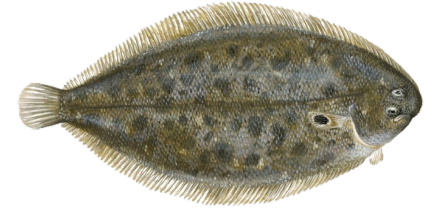




CARBODIET

Hacia una acuicultura sostenible



Biocarbones en la alimentación de peces planos: respuestas metabólicas

Dr. Juan Miguel Mancera Romero
Departamento de Biología
Facultad de Ciencias del Mar y Ambientales
Universidad de Cádiz
Cádiz, 10 de febrero de 2026

Rodaballo

Condiciones experimentales

- Tanques de 600L
- Temperatura natural
- Circuito abierto (6 renovaciones diarias)
- Fotoperiodo (luz:oscuridad) 16:8

Alimentación:

- Manual-*Ad libitum*
- 2 veces/día (10:00 h – 18:00 h)
- 6 días/semana



Lenguado

Condiciones experimentales

- Tanques de 200L
- Temperatura 20°C
- Circuito abierto (8 renovaciones diarias)
- Fotoperiodo natural

Alimentación:

- Comederos (1%)
- 3 veces/día (14:00 h – 16:00 h - 18:00 h)
- 6 días/semana

- Evaluación multidisciplinar:
 - Zootecnia
 - Fisiología y metabolismo
 - Bienestar animal
 - Calidad del agua

1 Experimento 1:

- CT: Control (0 % biocarbón)
- B0.25: 0,25 % biocarbón
- B0.50: 0,50 % biocarbón

Resultado experimento 1



DIETA ÓPTIMA EXPERIMENTO 1

2 Experimento 2:

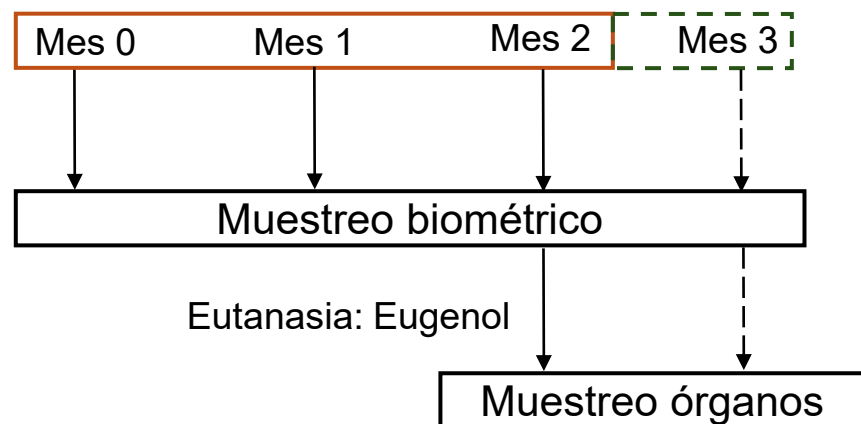
- CT: Control (0 % biocarbón)
- BXX: X % biocarbón
- M5: 5 % microalgas
- BM: X % biocarbón + 5 % microalgas



- ✓ Dietas **isoproteicas e isolipídicas**
- ✓ Composición proximal similar entre dietas

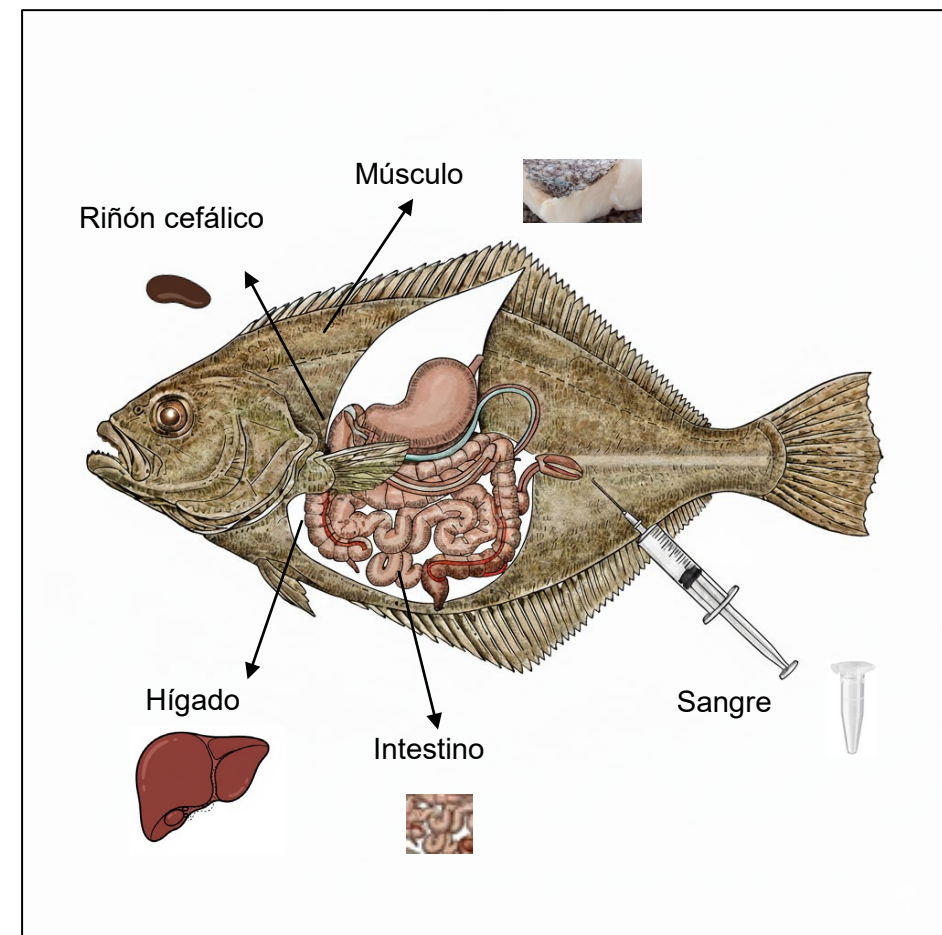
- ✓ Perfil de ácidos grasos comparable
- ✓ Perfil aminoacídico equilibrado

Ayunas 24 h



DESAFIOS TRAS ALIMENTACIÓN

- Metabólico: ayuno durante 10 días
- Inmunológico: tratamiento con LPS





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PARÁMETROS



PLASMA

PARÁMETROS METABÓLICOS:

- Glucosa
- Lactato
- Proteínas
- Triglicéridos
- Colesterol

PARÁMETROS HORMONALES:

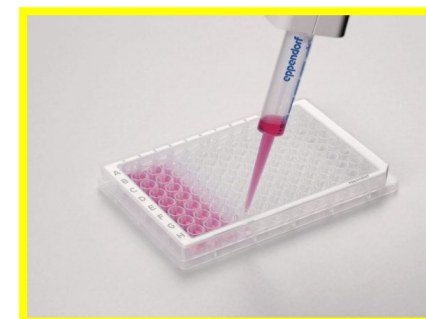
- Cortisol



HÍGADO
y
MÚSCULO

METABOLITOS:

- Glucosa
- Glucógeno
- Lactato
- Triglicéridos
- Colesterol



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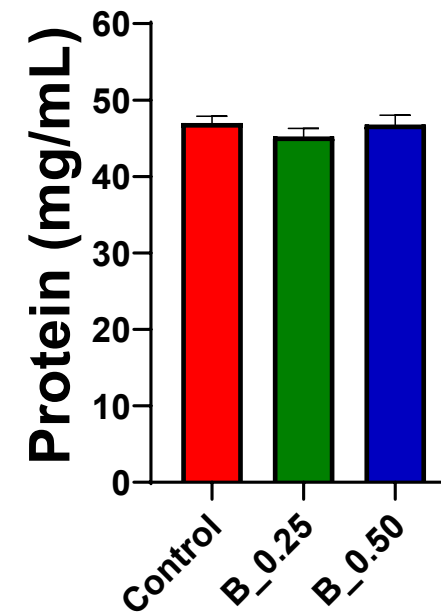
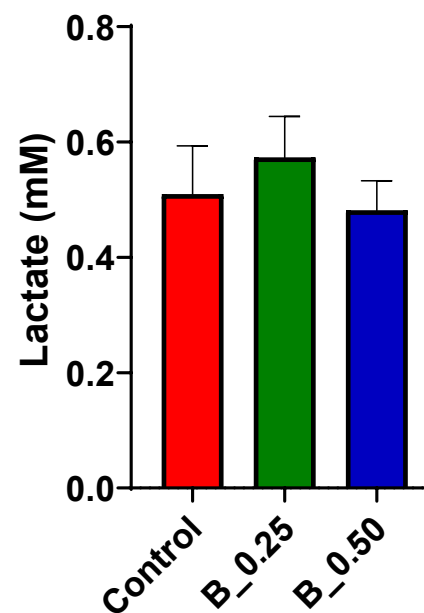
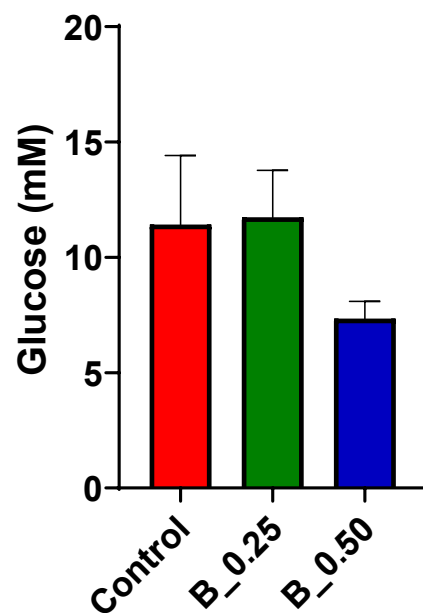
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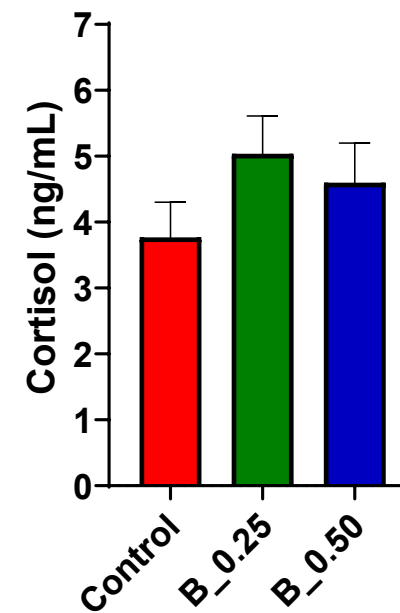
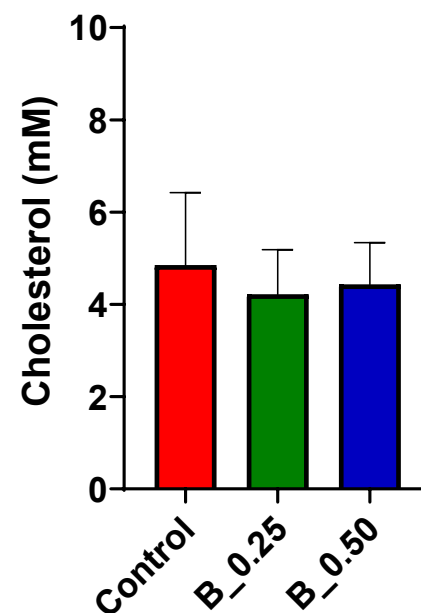
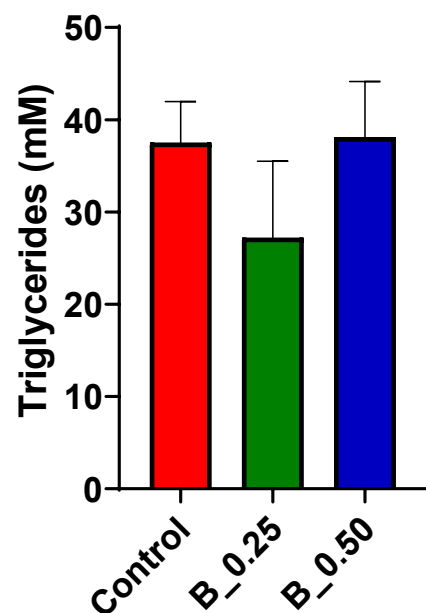
ASEMA

El Proyecto CARBODIET se desarrolla con la colaboración de la Fundación Biodiversidad del Ministerio para la Transición Ecológica y el Reto Demográfico, a través del Programa Pleamar y está cofinanciado por la Unión Europea a través de Fondo Europeo Marítimo de Pesca y Acuicultura.

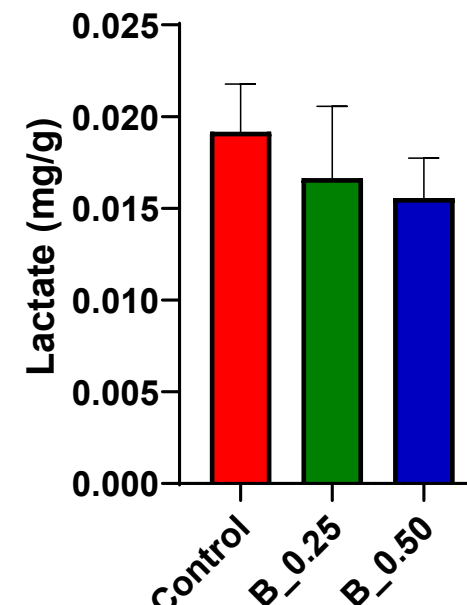
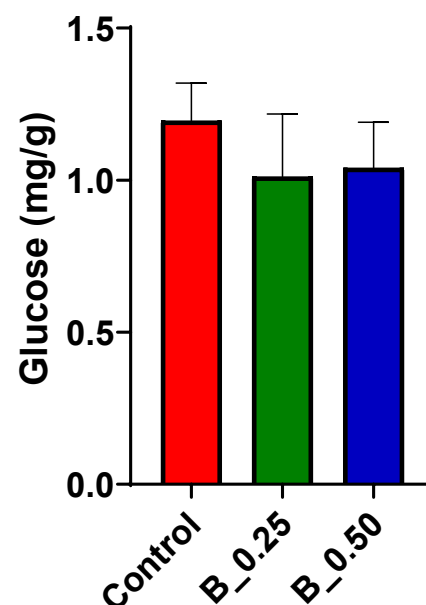
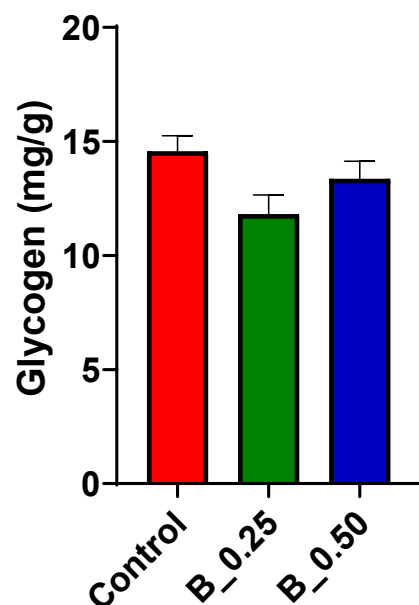
EXPERIMENTO 1 LENGUADO: PLASMA



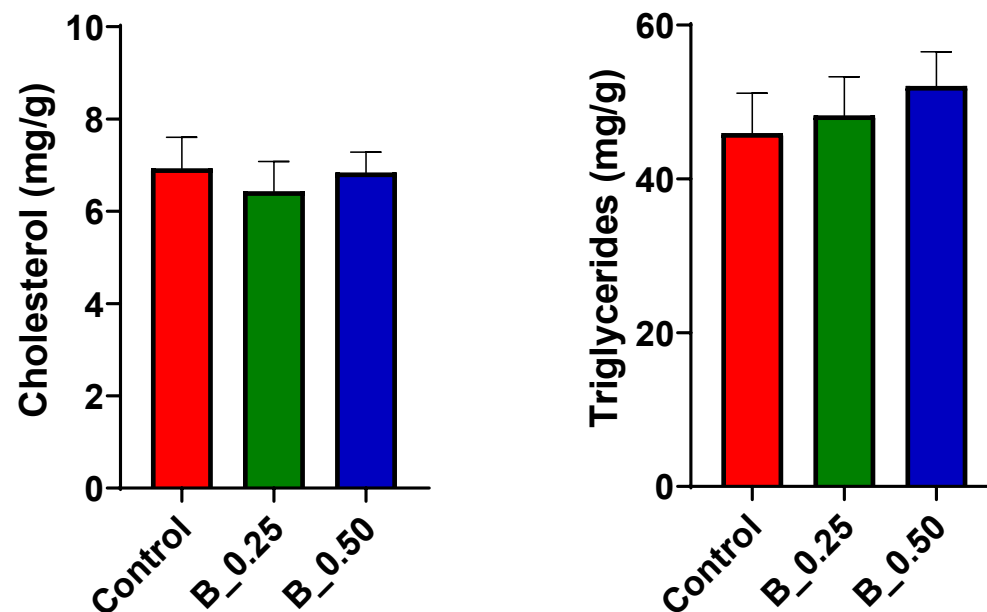
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EXPERIMENTO 1 LENGUADO: HÍGADO

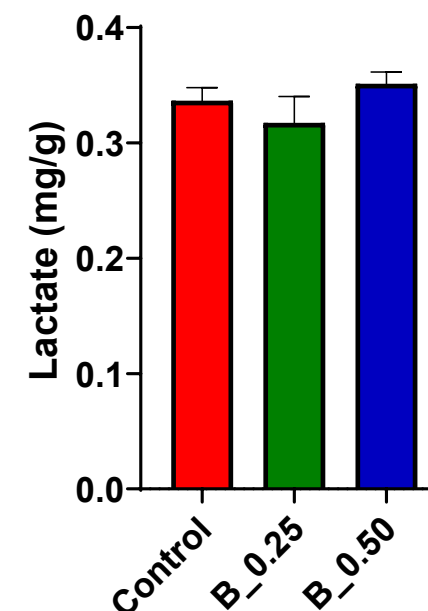
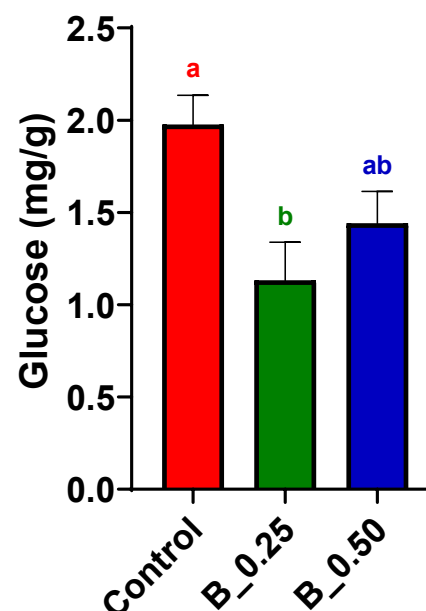
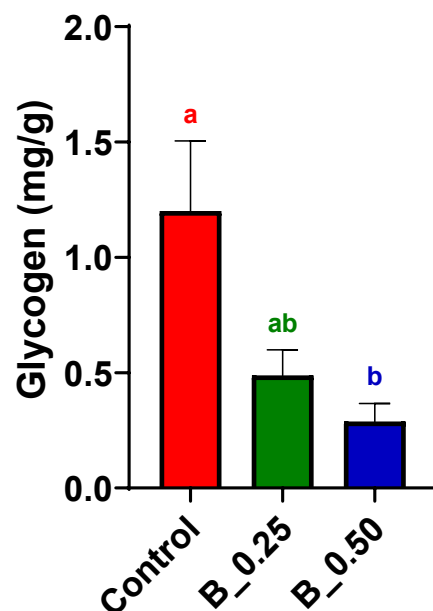


EXPERIMENTO 1 LENGUADO: HÍGADO





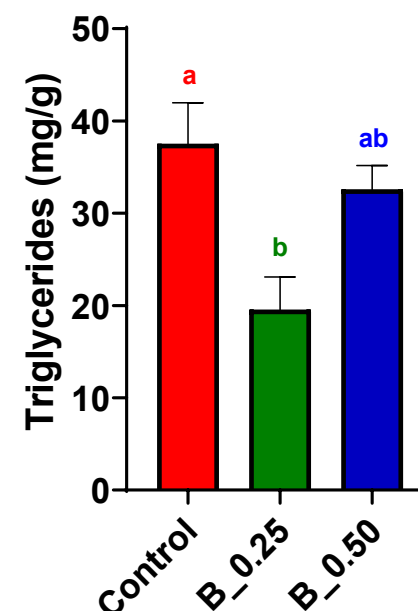
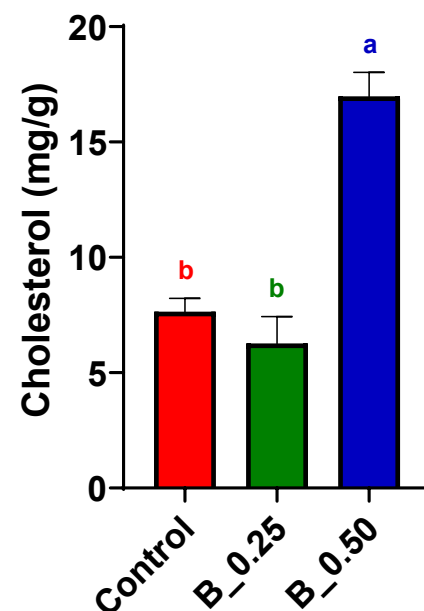
EXPERIMENTO 1 LENGUADO: MÚSCULO





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EXPERIMENTO 1 LENGUADO: MÚSCULO



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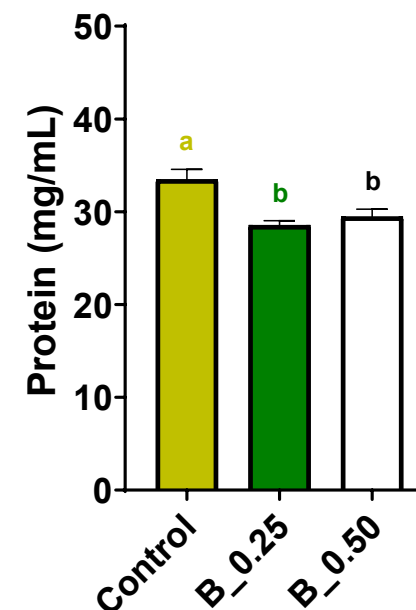
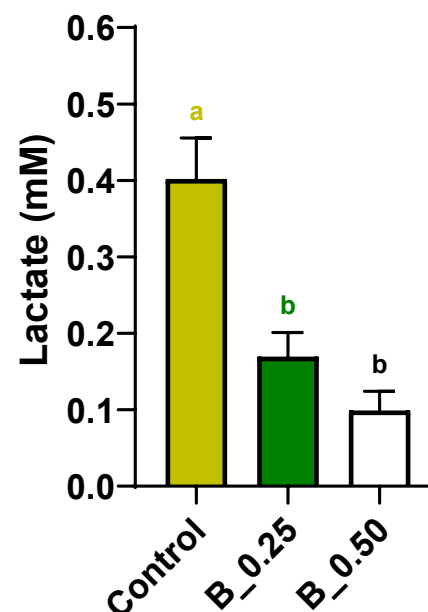
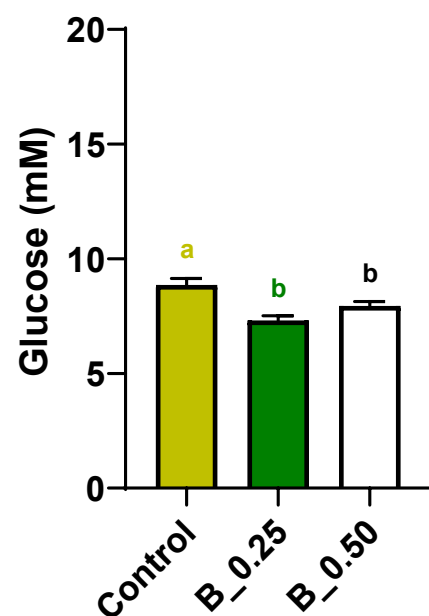
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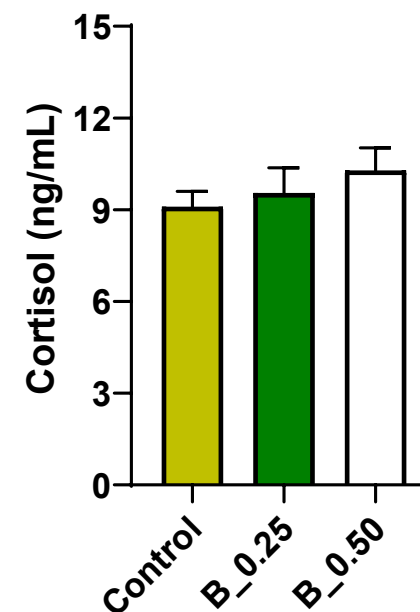
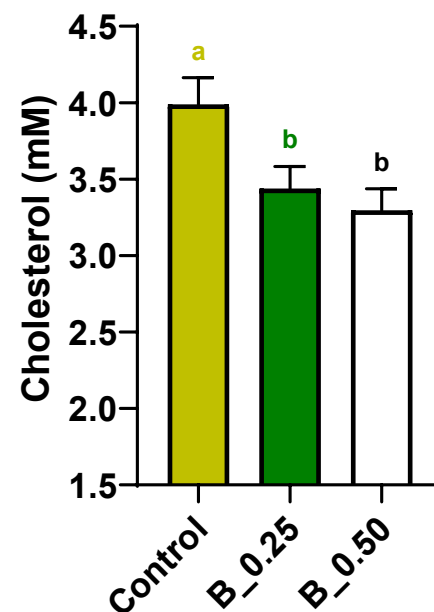
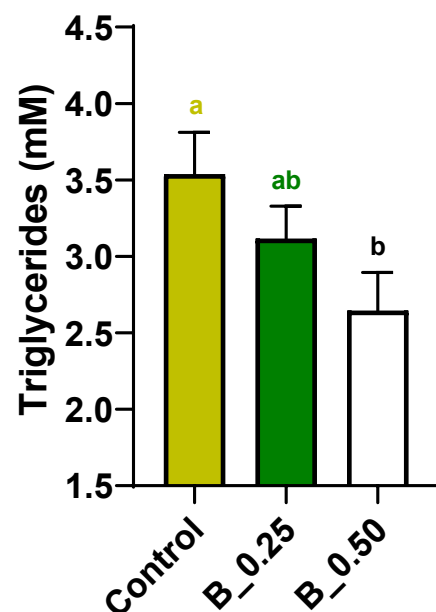
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- ## SUSTAINABLE BIOCHAR SUPPLEMENTATION IN AAQUEFEDS: IMPLICATIONS FOR WATER QUALITY AND METABOLIC RESPONSE IN SENEGALESE SOLE (*Solea senegalensis*)
-  
- E. Rosell-Moll^{1*}, C. Rodríguez², M.C. Castro Pérez³, F.J. Alarcón-López⁴, T.A. Centeno⁵, A. Hernández-de Rojas⁶, J.A. Martos-Sitcha¹, J.M. Mancera¹
- ¹Department of Biology, Faculty of Marine and Environmental Sciences, Instituto Universitario de Investigación Marítima (IUMAR), Campus de Experimentación Intercomunal del Mar (CEI-MAR), University of Cádiz, 11519 Puerto Real, Spain; ²Instituto Español de Oceanografía (IEO-CSIC), Planta de Cultivos II Bosc, Santander, Spain; ³Instituto Español de Oceanografía (IEO-CSIC), Centro Oceanográfico de Gijón, Gijón, Spain; ⁴Department of Biology and Geology, OUMAR, University of Almería, 04120 Almería, Spain; ⁵Carbon Science and Technology Institute (CNCI), CISC, Francisco Píladre Fe 26, 33011 Oviedo, Spain.
* E-mail: erosell.moll@uca.es
- Introduction:** Biochar is a carbon-rich material obtained through biomass pyrolysis under low-oxygen conditions. Recently, its use as a feed additive in aquaculture has attracted attention due to its porous structure and high adsorption capacity, which may improve nutrient uptake, enhance feed utilization, and support fish health. It can also help retain nitrogenous compounds, reducing their accumulation in water. Beyond these functional benefits, biochar from wood industry waste contributes to circular economy strategies by promoting sustainable practices and reducing dependence on conventional ingredients such as fish meal and fish oil.
- Objective:** This study evaluates the metabolic impact of dietary biochar supplementation in Senegalese sole (*Solea senegalensis*), in order to determine best level of inclusion that supports growth and health.
- Results:**
- Growth parameters:** A line graph showing SWT (g) over 70 days for Control, B 0.25, and B 0.50 groups. All groups show an increase in weight, with B 0.50 showing the highest weight at day 70.
 - Metabolites and Cortisol:** Bar charts showing levels of Glucose (mg/l), Glucose (mg/l), Triglycerides (mg/l), and Cholesterol (mg/l) in Plasma, Liver, and Muscle for Control, B 0.25, and B 0.50 groups. In Plasma, Glucose and Triglycerides are significantly higher in B 0.50. In Liver, Glucose is significantly higher in B 0.50. In Muscle, Cholesterol is significantly higher in B 0.50. Cortisol levels are not significantly different.
 - Water quality:** A bar chart showing PO₄³⁻ (µM) in water for Control, B 0.25, and B 0.50 groups. B 0.50 shows significantly lower PO₄³⁻ levels.
- Conclusion:**
- Biochar predisposed fish for better growth, resource efficiency, and water quality, showing short term potential.
 - Mild physiological adjustments (growth index and muscular metabolites) indicate greater metabolic efficiency.
 - Significant muscle metabolite changes suggest better growth potential.
 - Reduced water phosphate levels suggest environmental benefits.
 - The inclusion of 0.25% of biochar in the aquafed in the Senegalese sole aquaculture showed the most consistent and promising effects.
- Acknowledgements:** This work was supported by CARBODIET project developed with the collaboration of the Biodiversity Foundation of the Ministry for Ecological Transition and the Demographic Challenge and financed by 2023 Planning Programme and the European Maritime, Fisheries and Aquaculture Fund.
- 
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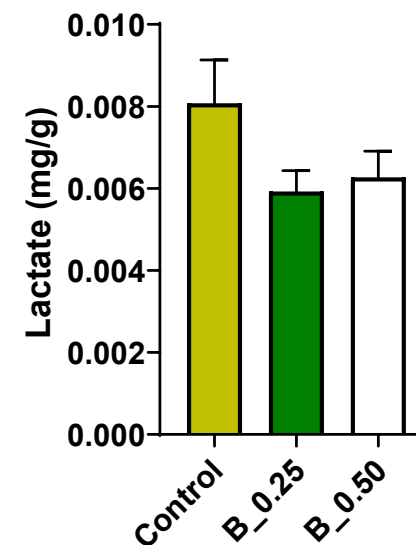
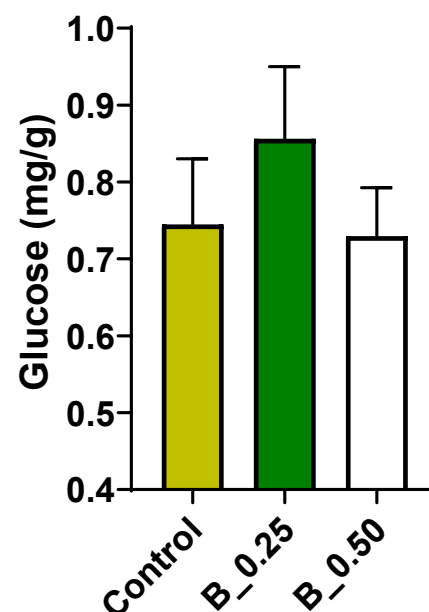
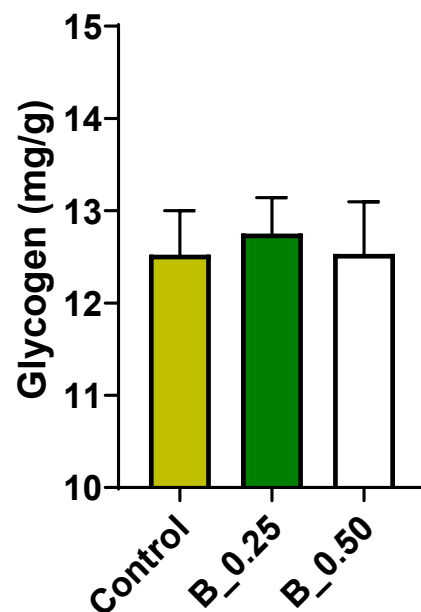
EXPERIMENTO 1 RODABALLO: PLASMA



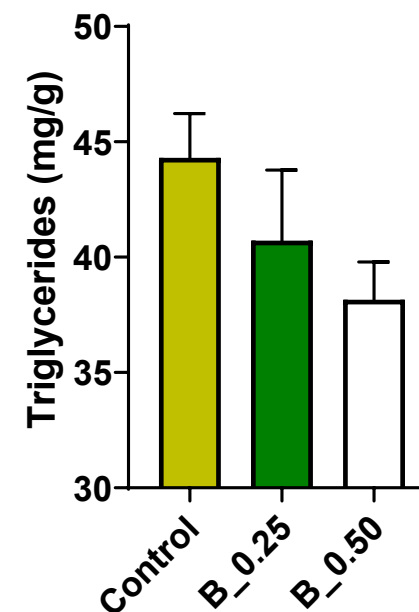
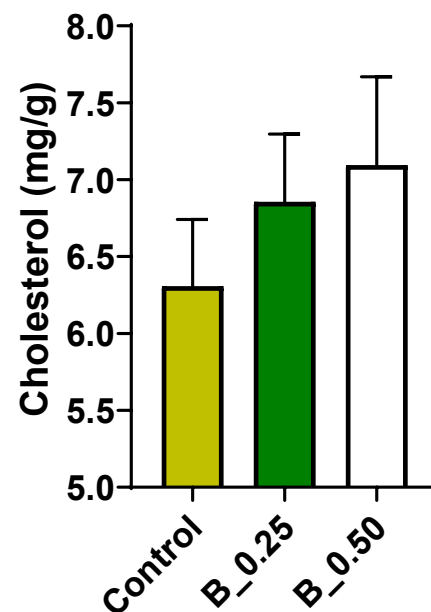
EXPERIMENTO 1 RODABALLO: PLASMA



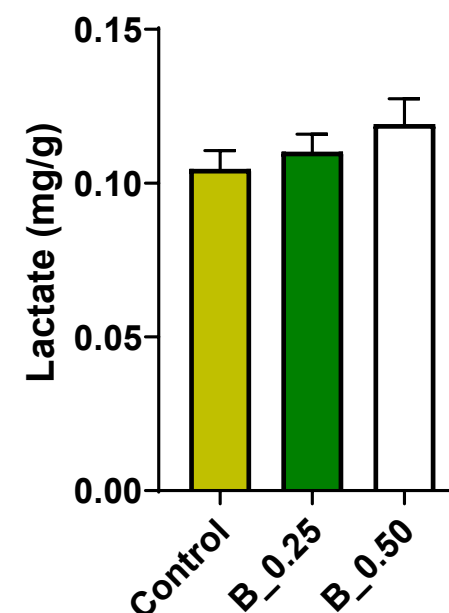
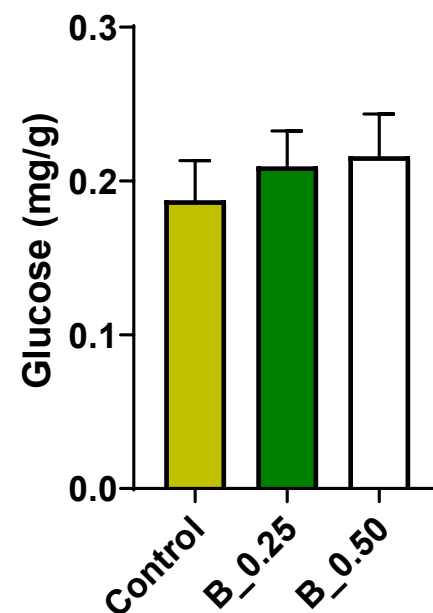
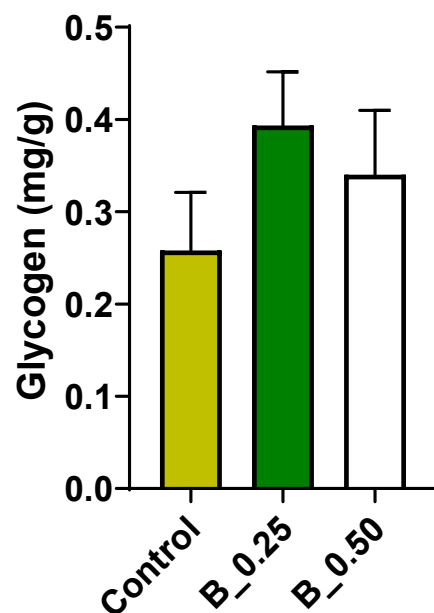
EXPERIMENTO 1 RODABALLO: HÍGADO



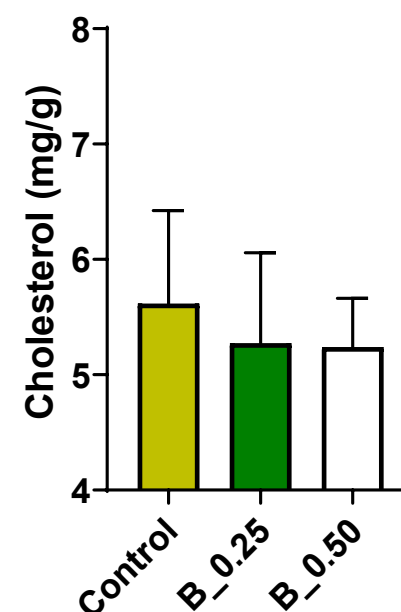
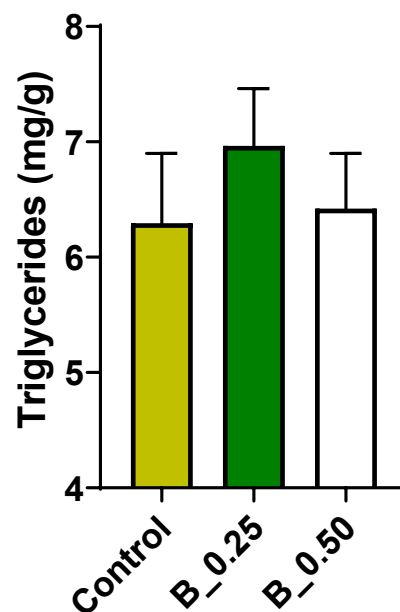
EXPERIMENTO 1 RODABALLO: HÍGADO



EXPERIMENTO 1 RODABALLO: MÚSCULO



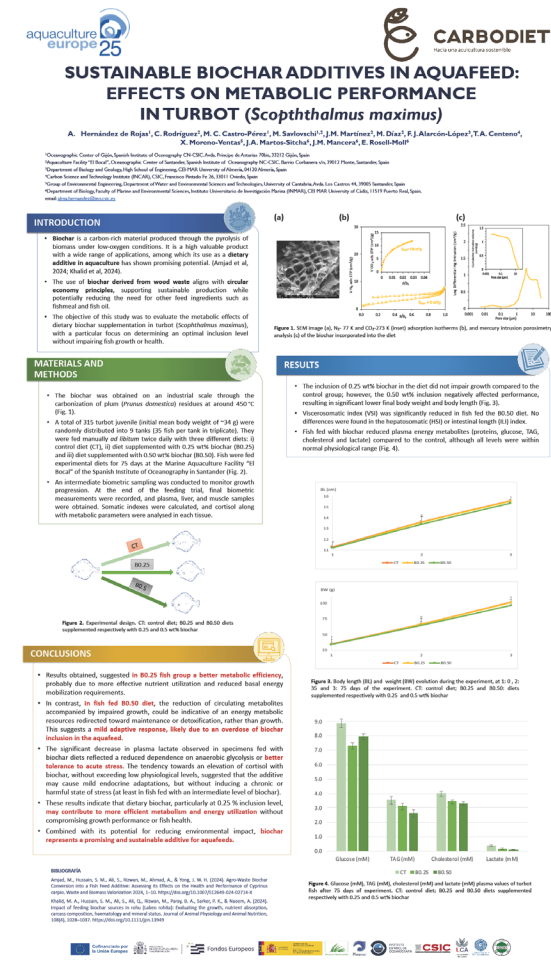
EXPERIMENTO 1 RODABALLO: MÚSCULO





EXPERIMENTO 1 RODABALLO: MENSAJES

- Los resultados obtenidos sugirieron una mejor eficiencia metabólica en el grupo de peces B0.25, probablemente debido a una utilización más eficaz de los nutrientes y a una menor movilización de energía basal.
- Por el contrario, en los peces alimentados con la dieta B0.50, la reducción de los metabolitos circulantes, acompañada de un crecimiento deficiente, podría indicar una redirección de los recursos metabólicos energéticos hacia la desintoxicación, en lugar del crecimiento.
- Estos resultados indican que el biocarbón dietético, especialmente al 0,25 %, puede contribuir a un metabolismo y un uso energético más eficientes sin comprometer el crecimiento ni la salud de los peces.
- Combinado con su potencial para reducir el impacto ambiental, el biocarbón representa un aditivo prometedor y sostenible para los alimentos acuícolas.



1 Experimento 1:

- CT: Control (0 % biocarbón)
- B0.25: 0,25 % biocarbón
- B0.50: 0,50 % biocarbón

Resultado experimento 1

DIETA ÓPTIMA EXPERIMENTO 1

2 Experimento 2:

- CT: Control (0 % biocarbón)
- BXX: X % biocarbón
- M5: 5 % microalgas
- BM: X % biocarbón + 5 % microalgas

DESAFIOS TRAS ALIMENTACIÓN

- Metabólico: ayuno durante 10 días
- Inmunológico: tratamiento con LPS



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AGRADECIMIENTOS

Integrantes del Grupo de Investigación del Proyecto CARBODIET:

- Dr. Juan Antonio Martos-Sitcha
- Dra. Milagrosa Oliva Ramírez

En especial a D. Enrique Rosell (contratado capítulo VI en el Proyecto CARBODIET).

A todos los miembros del Grupo de Fisiología de la Alimentación y el Bienestar en Acuicultura de la UCA.

