

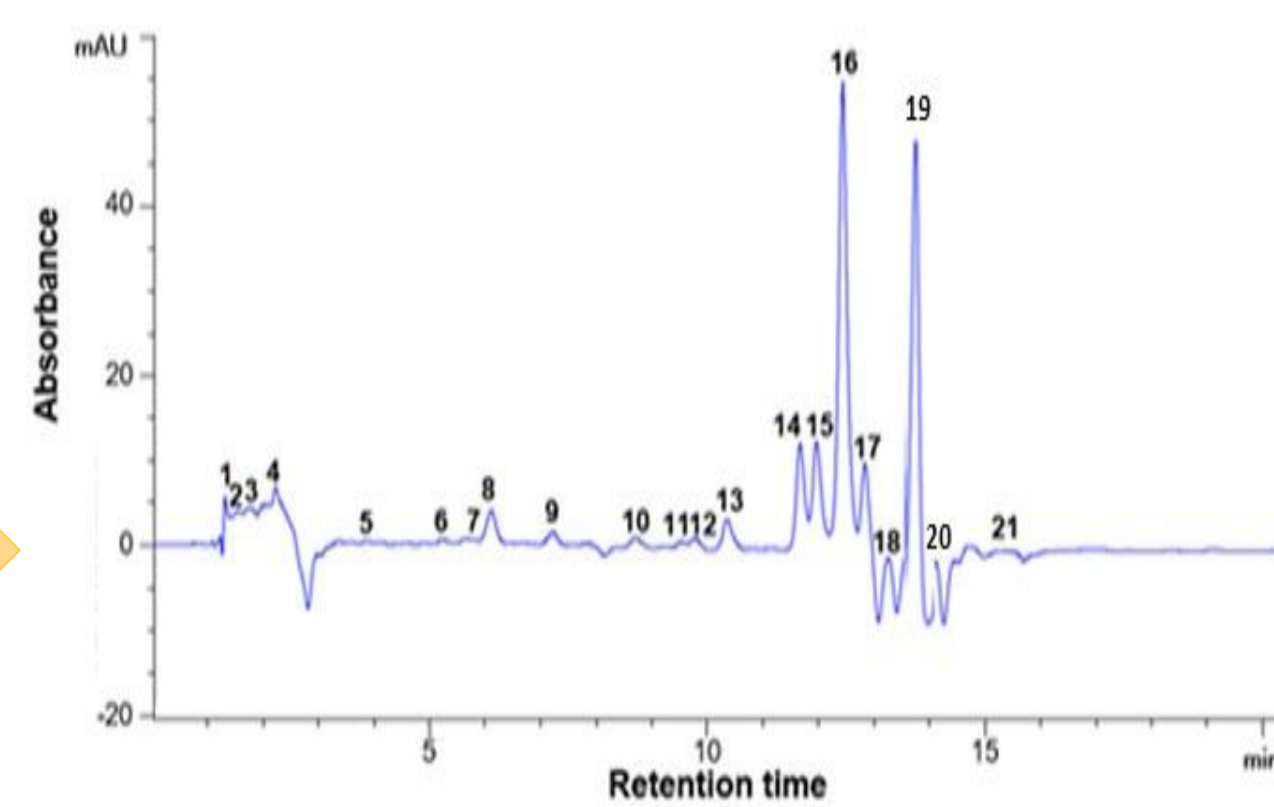
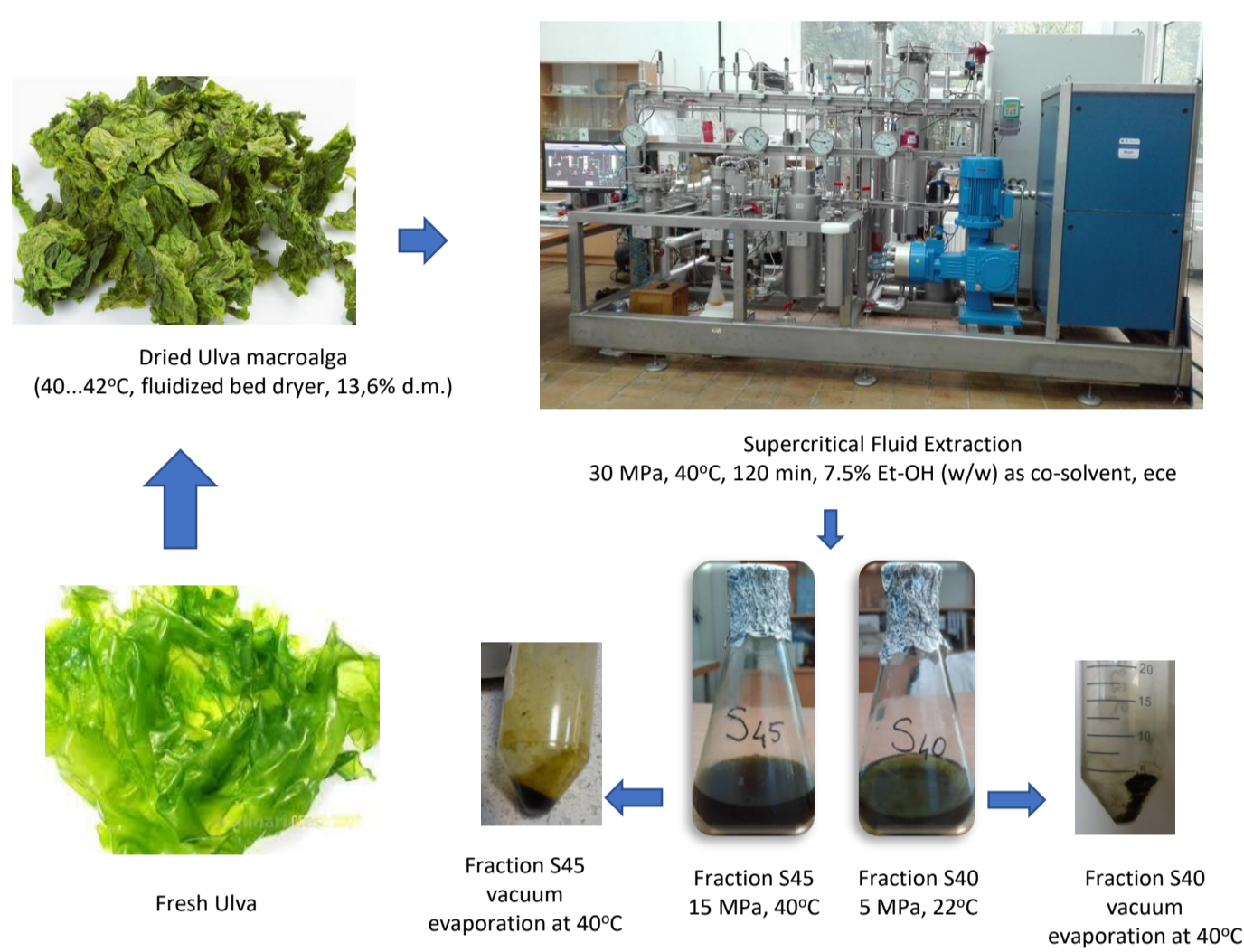
# EFFECT OF GREEN SEAWEED EXTRACT OBTAINED BY SUPERCRITICAL CO<sub>2</sub> ON GROWTH PERFORMANCE AND HEALTH STATUS OF *CYPRINUS CARPIO* REARED UNDER DIFFERENT WATER QUALITY REGIME

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A major concern in the context of current climate change is producing food in a way that protects natural resources by using production systems with minimal ecological impact. Technological advancements have led to the discovery of alternative feed sources, using high-quality ingredients aimed to improve fish health, stress tolerance, and disease resistance through specific nutritional contributions. The main goal of this research was to assess the efficacy of incorporating *Ulva lactuca* extracts into carp feed to enhance the fish's resilience to suboptimal water quality conditions, while ensuring that growth performance and overall health remain uncompromised.

## Experimental Design

### The Ulva extract



Main bioactive compound	Concentration, mg/g DW extract
Zeaxanthin	3.09±7.1
Astaxanthin	0.13 ±2.1
β-cryptoxanthin	1.15±3.01
α-carotene	27.04±3.5
β-carotene	151.05±9.1

Figure 1. Carotenoids' profile of the algae extract (S45 fraction) at 450 nm. Peaks' identification: 1 – zeaxanthin, 5 – astaxanthin, 12 – β-cryptoxanthin, 19 – α-carotene, 21 – β-carotene, 2 – 4, 6 – 11, 13 – 18, 20 – unidentified compounds.

### The factorial design experiment

#### Factor1 - Water quality

LA - Low accumulation (28,5 L/kg feed/day exchange rate)  
MA - Middle accumulation (14,2 L/kg feed/day exchange rate)  
HA - High accumulation (9,5 L/kg feed/day exchange rate)

#### Factor 2 – Feed

C (Control) – conventional feed for carp  
UE5 – Conventional feed and Ulva extract (5%/kg feed)  
UE10 – Conventional feed and Ulva extract (10%/kg feed)

9 variants

### The fish



**Cyprinus carpio**  
23 fingerlings  
(46,5 ± 3,56 g variant)  
RAS systems ( with 300 L aquariums)

80 days

### Investigations



- Growth performance
- Serum biochemical parameters
- Haematology
- Enzymology

## Results

### Growth performance

Table 1-Growth performance of *Cyprinus carpio* fed the experimental diets with extract of *Ulva lactuca* reared under different water quality regime.

Water quality	Low accumulation			Middle accumulation			High accumulation		
	UE 10	UE5	C	UE 10	UE5	C	UE 10	UE5	C
Initial biomass (g)	1024	1074	1023	1063	1072	1082	1084	1063	1027
Final biomass (g)	1960	2048	1846	1921	2045	1844	1929	2002	1644
Weight gain (g)	936,00	974,00	823,00	858,00	973,00	762,00	845,00	939,00	617,00
Feeding rate (g/kg0.8/day)	16,14	15,54	16,15	15,67	15,56	15,44	15,42	15,67	16,10
SGR (%)	0,84	0,81	0,74	0,74	0,81	0,67	0,72	0,79	0,59
Growth rate (g/day)	11,70	12,18	10,29	10,73	12,16	9,53	10,56	11,74	7,71
Feed conversion ratio (g/g)	1,30	1,25	1,48	1,42	1,25	1,60	1,44	1,30	1,97
Survival rate (%)	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

### Serum biochemical parameters

Table 2-The serum biochemical parameters of *Cyprinus carpio* under different water quality regimes and dietary conditions.

Water quality	Diet	TGO	TGP	CHOL	TRIGL	BIL D	BIL T	LDL	HDL
		U/I	U/I	mg/dl	mg/dl	mg/dl	mg/dl	mg/dl	mg/dl
LA	C	86,33	25,17	259,33	689,00	0,93	1,03	67,00	36,12
	UE10	69,40	21,20	237,80	516,40	0,67	1,00	64,20	38,80
	UE5	76,33	21,83	242,67	505,17	0,84	0,93	69,50	37,57
MA	C	85,33	26,17	270,67	708,17	1,01	1,14	71,00	35,28
	UE10	76,67	21,33	236,33	573,83	0,76	1,00	69,33	39,83
	UE5	81,83	22,33	251,50	491,67	0,89	0,93	70,33	39,33
HA	C	96,50	26,17	287,83	732,83	1,08	1,15	72,50	32,07
	UE10	86,00	24,83	237,98	717,17	0,85	0,93	72,33	35,83
	UE5	89,50	24,00	229,98	686,17	0,94	1,00	72,50	34,67

### Oxidative stress and immune responses

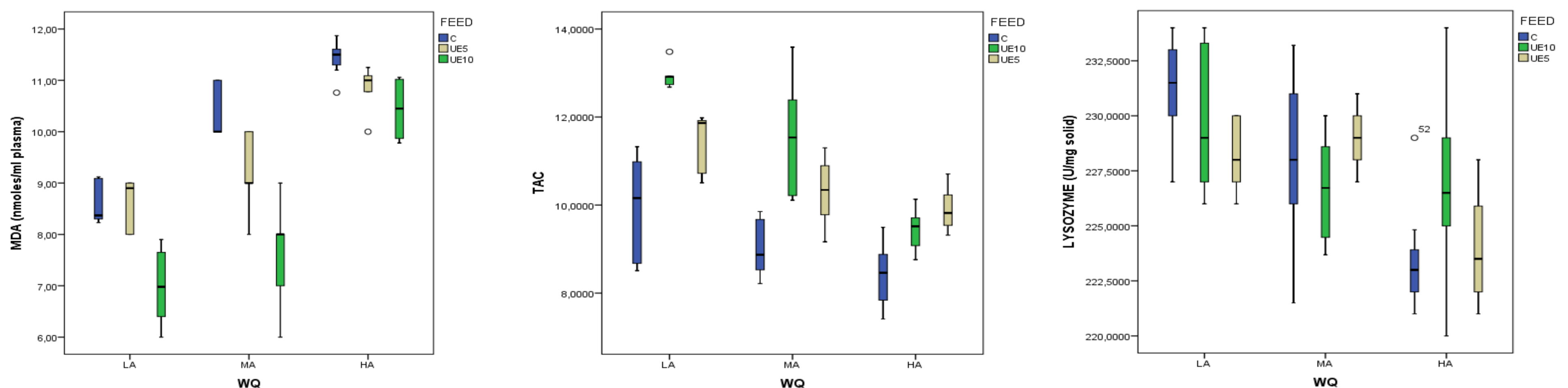


Figure 2. Oxidative stress markers of *Cyprinus carpio* for different treatments under different water quality regime

## Conclusions

The overall health profile of the fish improved significantly when their diet was supplemented with 10% Ulva extract, in the context of a high-accumulation water regime. This result highlights the positive effect of the bioactive compounds in Ulva extract in combating oxidative stress and modulating the nonspecific immune system. Additionally, a diet supplemented with 5% Ulva extract demonstrated the best growth performance under the same water regime. In conclusion, our research has confirmed the effectiveness of Ulva extract in enhancing the general health of fish, both in terms of their growth and in managing stress and stimulating the immune response.

