

subjected to inferential statistical analysis. As such, they are interpreted as indicative of compositional differences rather than statistically confirmed variation.

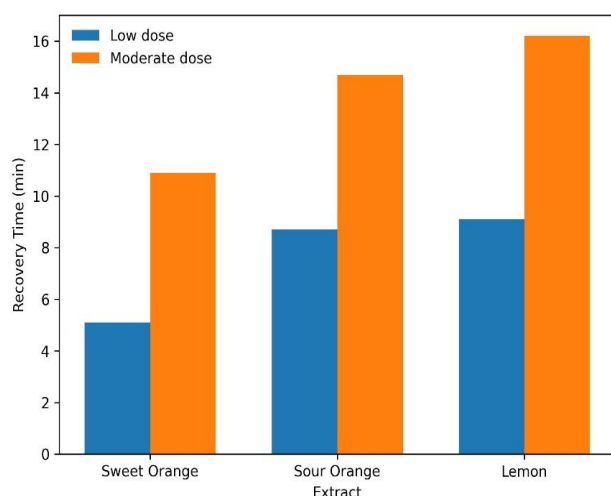


Figure 1 Recovery patterns of fish following exposure to citrus leaf extracts.

Table 1 Qualitative phytochemical composition of aqueous citrus leaf extracts

Phytochemical Group	<i>C. sinensis</i>	<i>C. aurantium</i>	<i>C. limon</i>
Flavonoids	Present	Present	Absent
Limonoids	Present	Present	Present
Terpenoids	Present	Absent	Absent
Phenolic acids	Present	Absent	Present
Carotenoids	Present	Present	Absent
Coumarins	Present	Present	Present
Essential oils	Absent	Present	Present
Alkaloids	Absent	Present	Absent

Presence and absence are based on qualitative phytochemical screening; no inferential statistical analysis was applied. The variation in phytochemical composition suggests species-specific bioactivity profiles, which may explain differences in anaesthetic potency and physiological responses observed in subsequent experiments.

### 3.2 Behavioural anaesthetic responses

#### 3.2.1 Behavioural responses of *Clarias gariepinus* under different extract concentrations

Behavioural responses of *Clarias gariepinus* across increasing extract concentrations are presented (Table 2). A progressive change in behavioural response was observed as concentration increased.

At lower concentrations, fish exhibited minimal or mild behavioural changes. As concentration increased, fish showed loss of equilibrium, reduced responsiveness, and eventual immobility. At the highest concentration, extracts of *Citrus aurantium* and *Citrus limon* were associated with cessation of opercular movement, suggesting pronounced respiratory depression. In contrast, *Citrus sinensis* produced less severe effects under comparable conditions. These observations are descriptive and were not subjected to statistical testing. Consequently, interpretations are limited to observed patterns.

Table 2 Behavioural responses of *Clarias gariepinus*

Concentration (mg L <sup>-1</sup> )	<i>C. sinensis</i>	<i>C. aurantium</i>	<i>C. limon</i>
1000	No observable effect	Initial agitation	Agitation followed by calming
2000	Slight loss of equilibrium	Partial loss of balance	Sedation
3000	Loss of equilibrium with gasping	Anaesthesia	Deep anaesthesia
4000	Prolonged immobility	Cessation of opercular movement	Cessation of opercular movement