ToxGenie Hypothesis Test Report

Report Date: 2026-06-28 17:23:11

Study Title:	Fathead minnow (Pimephales promelas) Early Life Stage Toxicity Test
Analysis Method:	Steel's Many-One Rank Test for Avg Dry Weight

Study No.:	Test-0123	**Test Material:**	Test Chemicals
Exposure Time:	21-days	**Test Medium:**	Reconstituted Water

Table 1. Raw Data Summary for Avg Dry Weight

(Unit: %)

Dose	1	2	3	4
Control	1.2900	1.3200	1.5900	1.2700
6.25	1.2700	1.0000	1.0800	0.9700
12.5	1.3200	1.3700	1.3500	1.3400
25	1.2900	1.3300	1.2000	1.1700
50	0.7800	0.7000	0.6600	0.7700

Step 1. Outlier Detection (Data QA/QC) Analysis

Table 2. Identified Statistical Outliers

Dose	Replicate No.	Observed Value	Normal Range (1.5 IQR)
Control	3	1.5900	[1.1313, 1.5413]

*Note: Outliers were identified using Tukey's fences (Values outside Q1 - 1.5*IQR or Q3 + 1.5*IQR).*
These values are flagged for Quality Assurance purposes but are typically retained to reflect true biological variance, unless experimental error is proven.

Step 2. Descriptive Statistics

Table 3. Descriptive Statistics for Avg Dry Weight

(Unit: %)

Dose	N	Mean	SD	SE	CV (%)	Median
Control	4	1.36750	0.14975	0.07487	10.95062	1.30500
6.25	4	1.08000	0.13491	0.06745	12.49142	1.04000
12.5	4	1.34500	0.02082	0.01041	1.54771	1.34500
25	4	1.24750	0.07500	0.03750	6.01202	1.24500
50	4	0.72750	0.05737	0.02869	7.88633	0.73500

Abbreviations & Explanations:
- N: Number of replicates.
- Mean: Average response value.
- SD: Standard Deviation of the mean.
- SE: Standard Error of the mean.
- CV (%): Coefficient of Variation.
- Median: 50th percentile of observed values.

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Table 4. Shapiro-Wilk's test for normality on the Avg Dry Weight.

Dose	Statistic	P-value	Result
Control	0.75194	0.04027	Reject Normal Distribution
6.25	0.88231	0.34860	Normal Distribution
12.5	0.99840	0.99506	Normal Distribution
25	0.92493	0.56491	Normal Distribution
50	0.89698	0.41622	Normal Distribution

P>0.05 indicates Normal Distribution.

Final decision: The Avg Dry Weight data does not follow a normal distribution.

Table 5. Levene's test for homogeneity on the Avg Dry Weight.

Statistic	P-value	Result
0.78026	0.55523	Equal Variances

P>0.05 indicates Equal Variances.

Final decision: The Avg Dry Weight data shows equal variances.

Table 6. Transformed Data Summary for Avg Dry Weight (Log transformation)

(Unit: %)

Dose	1	2	3	4	Mean	SD
Control	0.8286	0.8416	0.9517	0.8198	0.6891	0.3474
6.25	0.8198	0.6931	0.7324	0.6780	0.8174	0.6425
12.5	0.8416	0.8629	0.8544	0.8502	1.0020	0.8551
25	0.8286	0.8459	0.7885	0.7747	1.0826	1.1142
50	0.5766	0.5306	0.5068	0.5710	1.0195	1.4436

SD: Standard Deviation

Table 7. Shapiro-Wilk's test for normality on the transformed Avg Dry Weight.

Dose	Statistic	P-value	Result
Control	0.75895	0.04668	Reject Normal Distribution
6.25	0.89126	0.38894	Normal Distribution
12.5	0.99838	0.99502	Normal Distribution
25	0.92497	0.56518	Normal Distribution
50	0.89721	0.41735	Normal Distribution

P>0.05 indicates Normal Distribution.

Final decision: The data does not follow a normal distribution.

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Table 8. Levene's test for homogeneity on the transformed Avg Dry Weight.

Statistic	P-value	Result
0.85204	0.51433	Equal Variances

P>0.05 indicates Equal Variances.

Final decision: The data shows equal variances.

Statistical Analysis Procedure & Decision Tree

The statistical analysis for 'Avg Dry Weight' was conducted based on the following decision steps:

1. Assumption Verification (Normality & Homogeneity):

- *Since the raw data did not meet the assumption(s) of Normality, data transformation was attempted to stabilize variance and normalize the distribution.*

2. Data Transformation Strategy:

- *A Log transformation was selected and applied.*
- *Logarithmic transformation reduces skewness in positive data and stabilizes variance when it increases with the mean. It was chosen because it yielded the highest combined score for Normality and Homogeneity among all candidates.*
- *Although Log transformation was the best available option, the transformed data still failed to fully meet the statistical assumptions.*
- *Therefore, Non-Parametric tests were applied to the original (untransformed) data. Note: Monotonic transformations (Log, Sqrt, etc.) do not change the rank order of data, so non-parametric rank-based tests yield identical results on both original and transformed data. (Hollander & Wolfe, 1999; OECD No. 54, 2006)*

3. Final Selected Test Method:

- *Because the data satisfied the required statistical assumptions (Normality and Homogeneity of Variance), the Steel's Many-One Rank Test (Parametric) was selected as the post-hoc test.*
- *Prior to this post-hoc analysis, an Omnibus Test (One-Way ANOVA) was performed to confirm if any statistically significant differences exist among the dose groups ($p < 0.05$).*
- *The selected method is appropriate for comparing multiple treatment groups against a single control group to determine the NOEC/LOEC (No Observed Effect Concentration/Lowest Observed Effect Concentration) or NOAEL/LOAEL (No Observed Adverse Effect Level/Lowest Observed Adverse Effect Level).*

Table 9. Kruskal-Wallis Test on the Avg Dry Weight data.

H-statistic	P-value	Result
15.4706	0.0038	Significant differences among doses

P<0.05 indicates a statistically significant difference among groups.

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Table 10. Post Hoc Analytical Method: Steel's Many-One Rank Test on the Avg Dry Weight.

Control	Dose	Statistic	P-value	Result
Control	6.25	2.1651	0.0304	Significant difference from Control
Control	12.5	-1.0104	0.3123	No significant difference from Control
Control	25	1.0104	0.3123	No significant difference from Control
Control	50	2.3094	0.0209	Significant difference from Control

P<0.05 indicates a statistically significant difference from the Control.

Table 11. NOEC (NOAEL) and LOEC (LOAEL) Estimates (Avg Dry Weight).

(Unit: %)

NOEC (NOAEL)	The NOEC cannot be calculated.
LOEC (LOAEL)	The LOEC cannot be calculated.

** NOEC: No Observed Effect Concentration*
** LOEC: Lowest Observed Effect Concentration*
** NOAEL: No Observed Adverse Effect Level*
** LOAEL: Lowest Observed Adverse Effect Level*

Note: NOEC/LOEC are typically used for Effects on Biotic Systems where exposure is expressed as concentration (e.g., mg/L). NOAEL/LOAEL are typically used for Health Effects studies where dose is expressed per body weight (e.g., mg/kg bw/day).

Warning: The NOEC and LOEC cannot be calculated due to a violation of the dose-response monotonicity assumption (i.e., a non-significant effect was observed at a concentration higher than a significant one).

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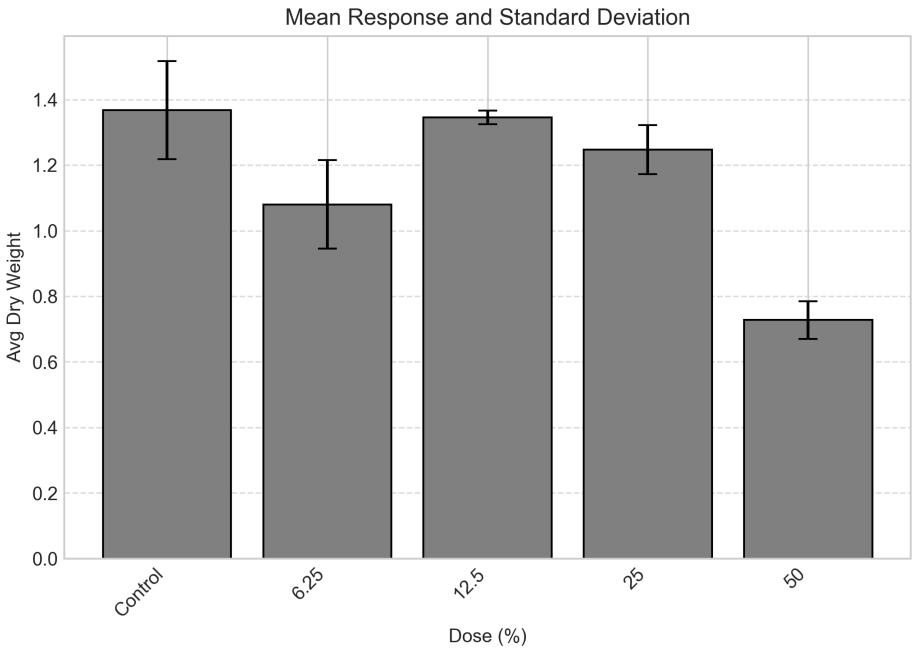

Figure 1. Dose-response trend for Avg Dry Weight. Bars represent the mean and Standard Deviation (SD).

Analyst: Toxgenie