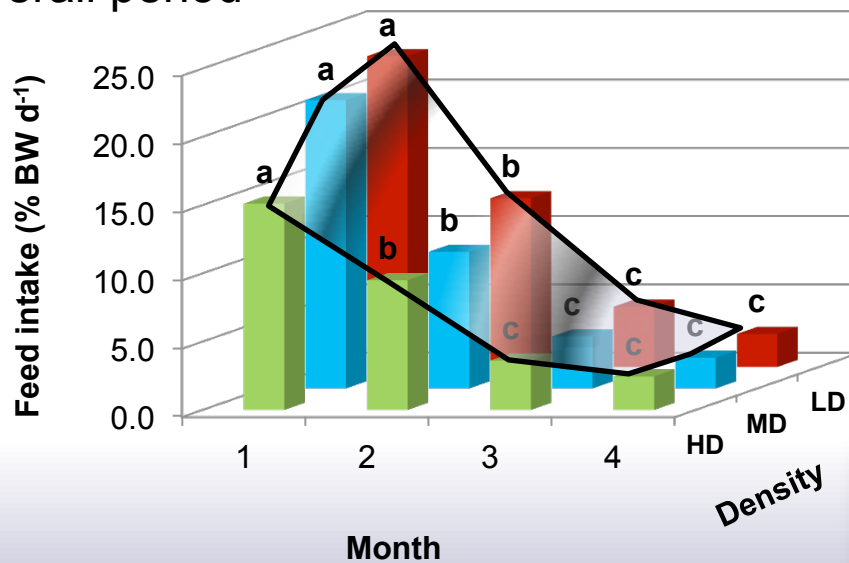
**Biomass increased more than 20 times**



# Task 21.2.2 Stocking density for 5 g juveniles

## ■ Feed intake and feeding pattern

- High density lower in overall period.
- Decreased during the study period in all densities.
- The decline occurred earlier in HD that in MD and finally in LD.
- Density no affected the daily feeding rhythms during the overall period





# Task 21.2.2 Stocking density for 5 g juveniles

## ■ Hematological and biochemical parameters

- Only triglycerides levels higher at high density

120 days	Low		Medium		High	
Erythrocytes ( $10^4 \text{ mm}^{-3}$ )	249.6	$\pm 73.8$	245.5	$\pm 55.4$	264.9	$\pm 46.3$
Leucocytes ( $10^3 \text{ mm}^{-3}$ )	90.8	$\pm 45.5$	78.2	$\pm 29.6$	83.5	$\pm 21.6$
Hematocrit (%)	46.2	$\pm 7.0$	43.0	$\pm 10.6$	44.7	$\pm 4.6$
Triglycerides ( $\text{mg dl}^{-1}$ )	117.9	$\pm 24.0$ b	125.3	$\pm 48.3$ ab	240.1	$\pm 137.5$ a
Cholesterol ( $\text{mg dl}^{-1}$ )	263.8	$\pm 41.8$	246.1	$\pm 33.5$	275.6	$\pm 62.4$
Protein ( $\text{g l}^{-1}$ )	36.1	$\pm 3.6$	36.4	$\pm 3.9$	38.8	$\pm 5.4$
Glucose ( $\text{mg dl}^{-1}$ )	63.5	$\pm 40.9$	52.9	$\pm 26.1$	44.2	$\pm 21.5$

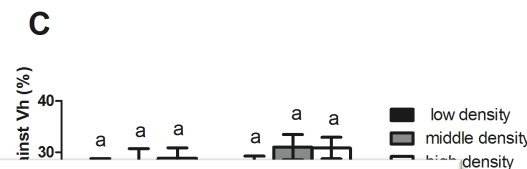
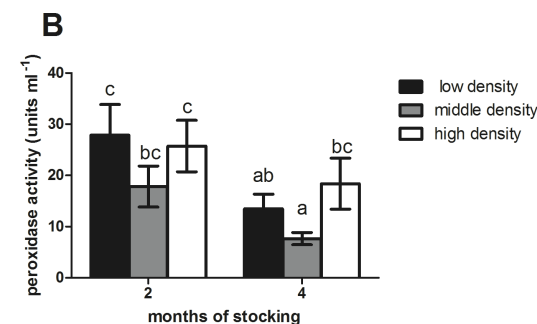
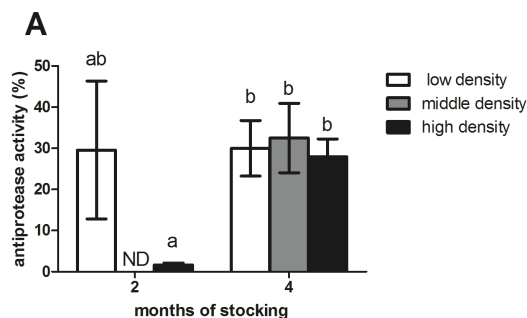
## ■ Immunological parameters

- Peroxidase activity decreased between 2 and 4 month
- Density no affected the immune system clearly

## ■ Oxidative stress enzymes

- Density no affected the activity of enzymes

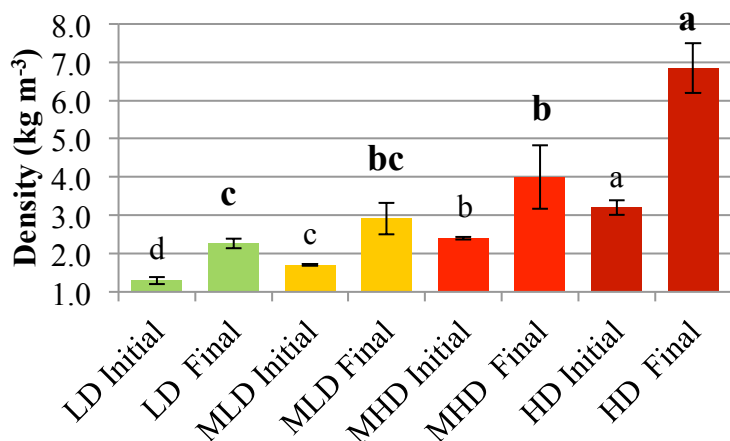
	LD	MD	HD
<b>Muscle</b>			
CAT	1.05 $\pm$ 0.27	0.84 $\pm$ 0.12	0.81 $\pm$ 0.39
GST	10.76 $\pm$ 0.70	11.77 $\pm$ 1.34	10.01 $\pm$ 1.26
SOD	147.92 $\pm$ 53.08	109.89 $\pm$ 48.95	85.77 $\pm$ 38.72
TBARS	42.42 $\pm$ 24.27	51.51 $\pm$ 23.37	29.32 $\pm$ 18.88
<b>Liver</b>			
GST	35.65 $\pm$ 14.12	38.38 $\pm$ 4.15	26.82 $\pm$ 4.49
SOD	1459.8 $\pm$ 154.0	1381.2 $\pm$ 123.4	1396.2 $\pm$ 334.9
TBARS	123.35 $\pm$ 43.10	102.30 $\pm$ 50.08	83.21 $\pm$ 36.77



# Task 21.2.2 Stocking density for 150 g juveniles

## Stocking density

- Density increased 1.0, 1.2, 1.6 and 3.6 kg m<sup>-3</sup> for LD, MLD, MHD and HD, respectively at 120 days



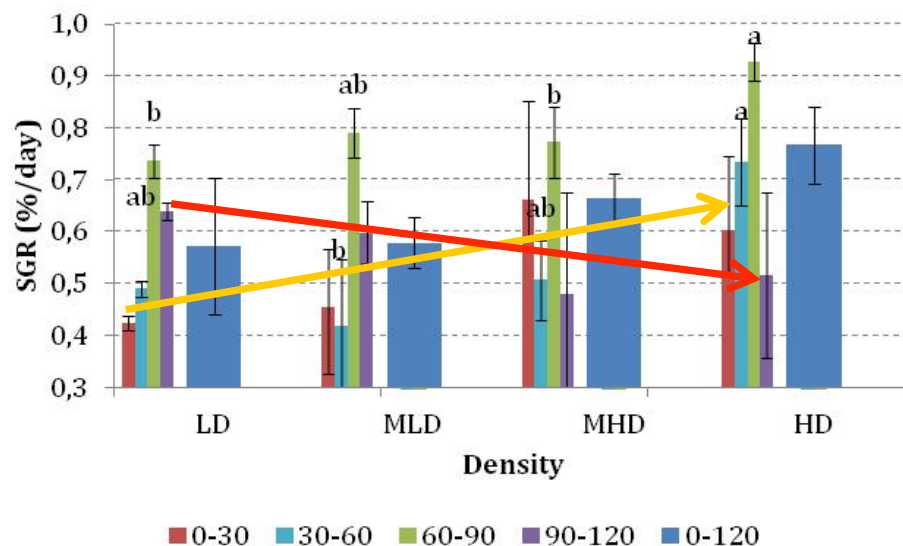
**Biomass increased between 1.8 and 2 times after 4 months**

## Condition factor, HSI and VSI

- Condition factor **tended** to decrease along the trial in all groups.
- Hepatosomatic (HSI) and Viscerosomatic Index (VSI) **tended** to rise with stocking density

## Specific growth rate (SGR)

- High density tended to higher SGR in 0-90 days period and changed in 90-120 days period

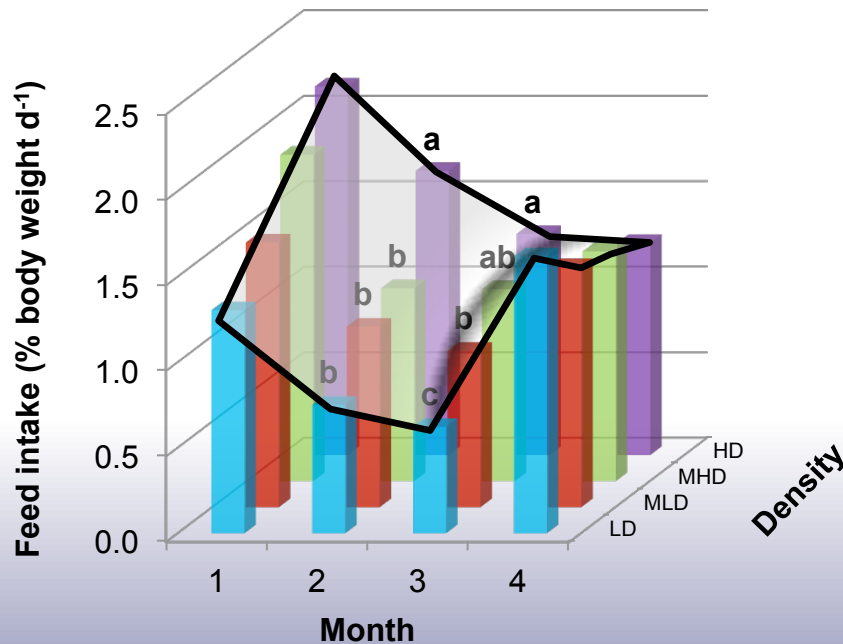
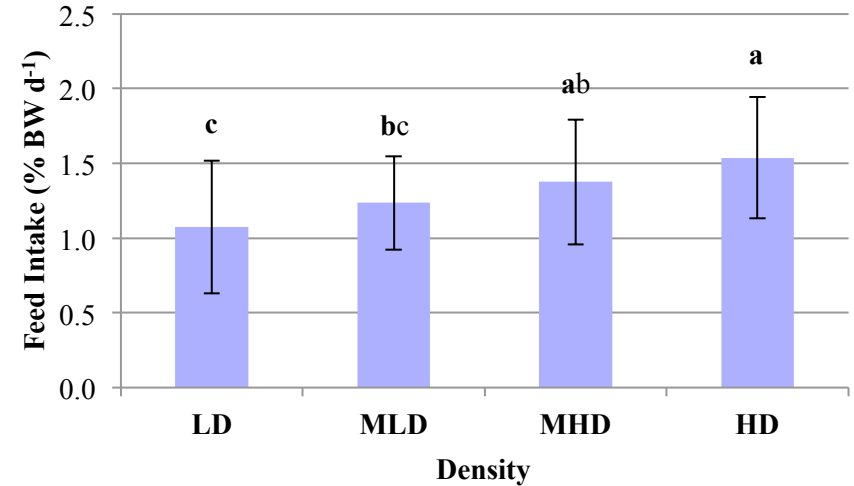




# Task 21.2.2 Stocking density for 150 g juveniles

## ■ Feed intake and feeding pattern

- Feed intake increased with density in overall period.
- Decreased along the time in HD and increased in the last month in the other densities, more important at lower density.



- Density no affected the daily feeding rhythms during the overall period



# Task 21.2.2 Stocking density for 150 g juveniles

## Hematological and biochemical parameters

- Only some hematological differences without defined pattern regarding density

120 days	Low	Medium Low	Medium High	High
<b>Erythrocytes (<math>10^4 \text{ mm}^{-3}</math>)</b>	<b>406.3 ± 42.5 ab</b>	<b>349.2 ± 75.2 b</b>	<b>360.9 ± 69.8 b</b>	<b>487.6 ± 81.6 a</b>
<b>Leucocytes (<math>10^3 \text{ mm}^{-3}</math>)</b>	368.8 ± 169.9	270.3 ± 72.4	300.8 ± 140.4	182.9 ± 20.3
<b>Hematocrit (%)</b>	<b>32.5 ± 3.9 b</b>	<b>38.9 ± 6.8 ab</b>	<b>40.4 ± 5.1 a</b>	<b>38.5 ± 4.8 ab</b>
<b>Triglycerides (mg dl<sup>-1</sup>)</b>	194.9 ± 67.5 *	199.7 ± 99.3	271.9 ± 100.3	194.9 ± 64.2 *
<b>Cholesterol (mg dl<sup>-1</sup>)</b>	237.1 ± 40.2	249.6 ± 76.8	266.9 ± 46.4	249.6 ± 15.3
<b>Protein (g l<sup>-1</sup>)</b>	35.9 ± 5.3	35.5 ± 7.4	39.0 ± 4.1	39.2 ± 4.9
<b>Glucose (mg dl<sup>-1</sup>)</b>	60.6 ± 13.5	79.7 ± 32.4	72.8 ± 22.7	72.9 ± 4.9 *

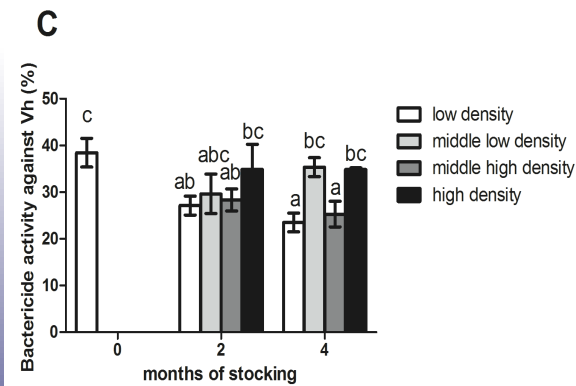
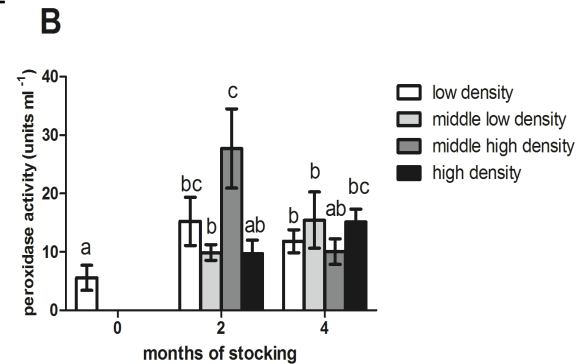
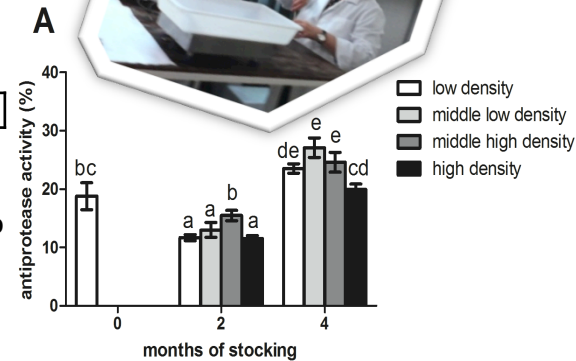
## Immunological parameters

- Antiprotease activity increased from 2 to 4 month
- Some differences in immunological enzymes activities without direct relation to Density

## Oxidative stress

- Density no affected the activity of enzymes

	LD	MLD	MHD	HD
<b>Muscle</b>				
<b>CAT</b>	1.92 ± 0.24	2.12 ± 0.47	1.62 ± 0.13	1.73 ± 0.47
<b>GST</b>	2.93 ± 0.49	3.14 ± 0.23	2.74 ± 0.34	2.86 ± 0.33
<b>SOD</b>	165.01 ± 21.87	216.90 ± 113.4	240.37 ± 95.71	224.38 ± 72.72
<b>TBARS</b>	49.03 ± 23.75	24.35 ± 10.21	36.50 ± 16.22	34.42 ± 20.21
<b>Liver</b>				
<b>GST</b>	26.89 ± 4.60	27.49 ± 5.83	24.00 ± 4.57	27.97 ± 5.12
<b>SOD</b>	985.2 ± 311.5	1063.7 ± 240.9	1143.9 ± 316.5	1087.2 ± 82.9
<b>TBARS</b>	66.19 ± 37.62	64.13 ± 27.79	48.33 ± 25.07	39.14 ± 13.37



## ***Conclusions***

### **For fish of 5 g:**

- High density showed the worst growth than those fish stocked at Medium and Low density.
- The feed intake was affected along the study period, decreasing with the increasing of the density.
- High density affected negatively the fish condition (FC and HIS), and increased the level of plasmatic triglycerides, but immunological parameters and oxidative stress were not affected in an important way.

### **For 200 g fish:**

- The densities assayed no affected the growth and condition of fish, although the tendencies observed suggest that the growth performance could be improved if the initial density is not excessively low.
- The hematological differences were not clearly related to the increase in stocking density as the results relating to the immune system. In addition, the enzymatic activity of the oxidative stress were not affected suggesting that the juveniles could be healthy at least during four months, under the stocking densities assayed.

**Thank you for your attention**

