

This is a qualitative comparative assessment; no statistical analysis was applied. The results indicate a trade-off between potency and safety, with *C. limon* being highly effective but less safe.

Rankings are derived from an integrated evaluation of induction time, behavioural anaesthetic stage, recovery duration, and mortality. Relative potency reflects the concentration required to achieve anaesthesia and the depth of response. Safety margin is based on survival and recovery across concentrations. Species sensitivity reflects differences in response between *Clarias gariepinus* and *Oreochromis niloticus* across all indicators.

3.6 Water quality conditions during the experiment

Water quality parameters remained within recommended ranges throughout the experimental period (Table 7). Temperature, dissolved oxygen, pH, conductivity, and ammonia levels were maintained within acceptable limits for tropical freshwater aquaculture.

As all measured values fell within established thresholds, no statistical analysis was required. The stability of these parameters suggests that environmental conditions did not confound the observed treatment effects.

Table 7 Water quality parameters

Parameter	Observed Range	Recommended Range	Status
Temperature (°C)	26.4–27.3	24–30	Suitable
Dissolved oxygen	5.8–6.3	≥5.0	Adequate
pH	6.8–7.3	6.5–8.0	Stable
Conductivity	182–191	150–400	Acceptable
Ammonia	0.01–0.02	<0.05	Safe

All values fall within recommended aquaculture limits; no statistical comparison required. Environmental conditions were within recommended ranges and are unlikely to have confounded experimental outcomes

3.7 Effects of extracts on flesh quality parameters

Flesh quality parameters are presented (Table 8). Significant differences were observed among treatments for muscle pH ($F(2,12) = 5.84$, $p = 0.017$), crude protein content ($F(2,12) = 4.96$, $p = 0.027$), and lipid content ($F(2,12) = 6.21$, $p = 0.014$).

Fish exposed to more potent extracts, particularly *Citrus limon*, tended to exhibit slightly lower values for these parameters. Although these differences were statistically significant, the magnitude of variation was relatively small and should be interpreted in the context of controlled experimental conditions and limited replication.

Table 8 Flesh quality parameters following exposure

Treatment	Species	pH (mean ± SE)	Protein	Lipid
Sweet Orange	<i>O. niloticus</i>	6.8 ± 0.07 ^a	18.5 ± 0.21 ^a	5.2 ± 0.14 ^a
Sweet Orange	<i>C. gariepinus</i>	6.9 ± 0.08 ^a	17.9 ± 0.16 ^a	5.4 ± 0.13 ^a
Sour Orange	<i>O. niloticus</i>	6.7 ± 0.09 ^b	18.1 ± 0.19 ^a	5.0 ± 0.11 ^b
Sour Orange	<i>C. gariepinus</i>	6.6 ± 0.08 ^b	17.5 ± 0.15 ^b	5.1 ± 0.12 ^b
Lemon	<i>O. niloticus</i>	6.5 ± 0.07 ^c	17.0 ± 0.18 ^c	4.8 ± 0.13 ^c
Lemon	<i>C. gariepinus</i>	6.4 ± 0.08 ^c	16.8 ± 0.14 ^c	4.7 ± 0.12 ^c

Values are mean ± SE ($n = 3$). Different superscripts indicate significant differences at $p < 0.05$ (ANOVA, Tukey's HSD). Flesh quality declined slightly with increasing extract potency, particularly under *C. limon* treatment.

3.8 Post-exposure welfare and behavioural recovery

Post exposure behavioural recovery is summarised in Table 10. Swimming recovery time differed significantly among treatments ($F(2,12) = 9.12$, $p = 0.004$). Feeding recovery time also varied significantly among recoverable treatments ($F(1,8) = 11.34$, $p = 0.010$).