

SUSTAINABLE BIOCHAR ADDITIVES IN AQUAFEED: EFFECTS ON METABOLIC PERFORMANCE IN TURBOT (*Scophthalmus maximus*)

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INTRODUCTION

- Biochar** is a carbon-rich material produced through the pyrolysis of biomass under low-oxygen conditions. It is a high valuable product with a wide range of applications, among which its use as a **dietary additive in aquaculture** has shown promising potential. (Amjad et al, 2024; Khalid et al, 2024).
- The use of **biochar derived from wood waste** aligns with **circular economy principles**, supporting sustainable production while potentially reducing the need for other feed ingredients such as fishmeal and fish oil.
- The objective of this study was to evaluate the metabolic effects of dietary biochar supplementation in turbot (*Scophthalmus maximus*), with a particular focus on determining an optimal inclusion level without impairing fish growth or health.

MATERIALS AND METHODS

- The biochar was obtained on an industrial scale through the carbonization of plum (*Prunus domestica*) residues at around 450 °C (Fig. 1).
- A total of 315 turbot juvenile (initial mean body weight of ~34 g) were randomly distributed into 9 tanks (35 fish per tank in triplicate). They were fed manually *ad libitum* twice daily with three different diets: i) control diet (CT), ii) diet supplemented with 0.25 wt% biochar (B0.25) and iii) diet supplemented with 0.50 wt% biochar (B0.50). Fish were fed experimental diets for 75 days at the Marine Aquaculture Facility “El Bocal” of the Spanish Institute of Oceanography in Santander (Fig. 2).
- An intermediate biometric sampling was conducted to monitor growth progression. At the end of the feeding trial, final biometric measurements were recorded, and plasma, liver, and muscle samples were obtained. Somatic indexes were calculated, and cortisol along with metabolic parameters were analysed in each tissue.

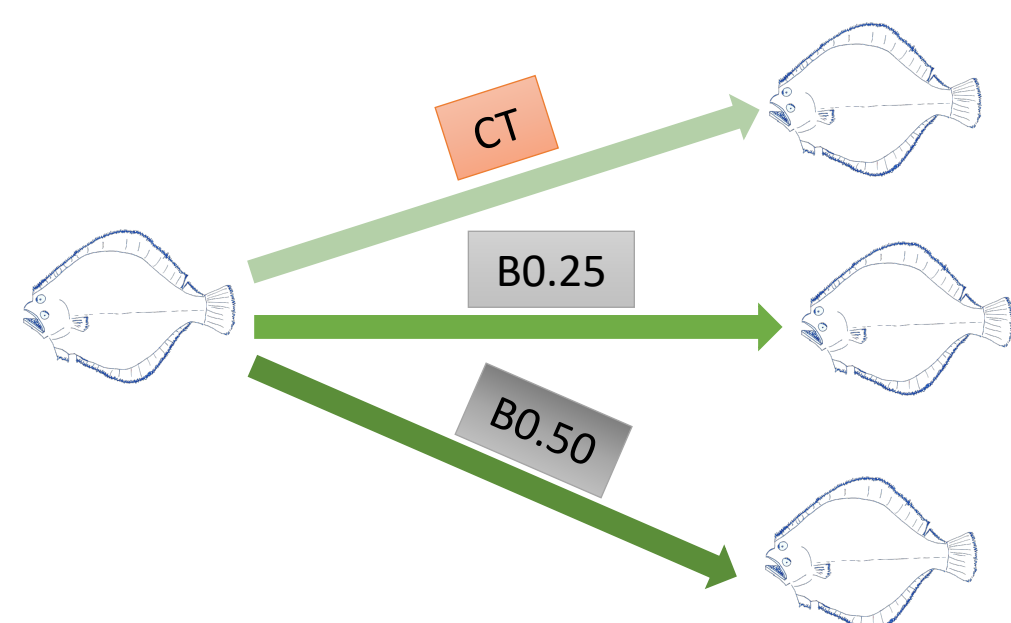


Figure 2. Experimental design. CT: control diet; B0.25 and B0.50 diets supplemented respectively with 0.25 and 0.50 wt% biochar

CONCLUSIONS

- Results obtained, suggested **in B0.25 fish group a better metabolic efficiency**, probably due to more effective nutrient utilization and reduced basal energy mobilization requirements.
- In contrast, **in fish fed B0.50 diet**, the reduction of circulating metabolites accompanied by impaired growth, could be indicative of an energy metabolic resources redirected toward maintenance or detoxification, rather than growth. This suggests a **mild adaptive response, likely due to an overdose of biochar inclusion in the aquafeed**.
- The significant decrease in plasma lactate observed in specimens fed with biochar diets reflected a reduced dependence on anaerobic glycolysis or **better tolerance to acute stress**. The tendency towards an elevation of cortisol with biochar, without exceeding low physiological levels, suggested that the additive may cause mild endocrine adaptations, but without inducing a chronic or harmful state of stress (at least in fish fed with an intermediate level of biochar).
- These results indicate that dietary biochar, particularly at 0.25 % inclusion level, **may contribute to more efficient metabolism and energy utilization** without compromising growth performance or fish health.
- Combined with its potential for reducing environmental impact, **biochar represents a promising and sustainable additive for aquafeeds**.

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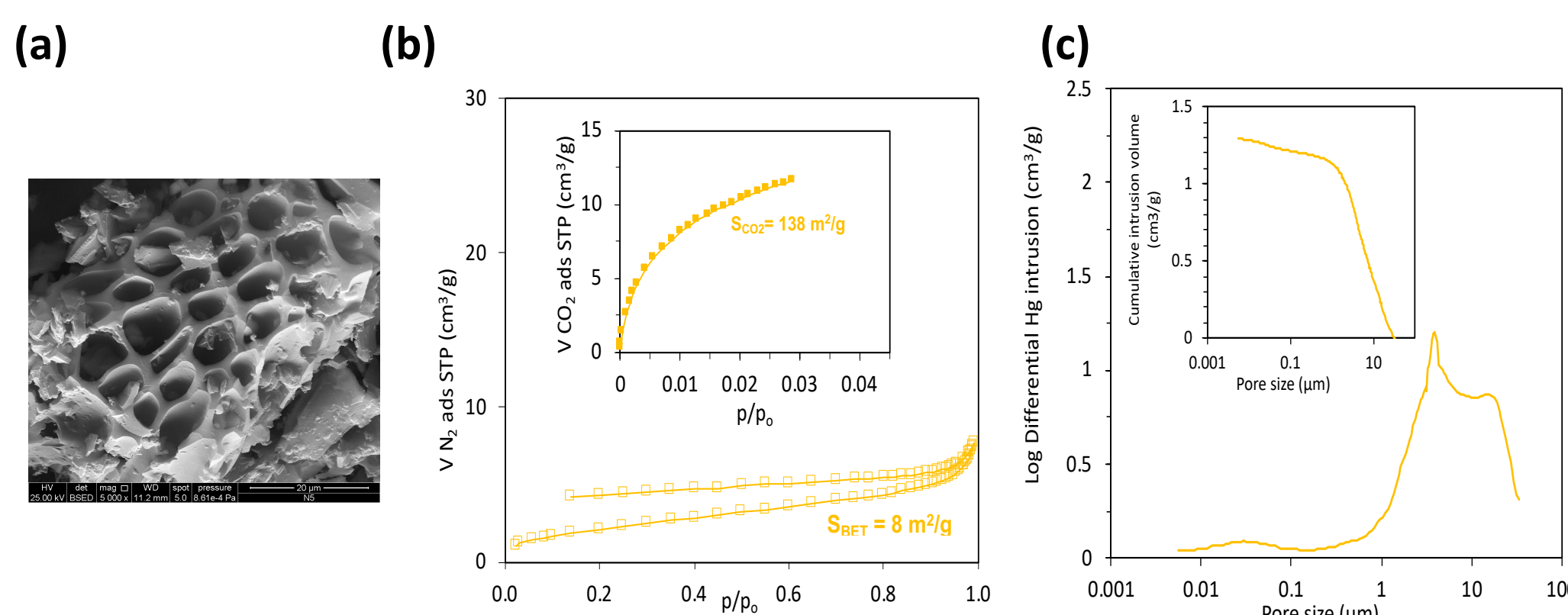


Figure 1. SEM image (a), N₂-77 K and CO₂-273 K (inset) adsorption isotherms (b), and mercury intrusion porosimetry analysis (c) of the biochar incorporated into the diet

RESULTS

- The inclusion of 0.25 wt% biochar in the diet did not impair growth compared to the control group; however, the 0.50 wt% inclusion negatively affected performance, resulting in significant lower final body weight and body length (Fig. 3).
- Viscerosomatic index (VSI) was significantly reduced in fish fed the B0.50 diet. No differences were found in the hepatosomatic (HSI) or intestinal length (ILI) index.
- Fish fed with biochar reduced plasma energy metabolites (proteins, glucose, TAG, cholesterol and lactate) compared to the control, although all levels were within normal physiological range (Fig. 4).

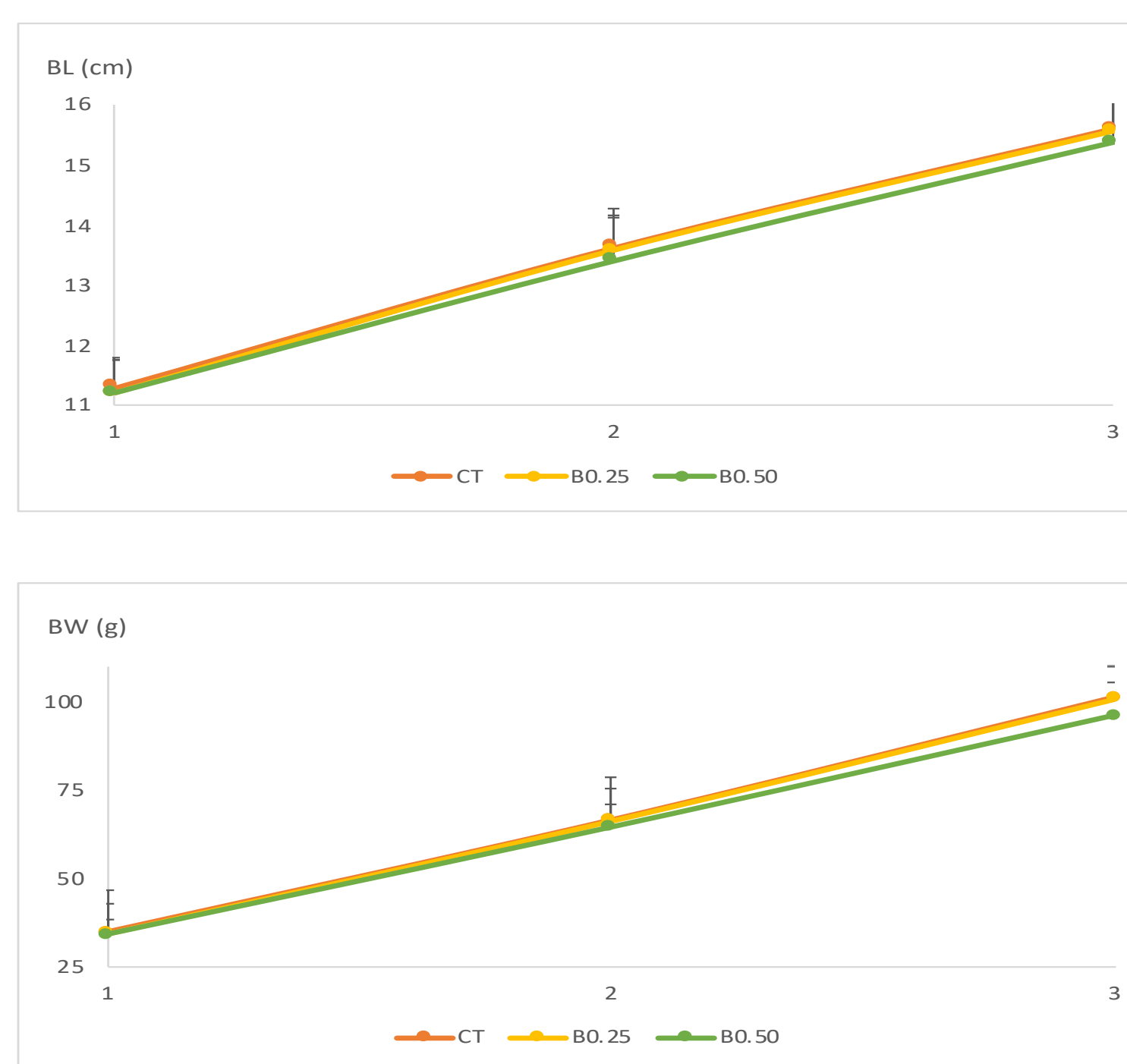


Figure 3. Body length (BL) and weight (BW) evolution during the experiment, at 1: 0, 2: 35 and 3: 75 days of the experiment. CT: control diet; B0.25 and B0.50: diets supplemented respectively with 0.25 and 0.50 wt% biochar

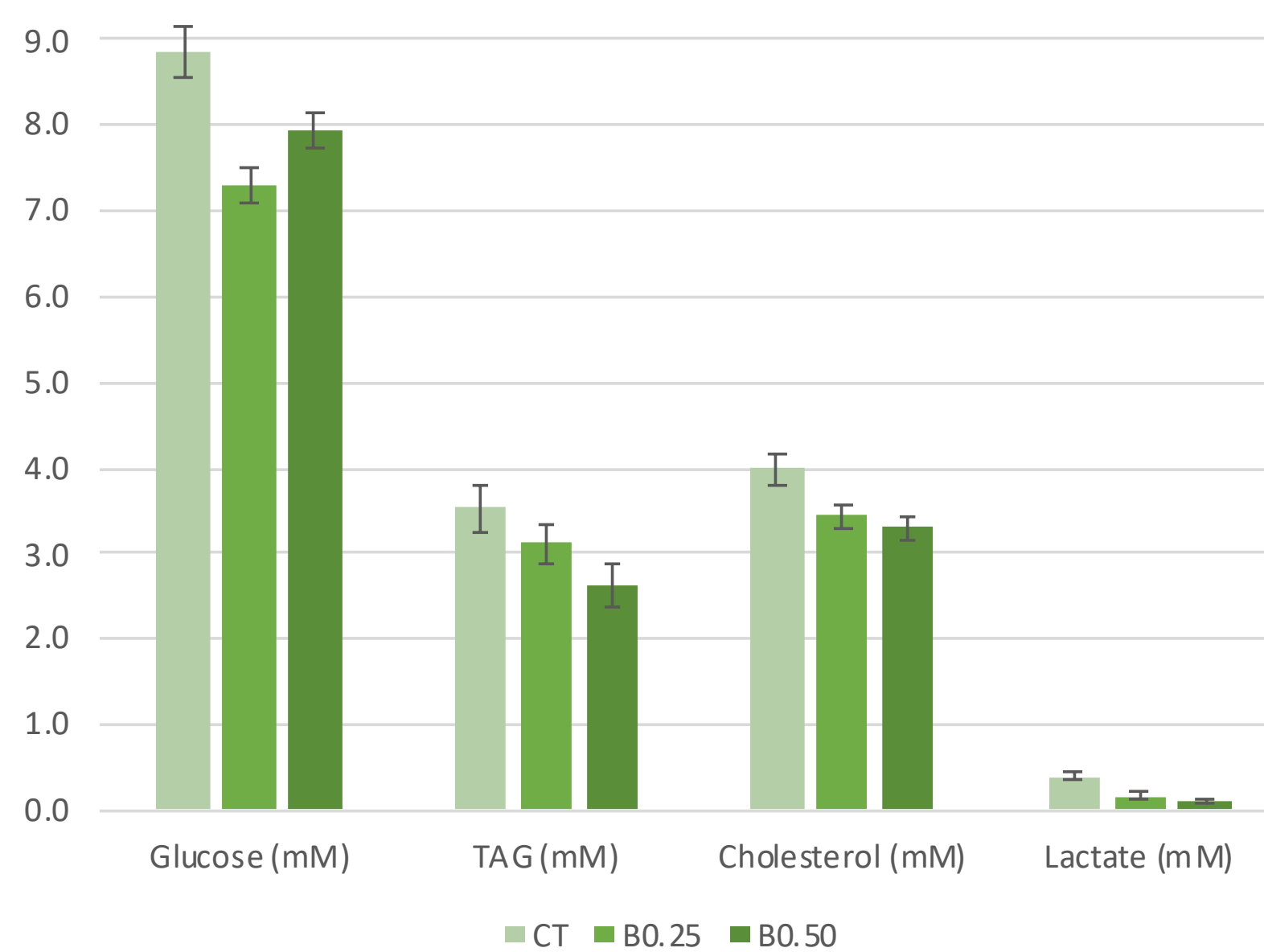


Figure 4. Glucose (mM), TAG (mM), cholesterol (mM) and lactate (mM) plasma values of turbot fish after 75 days of experiment. CT: control diet; B0.25 and B0.50: diets supplemented respectively with 0.25 and 0.5 wt% biochar