Energetic cost derived of short-term starvation on marine crustacean *Palaemon elegans*

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INTRODUCTION

Starvation has a major impact on physiological processes in marine plankton and, in turn, these processes have a major impact on the energy transfer through marine ecosystems. How starvation changes different aspects of the energy transfer has been understudied because planktologists have largely relied on biomass fractionation as a research tool. Here, with a caridean shrimp, Palaemon elegans, we experiment with the cellular energy allocation approach (CEA index), a new index that is calculated as the ratio between energy available (Ea), to energy consumption (Ec). It allows us to evaluate the net energy budget (Verslycke and Janssen, 2002). We analyzed the effect of 72 hours of starvation on the CEA index, the respiratory electron transport system activity (ETS), and on the shrimps' lipids (LIP), carbohydrates (CARB) and proteins (PROT) to help further our understanding on the energy transfer in the shrimp. The Ea equals the sum of the LIP, CARB, and PROT. The Ec equals the ETS activity in comparable units.

METHODOLOGY

ENERGY AVAILABLE (Ea)

CARB

Dubois et al. (1956)
- 150µL sample + 150µL phenol (5%) + 750µL H_2SO_4
- 10min, vortex
- Incubation 30ºC, 10min
- Read absorbance at 485nm

(Standard: Glucose in buffer)

+

LIP

1) Extraction (1:1:0.9; Bligh and Dyer, 1959)
- 250µL sample + 500µL chloroform + 500µL methanol + 200µL water
- 500µL standard + 500µL methanol + 450µL water
- Centrifugation (2600g, 10min, 4ºC)

2) Charring (200ºC, 15min): 100µL organic phase + 500µL H_2SO_4

3) Colorimetric assay (Barnes and Blackstock, 1973):
- 40µL charred sample + 1mL phosphovanillin reagent
- Incubation 37ºC, 15min
- Read absorbance at 525nm

(Standard: Oleic acid in methanol)

+

PROT

Smith et al. (1985)
- 250µL sample + 250µL work reagent
- Incubation 37ºC, 30min
- Read absorbance at 540nm

(Standard: BSA in buffer)

SAMPLE PRE-TREATMENT

- ✓ Homogenization in 0.1M sodium-potassium phosphate buffer
- ✓ Centrifugation: 4000rpm, 10min, 0ºC

Palaemon elegans

ENERGY CONSUMPTION (Ec)

ETS

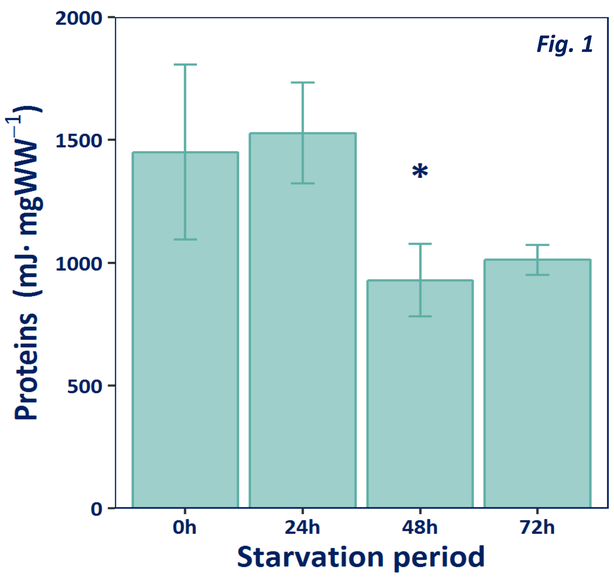
Owens and King (1975); Gómez et al. (1996)
- 100µL sample + 300µL substrate solution + 100µL INT
- Read absorbance kinetically at 490nm during 8 min

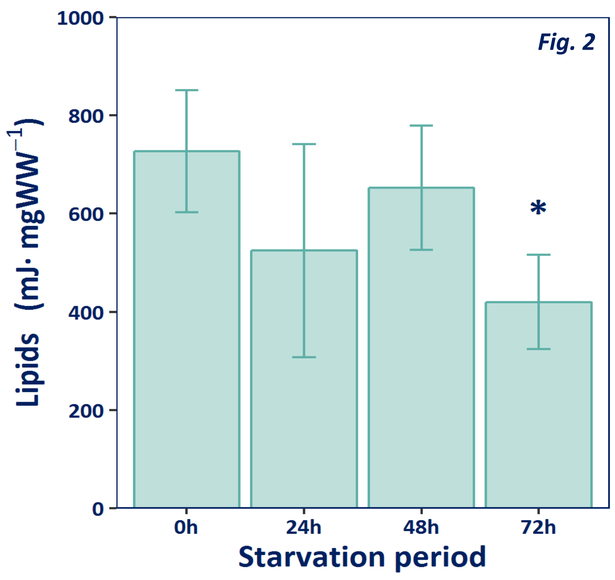
ENERGY BUDGET

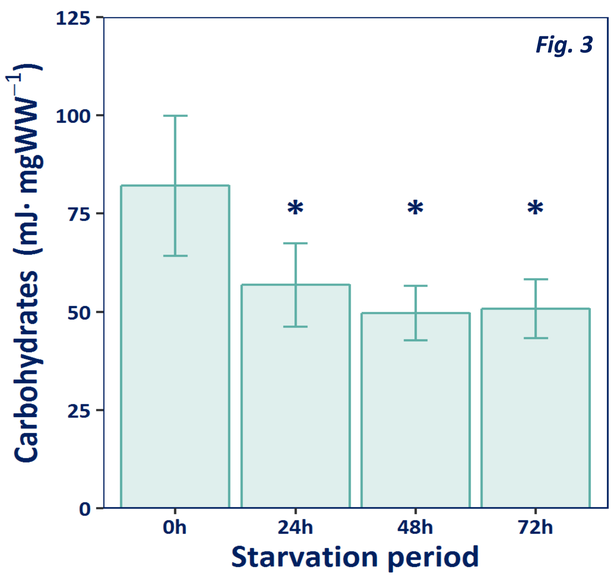
CEA index = Ea / Ec

Paremeters transformed into energy equivalents (Gnaiger, 1983)

RESULTS







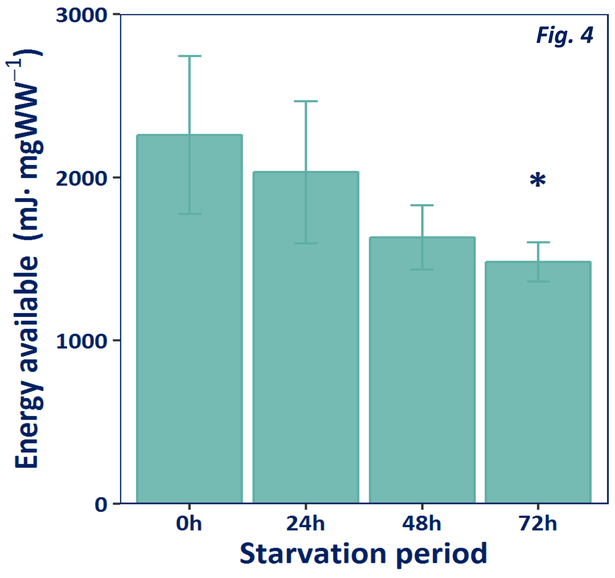
(*) Significant differences compared with the control group (0h)

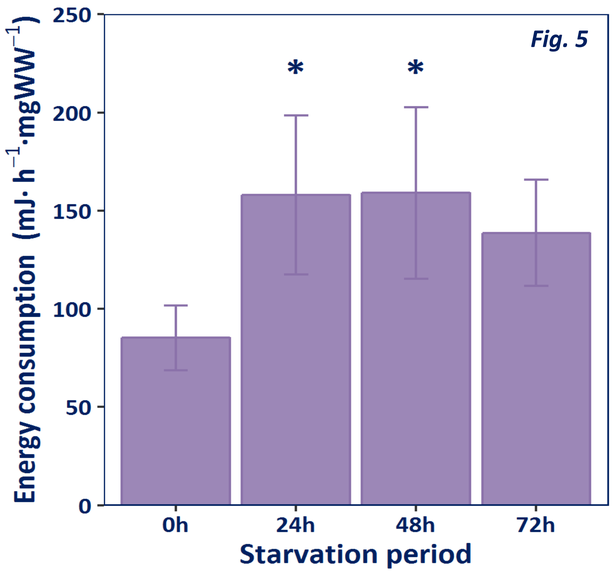
- ➢ *After 24h*: Carbohydrates dropped by 38.2% (Fig. 3)
- ➢ *After 48h*: Proteins had decreased by 36.0% (Fig. 1)
- ➢ *After 72h*: Lipids had dropped by 42.3% (Fig. 2)

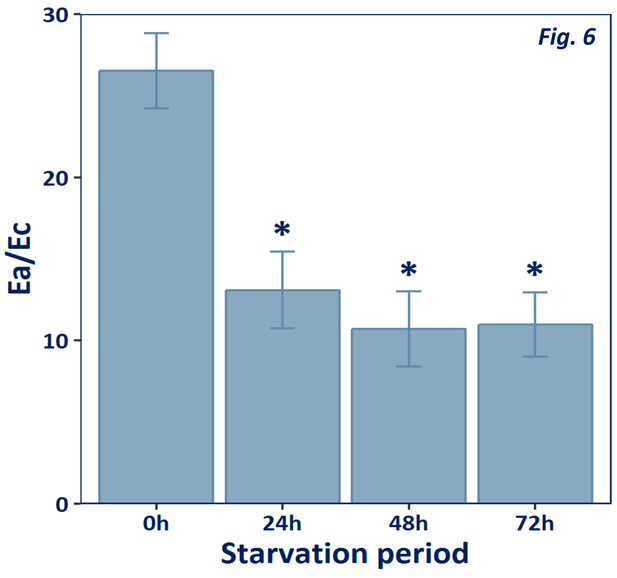
- ➢ *Energy available*: significant decreasing trend of 34.42% at 72 h. (Fig. 4)
- ➢ *Energy consumption*: significant increase at 24h that stabilized after 72h. (Fig. 5)

ENERGY BUDGET (Fig. 6)

Energy available was higher than the energy consumption during the experiment. The ratio (Ea/Ec) decreased for the first 24h then remained stable up to 72h.







CONCLUSIONS

- ❖ Proteins were the main energy reserve (1450.8 ± 355.7 mJ·mgWW^{-1}) followed by lipids (727.2 ± 121.4 mJ·mgWW^{-1}) and carbohydrates (82.1 ± 17.9 mJ·mgWW^{-1}).
- ❖ Carbohydrates were the first energy source mobilised (after 24h), followed by proteins (48h), and lipids the last (at 72h).
- ❖ Energy regulation shows a rapid shift mechanism of *P. elegans* under adverse conditions.

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