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## Skin mucus metabolites and cortisol in meagre fed acute stress-attenuating diets: correlations between plasma and mucus

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### ABSTRACT

The welfare of fish is influenced by management and environmental factors which may greatly increase animal stress levels and even endanger their survival. In this study of meagre (*Argyrosomus regius*), two stressor conditions, hypoxia and netting, are employed to evaluate the potential use of fish skin mucus as a non-invasive stress biomarker. Dietary supplementation for a week with stress-attenuating amino acids (aspartate, Asp, 1%; and tryptophan, Trp, 1%) was assayed for both conditions. Mucus and plasma samples were obtained from non-stressed fish (basal), and both one and six post-stress hours; and the levels of glucose, lactate, protein and cortisol were determined. Moreover, the correlations between plasma and mucus stress metabolites and cortisol were established. A classic stress response was evidenced in plasma by increased glucose, lactate and cortisol levels ( $p < 0.05$ ), irrespective of the stressor. The skin mucus responses were amplified with respect plasma; and mucus metabolites and cortisol rose higher under hypoxia than under netting, possibly in relation to an overall higher energy demand. Dietary supplementation with Trp seems to be protective, mitigating the acute stress provoked by netting; in contrast, additional Asp produces over-exudation of mucus metabolites and cortisol, and an undesirable energy loss. The statistical analysis showed a positive relation between plasma and skin mucus stress markers, opening up new possibilities for non-invasive, quick and simple methods to detect early stress responses in the fish.

### INTRODUCTION

Classic diagnoses of the physiological and health status of fish are provided by haematological and clinical chemical analyses (Hrubec et al., 2000; Tavares-Dias and De Moraes, 2007). Blood analysis may be a rapid and non-lethal tool to detect stress, but blood extraction could itself add an extra stress response, due to skin injuries that increase the probability of suffering bacterial and fungal infections. In spite of numerous studies in fish, reliable and standardised reference values for clinically normal, non-stressed animals are lacking for most species. Overall, plasma cortisol level is the blood parameter most

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