Output log

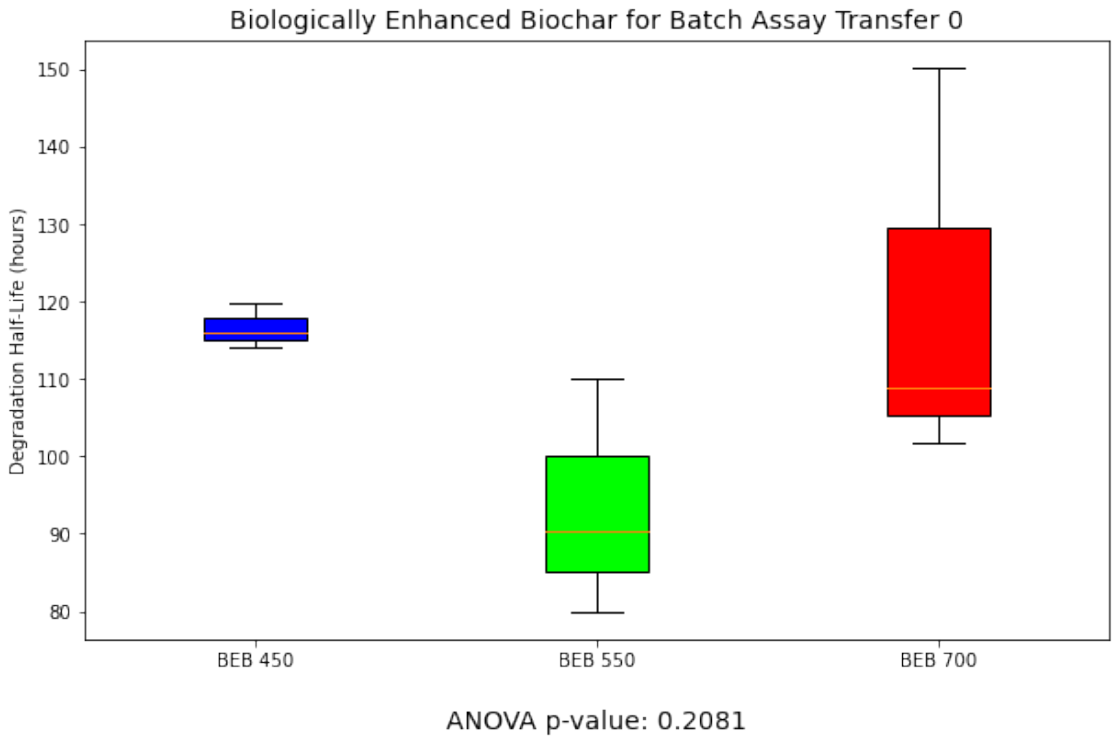
August 20, 2023

[ ]:
```
import numpy as np
from scipy.stats import f_oneway
from scipy.stats import ttest_ind
import matplotlib.pyplot as plt
import pandas as pd
df = pd.read_excel('biochar.xlsx')
grouped = df.groupby('Assay')
scaled = ['Transfer 0', 'Transfer 1', 'Transfer 2', 'Transfer 3']
colors = ['blue', 'lime', 'red','blue', 'lime', 'red']
variables = ['BEB 450', 'BEB 550', 'BEB 700']
variables_s = ['BEB 450_S', 'BEB 550_S', 'BEB 700_S']
variables_t = ['BEB 450', 'BEB 550', 'BEB 700','BEB 450_S', 'BEB 550_S', 'BEB␣
 ↪700_S']
for category, group_df in grouped:
    print(f"Assay: {category}")
    data =  [group_df[var] for var in variables]
    statistic, p_value = f_oneway(*data)
    print("ANOVA Results:")
    print("F-statistic:", statistic)
    print("p-value:", p_value)
    # Interpret the results based on the p-value
    alpha = 0.05  # significance level
    if p_value < alpha:
        print("Reject null hypothesis: There is a significant difference among␣
 ↪at least one pair of groups.")
    else:
        print("Fail to reject null hypothesis: There is no significant␣
 ↪difference among the groups.")
    print("")
    plt.figure(figsize=(10, 6))
    box = plt.boxplot(data, labels=variables, patch_artist=True)
    for patch, color in zip(box['boxes'], colors):
        patch.set_facecolor(color)
    plt.ylabel('Degradation Half-Life (hours)')
    plt.title(f'Biologically Enhanced Biochar for Batch Assay␣
 ↪{category}',fontsize=14)
    # Display the p-value at the bottom of the plot
```

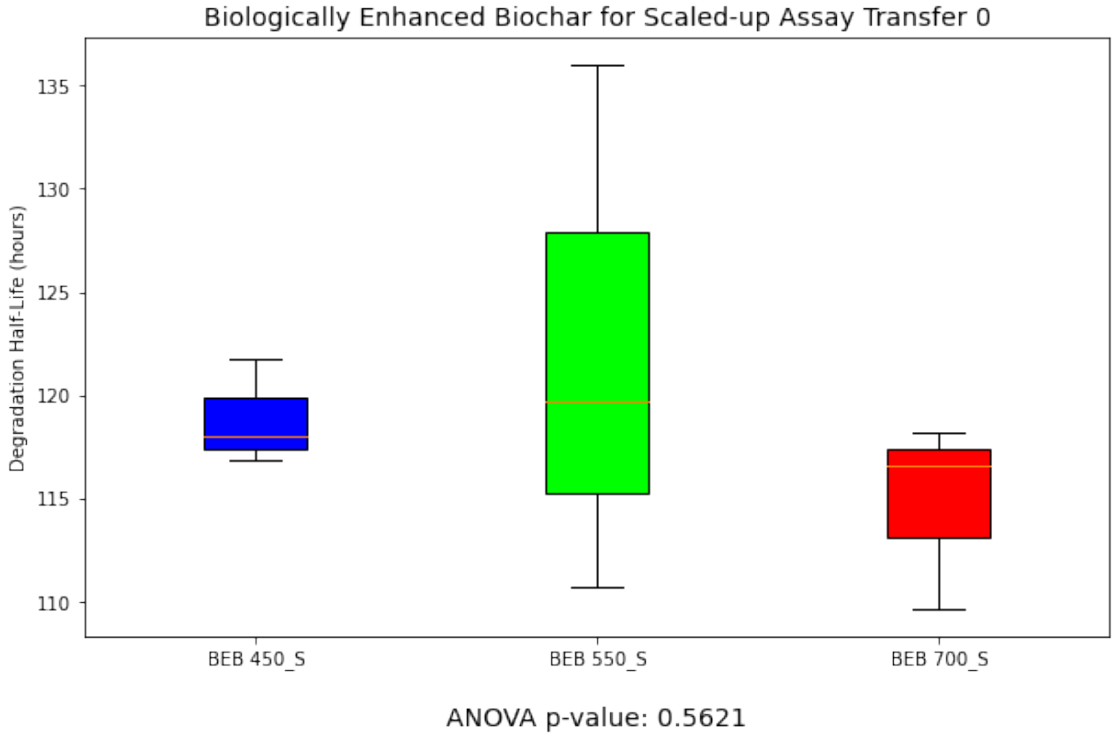
```
    plt.text(0.5, -0.15, f'ANOVA p-value: {p_value:.4f}', fontsize=14,␣
↪ha='center', transform=plt.gca().transAxes)
    filename = f'images/box_{category}.tiff'
    plt.savefig(filename)
    plt.show()
    if category in scaled:
        print(f"Assay for Scaled up: {category}")
        data =  [group_df[var] for var in variables_s]
        statistic, p_value = f_oneway(*data)
        print("ANOVA Results:")
        print("F-statistic:", statistic)
        print("p-value:", p_value)
        # Interpret the results based on the p-value
        alpha = 0.05  # significance level
        if p_value < alpha:
            print("Reject null hypothesis: There is a significant difference␣
↪among at least one pair of groups.")
        else:
            print("Fail to reject null hypothesis: There is no significant␣
↪difference among the groups.")
        print("")
        plt.figure(figsize=(10, 6))
        box = plt.boxplot(data, labels=variables_s, patch_artist=True)
        for patch, color in zip(box['boxes'], colors):
            patch.set_facecolor(color)
        plt.ylabel('Degradation Half-Life (hours)')
        plt.title(f'Biologically Enhanced Biochar for Scaled-up Assay␣
↪{category}',fontsize=14)
        # Display the p-value at the bottom of the plot
        plt.text(0.5, -0.15, f'ANOVA p-value: {p_value:.4f}', fontsize=14,␣
↪ha='center', transform=plt.gca().transAxes)
        filename = f'images/box_scaled_{category}.tiff'
        plt.savefig(filename)
        plt.show()
        ##Comparison across 6 groups
        print(f"Assay for all groups: {category}")
        data =  [group_df[var] for var in variables_t]
        statistic, p_value = f_oneway(*data)
        print("ANOVA Results:")
        print("F-statistic:", statistic)
        print("p-value:", p_value)
        # Interpret the results based on the p-value
        alpha = 0.05  # significance level
        if p_value < alpha:
            print("Reject null hypothesis: There is a significant difference␣
↪among at least one pair of groups.")
```

```
        else:
            print("Fail to reject null hypothesis: There is no significant␣
↪difference among the groups.")
        print("")
        plt.figure(figsize=(10, 6))
        box = plt.boxplot(data, labels=variables_t, patch_artist=True)
        for patch, color in zip(box['boxes'], colors):
            patch.set_facecolor(color)
        plt.ylabel('Degradation Half-Life (hours)')
        plt.title(f'Biologically Enhanced Biochar for All Assay␣
↪{category}',fontsize=14)
        # Display the p-value at the bottom of the plot
        plt.text(0.5, -0.15, f'ANOVA p-value: {p_value:.4f}', fontsize=14,␣
↪ha='center', transform=plt.gca().transAxes)
        filename = f'images/box_total_{category}.tiff'
        plt.savefig(filename)
        plt.show()
```

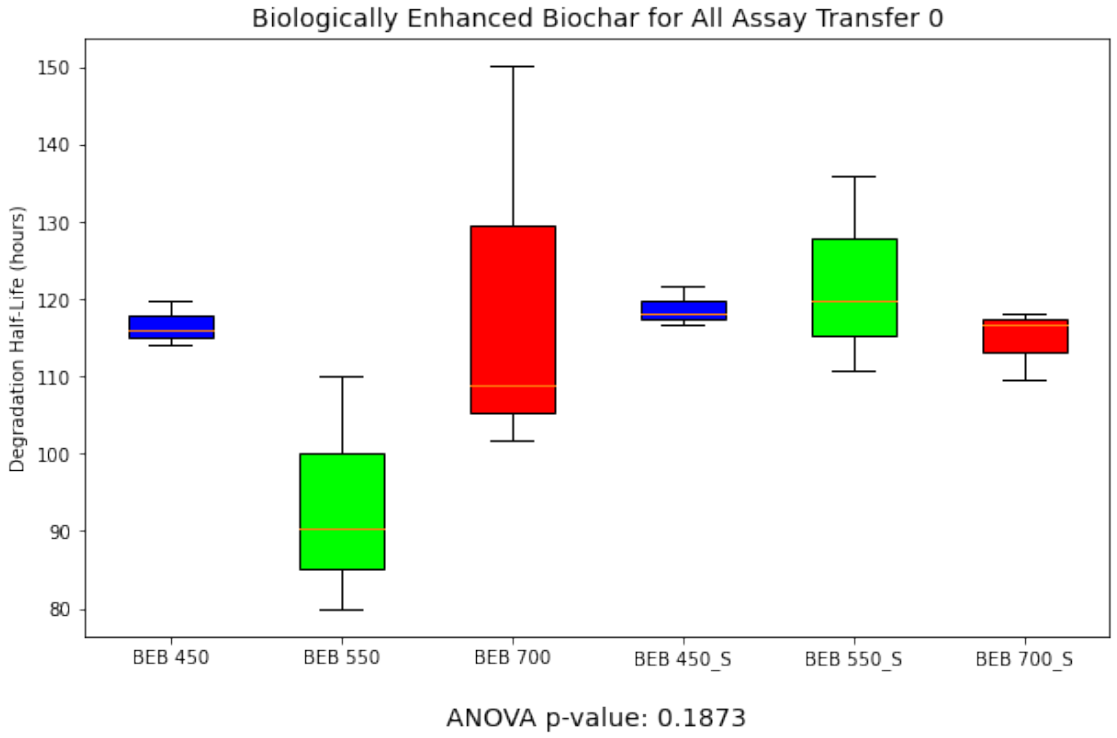
```
Assay: Transfer 0
ANOVA Results:
F-statistic: 2.062495449562643
p-value: 0.2080989201397685
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



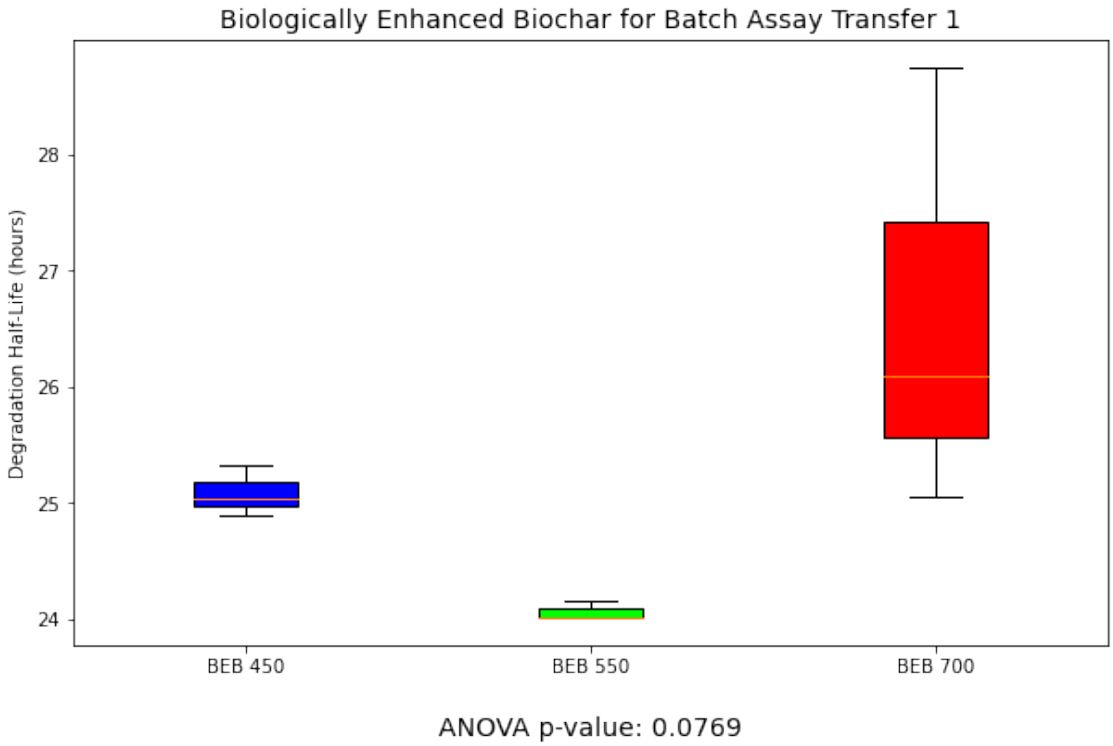
```
Assay for Scaled up: Transfer 0
ANOVA Results:
F-statistic: 0.6351993904878043
p-value: 0.5620553078978493
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



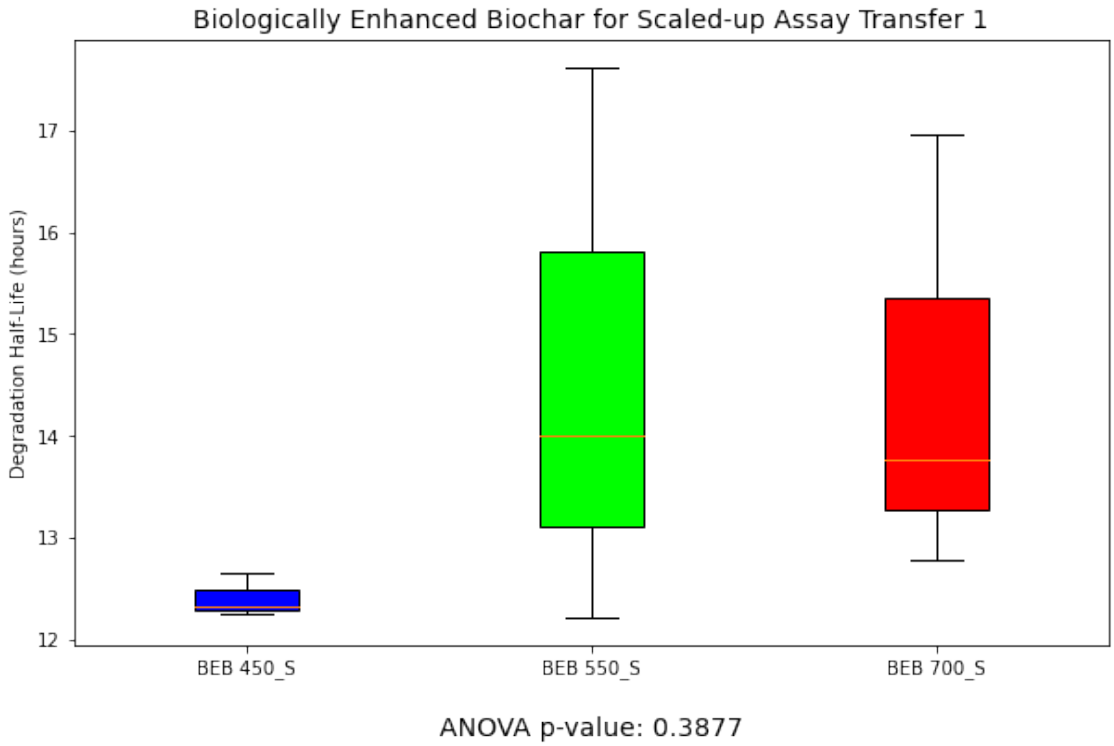

```
Assay for all groups: Transfer 0
ANOVA Results:
F-statistic: 1.800411652762449
p-value: 0.18726471848080517
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



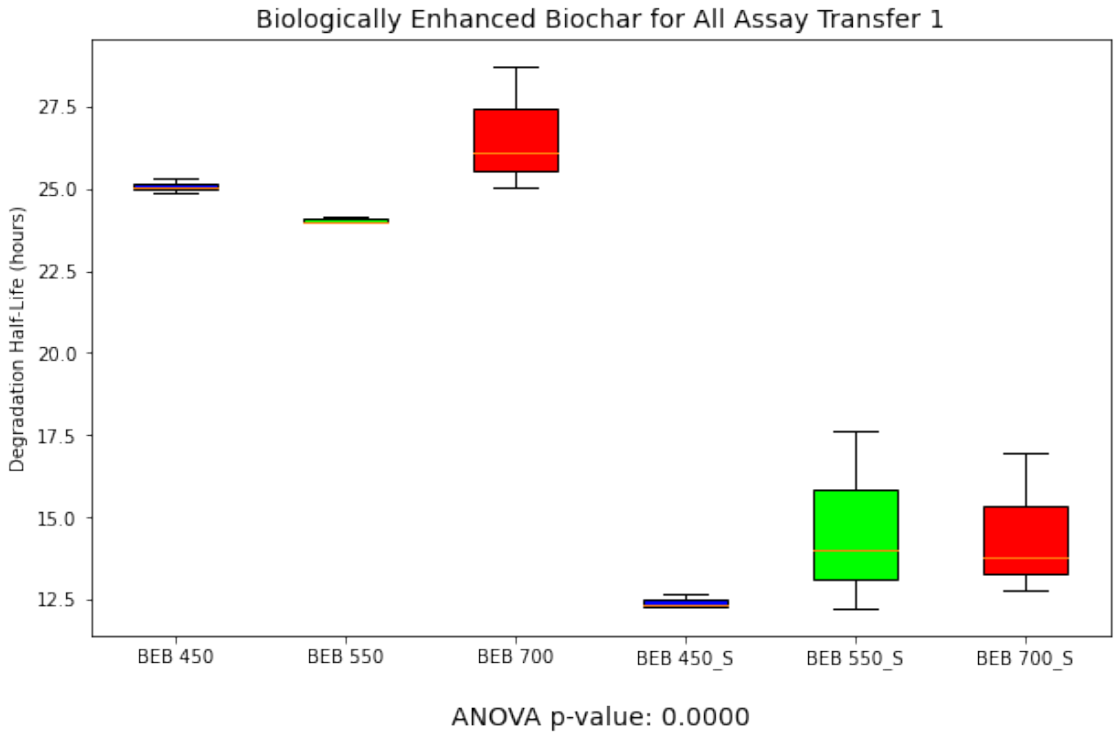
Assay: Transfer 1
ANOVA Results:
F-statistic: 4.053411134322034
p-value: 0.07694247764031245
Fail to reject null hypothesis: There is no significant difference among the groups.



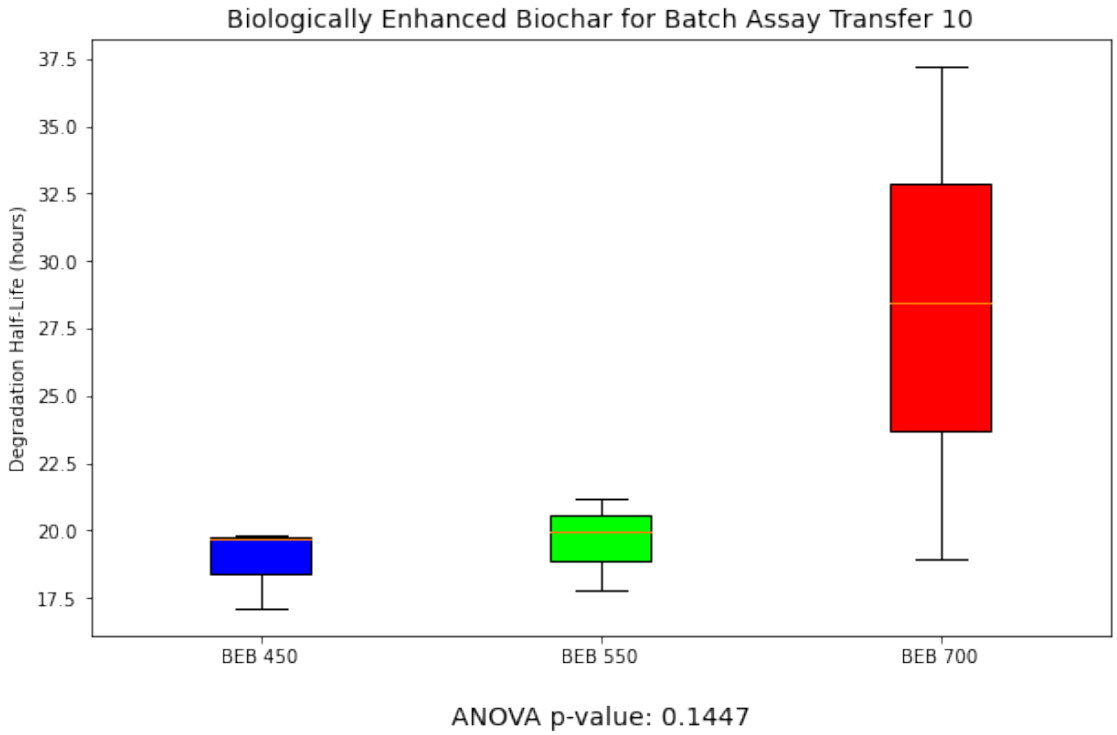

```
Assay for Scaled up: Transfer 1
ANOVA Results:
F-statistic: 1.1141658395836245
p-value: 0.38772015935785414
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



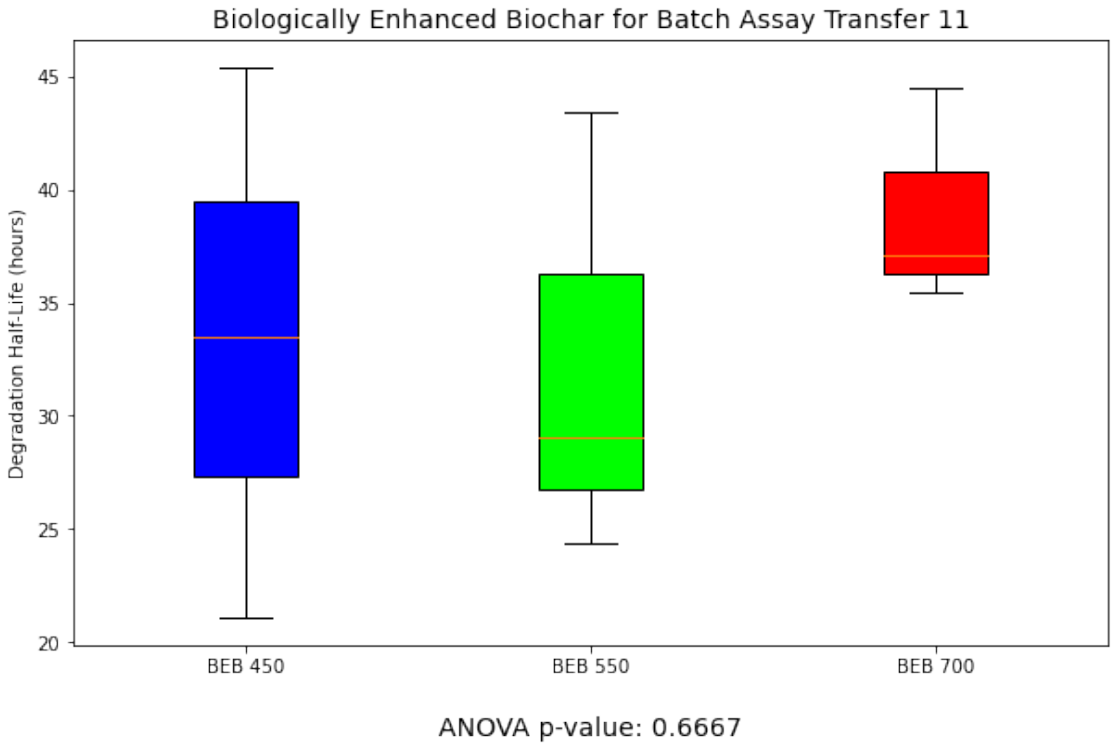

```
Assay for all groups: Transfer 1
ANOVA Results:
F-statistic: 44.987095267484634
p-value: 2.315405399095259e-07
Reject null hypothesis: There is a significant difference among at least one
pair of groups.
```



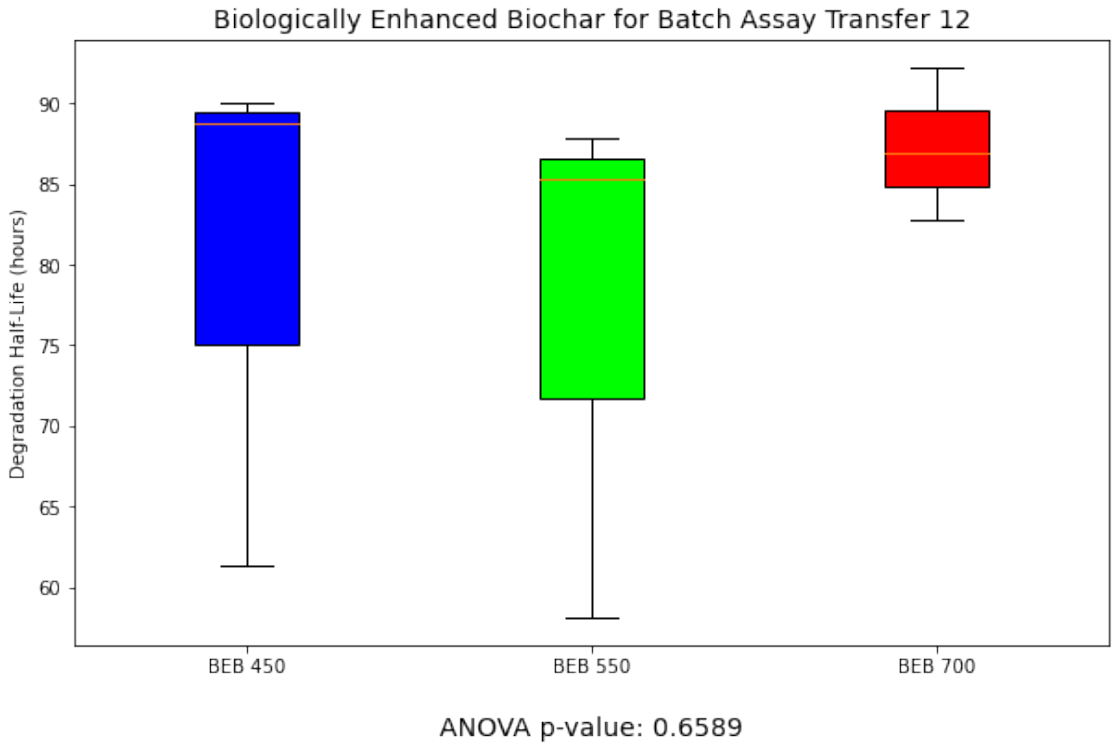
Assay: Transfer 10
ANOVA Results:
F-statistic: 2.714736253789114
p-value: 0.14466890329763096
Fail to reject null hypothesis: There is no significant difference among the groups.



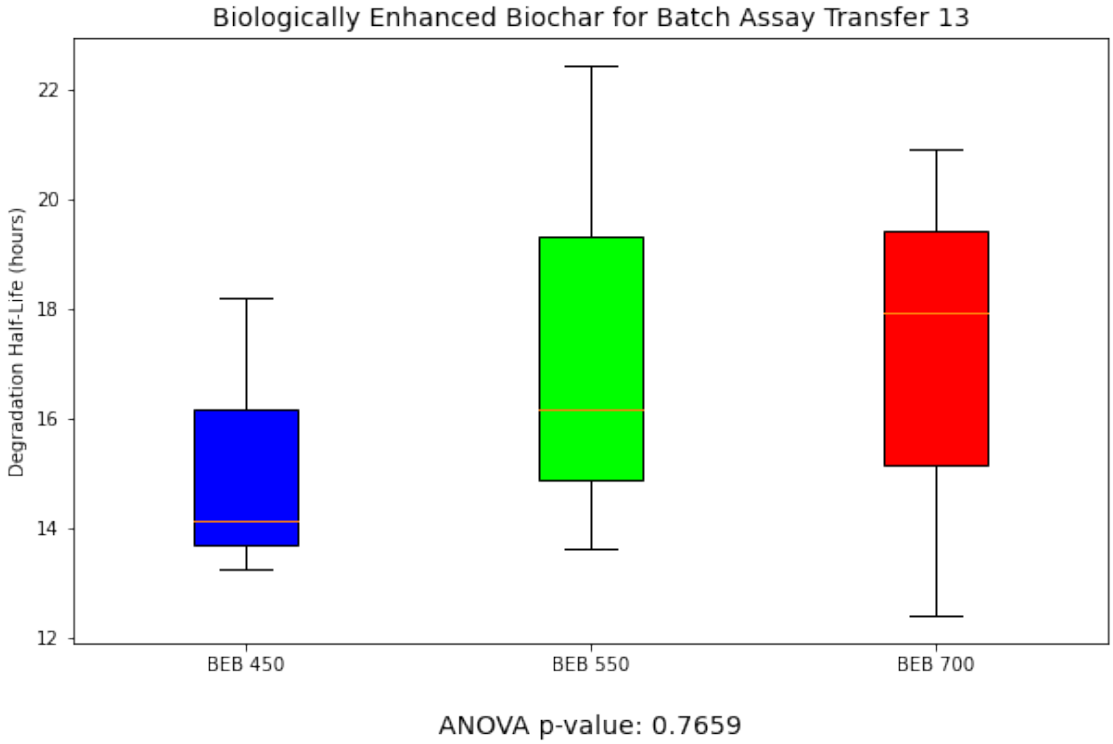

```
Assay: Transfer 11
ANOVA Results:
F-statistic: 0.434034487554102
p-value: 0.6667297082686242
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



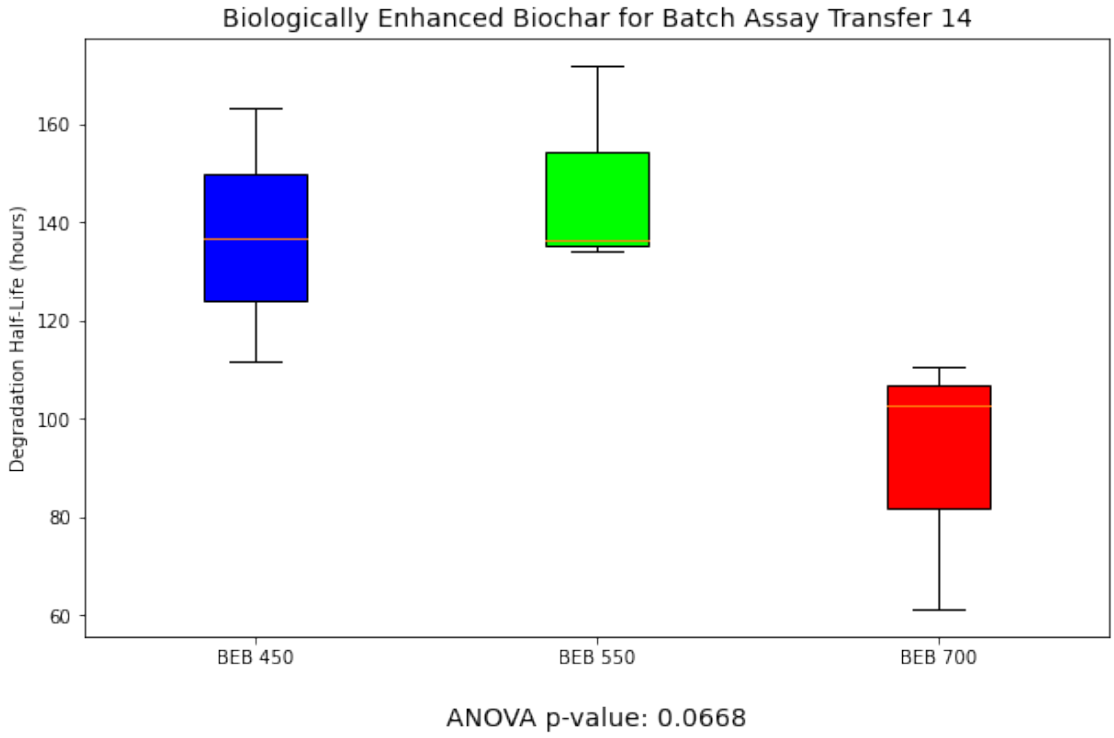

```
Assay: Transfer 12
ANOVA Results:
F-statistic: 0.4475412991067842
p-value: 0.6589240087219903
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



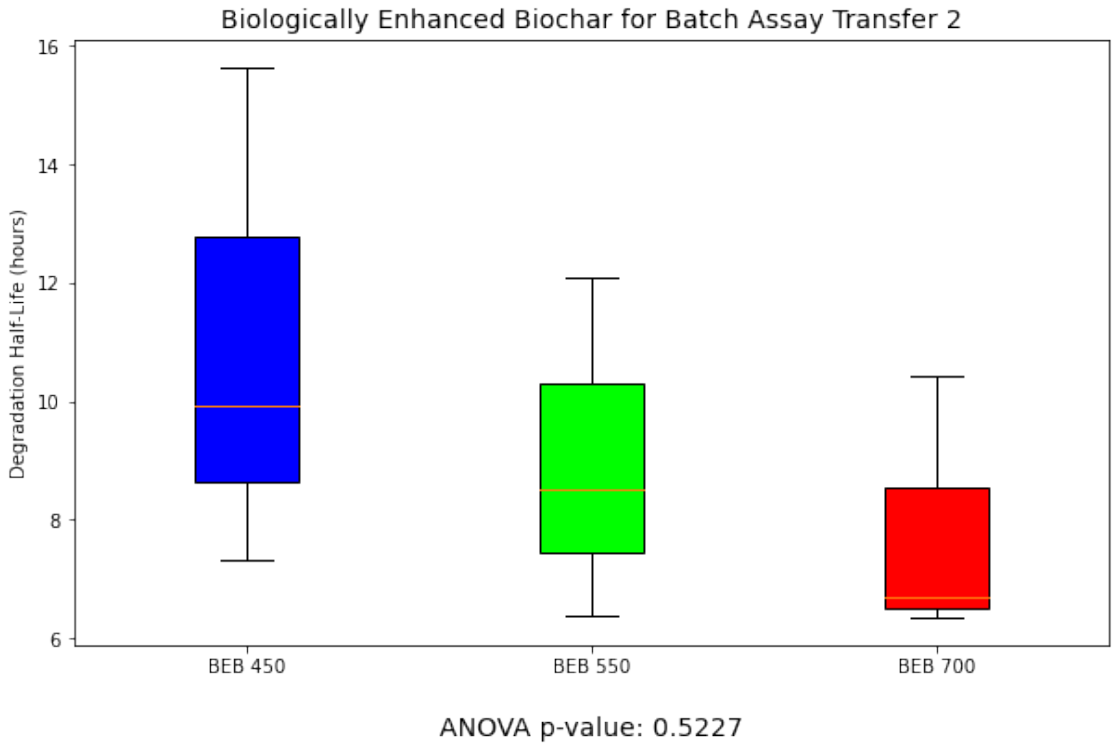

```
Assay: Transfer 13
ANOVA Results:
F-statistic: 0.2789011629790405
p-value: 0.7659118463663644
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



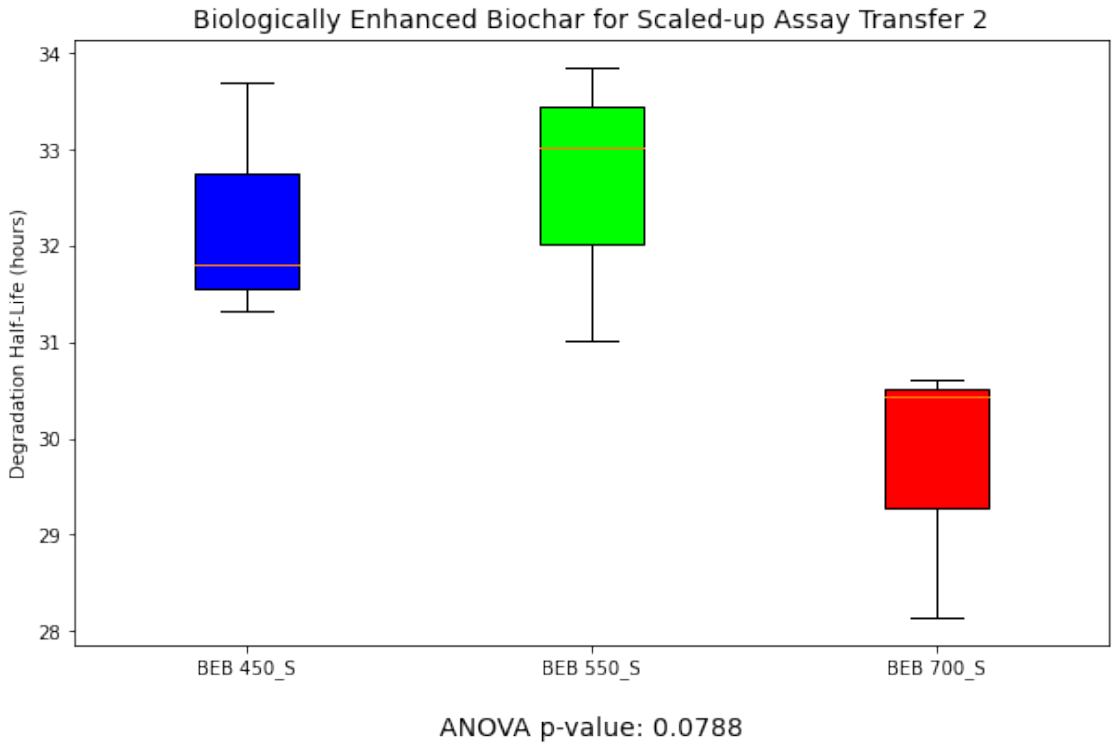

```
Assay: Transfer 14
ANOVA Results:
F-statistic: 4.392388098455526
p-value: 0.06683585169649267
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



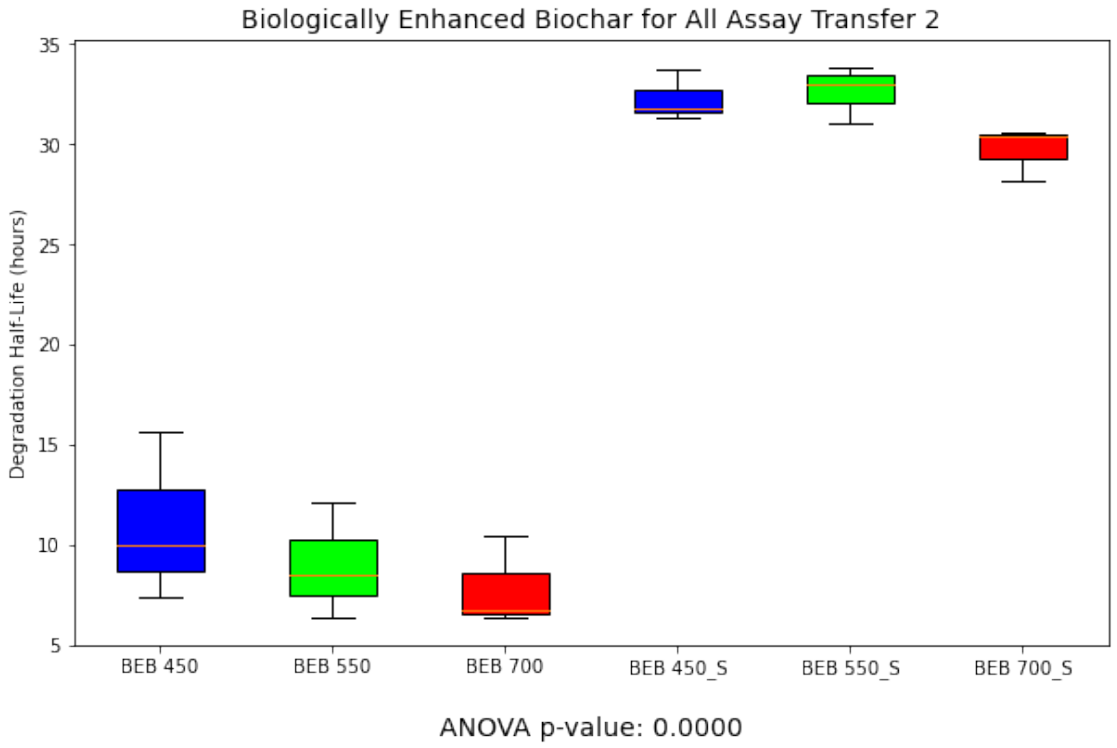

```
Assay: Transfer 2
ANOVA Results:
F-statistic: 0.724222111441004
p-value: 0.5227054657073055
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



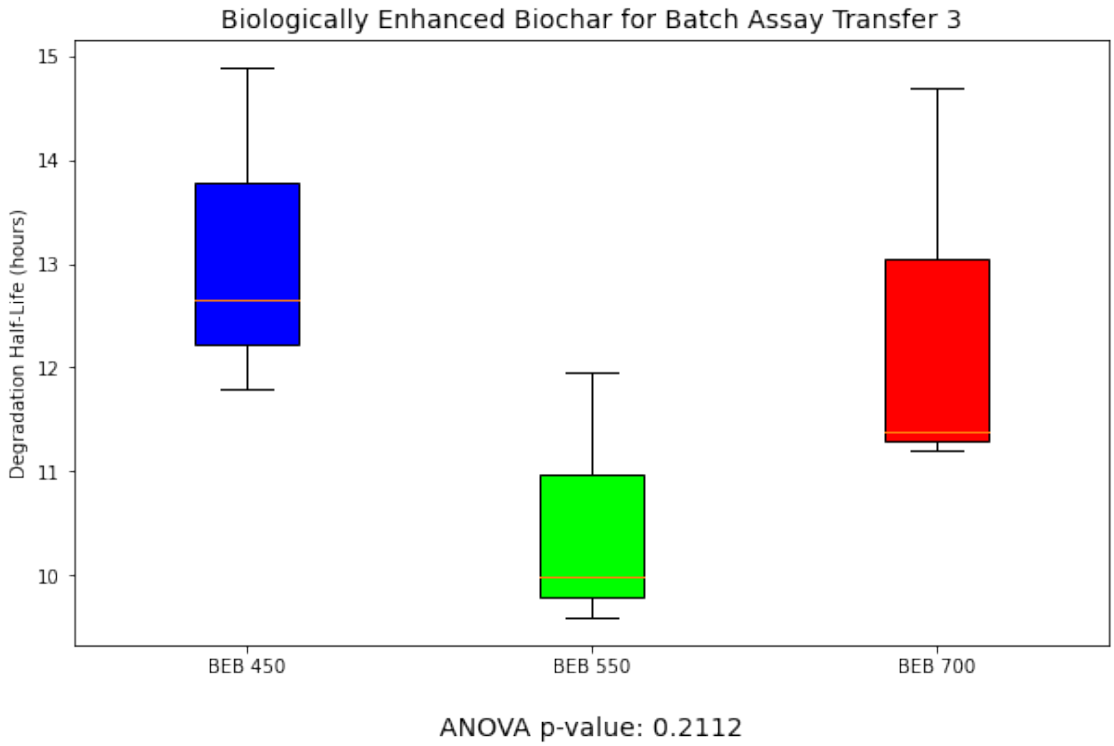

```
Assay for Scaled up: Transfer 2
ANOVA Results:
F-statistic: 3.9973684374377827
p-value: 0.07880604620371164
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



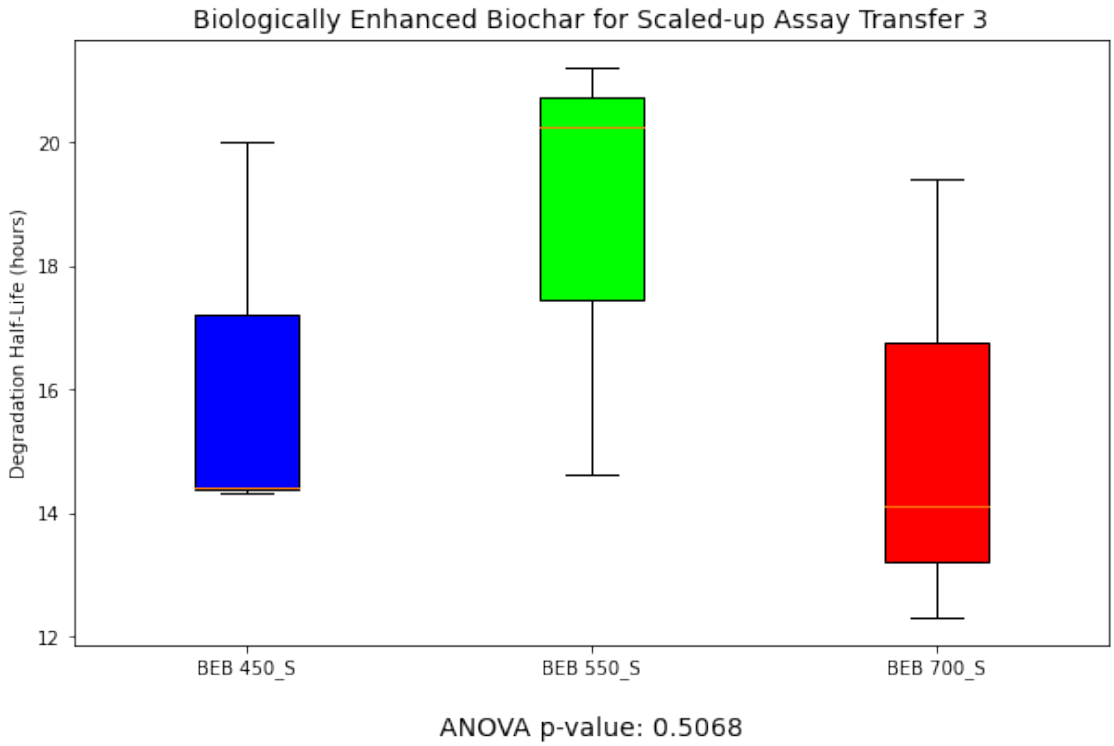

```
Assay for all groups: Transfer 2
ANOVA Results:
F-statistic: 73.0981934319785
p-value: 1.4517091480836427e-08
Reject null hypothesis: There is a significant difference among at least one
pair of groups.
```



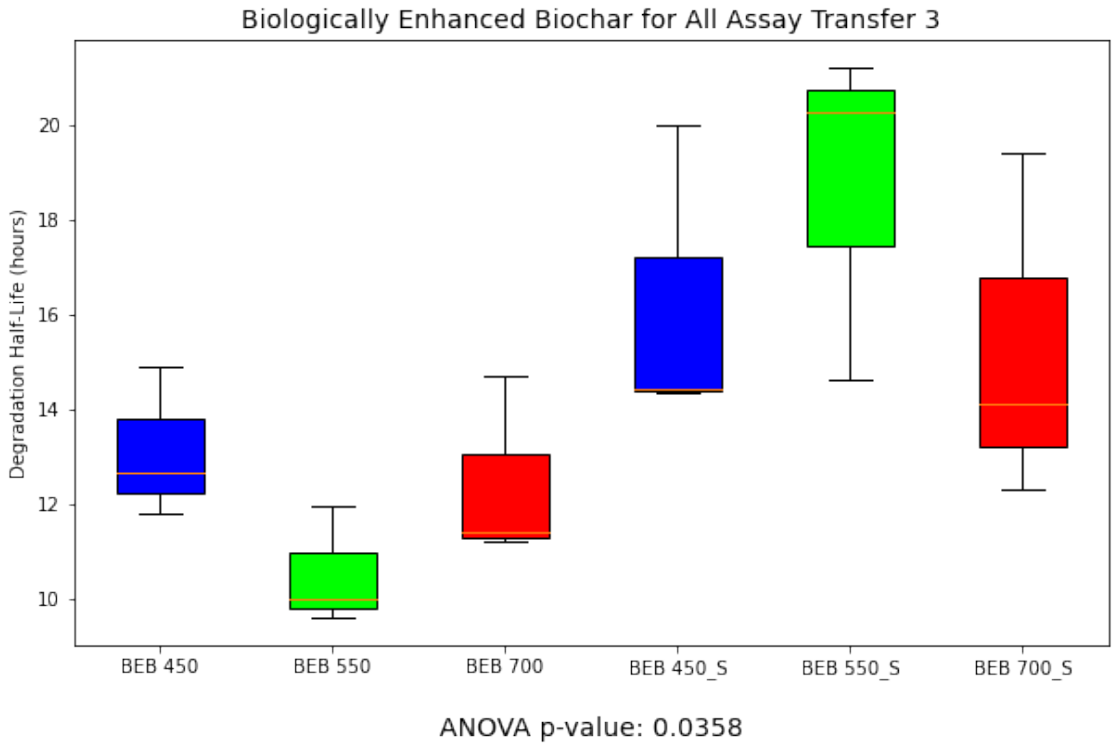
Assay: Transfer 3
ANOVA Results:
F-statistic: 2.0377531236535993
p-value: 0.2111801632341345
Fail to reject null hypothesis: There is no significant difference among the groups.



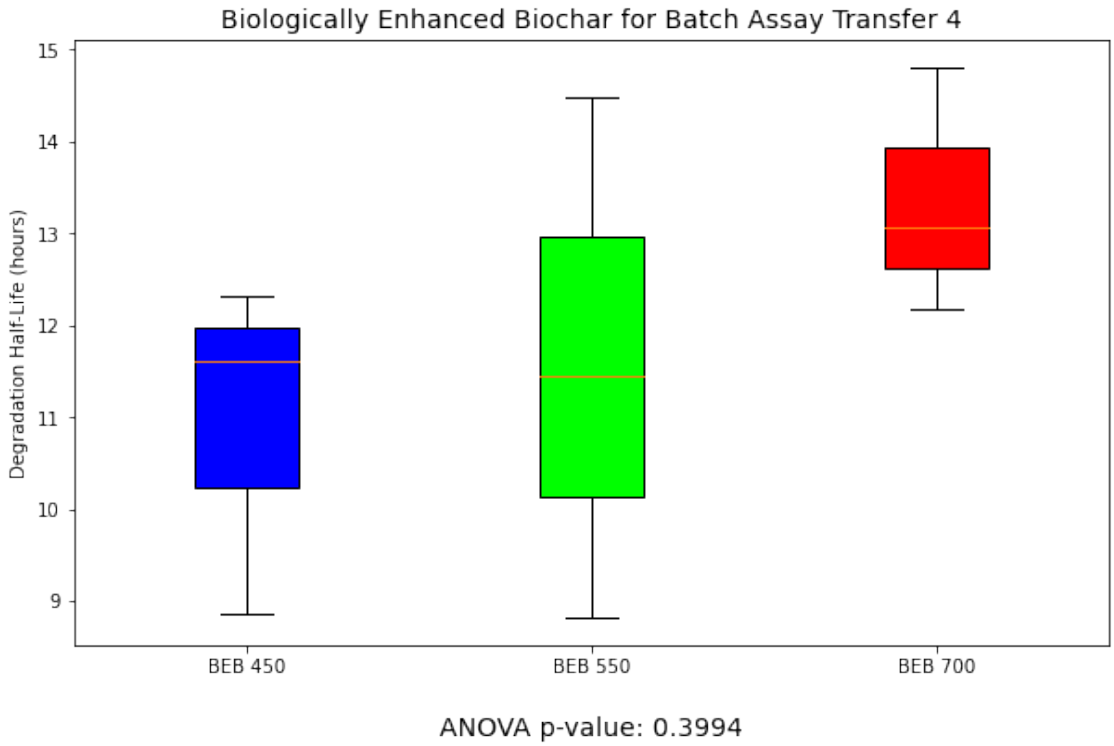

```
Assay for Scaled up: Transfer 3
ANOVA Results:
F-statistic: 0.7628118724313165
p-value: 0.5067879117335325
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



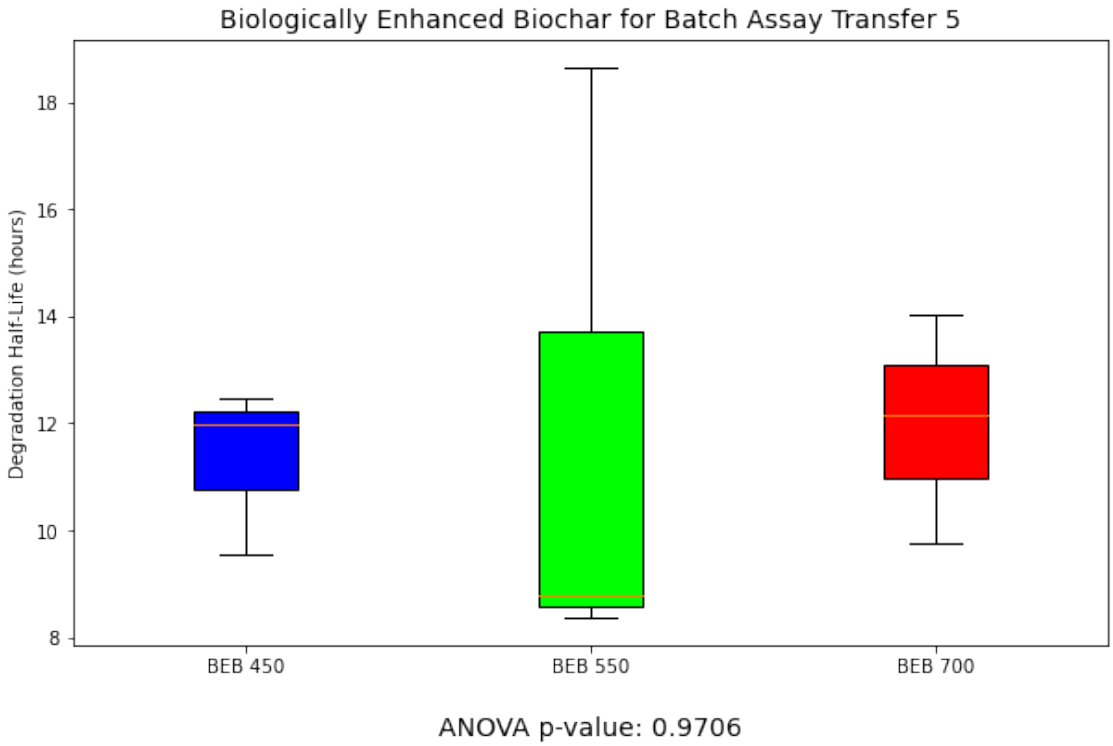

```
Assay for all groups: Transfer 3
ANOVA Results:
F-statistic: 3.473645453683184
p-value: 0.03582226546535229
Reject null hypothesis: There is a significant difference among at least one
pair of groups.
```



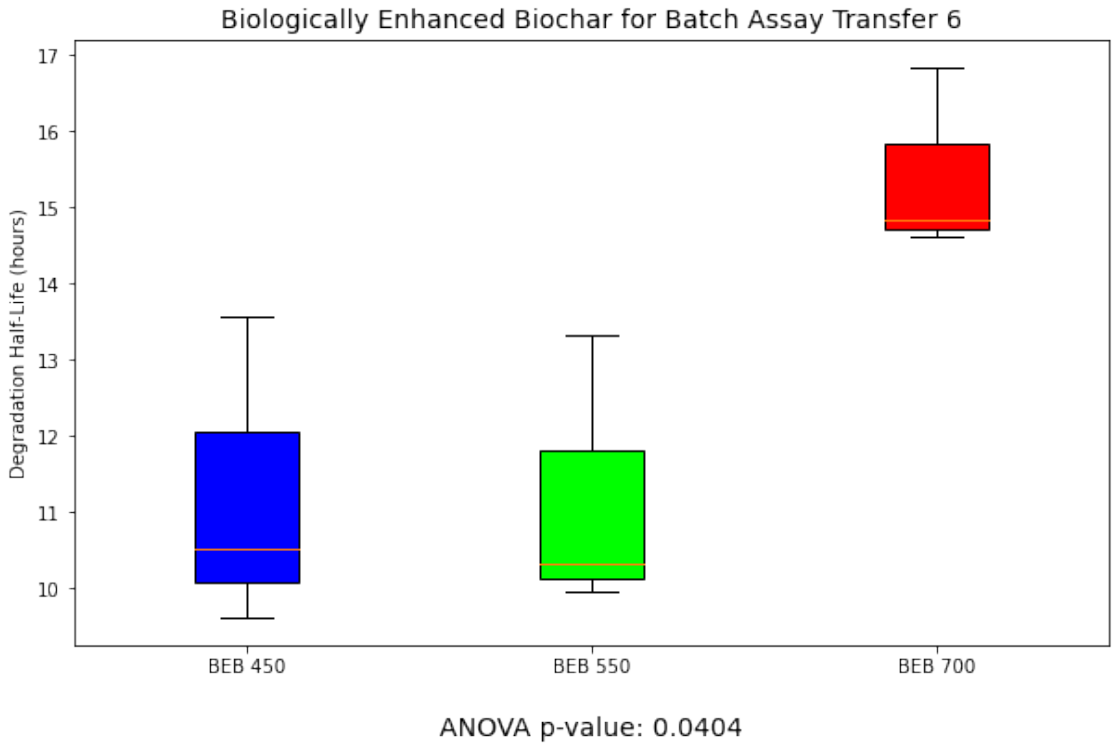

```
Assay: Transfer 4
ANOVA Results:
F-statistic: 1.073661729657922
p-value: 0.39940074905183176
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



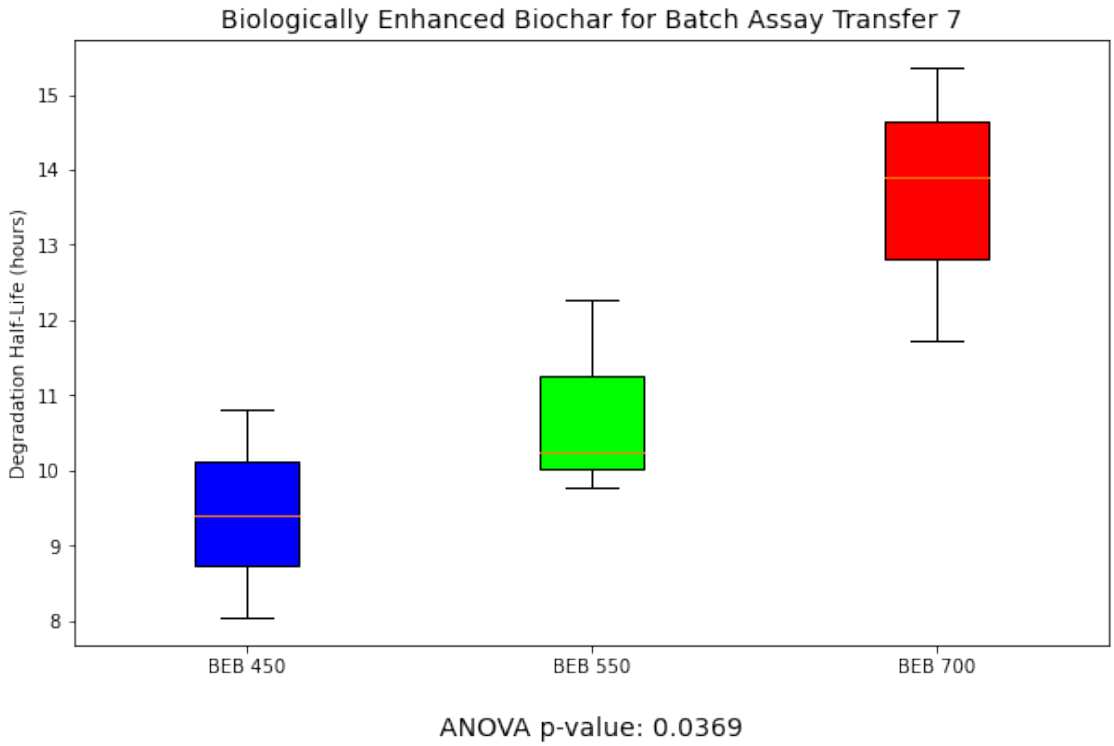

```
Assay: Transfer 5
ANOVA Results:
F-statistic: 0.03002413927432212
p-value: 0.9705669509291016
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



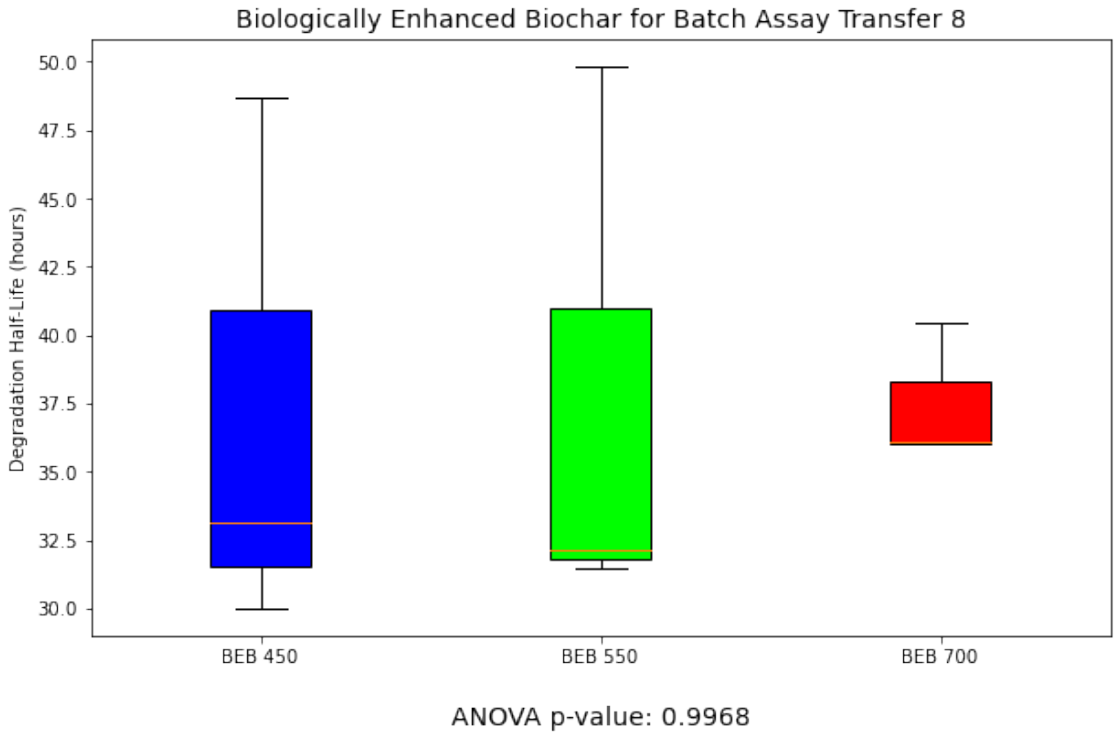

```
Assay: Transfer 6
ANOVA Results:
F-statistic: 5.742197478658072
p-value: 0.0404112166991441
Reject null hypothesis: There is a significant difference among at least one
pair of groups.
```



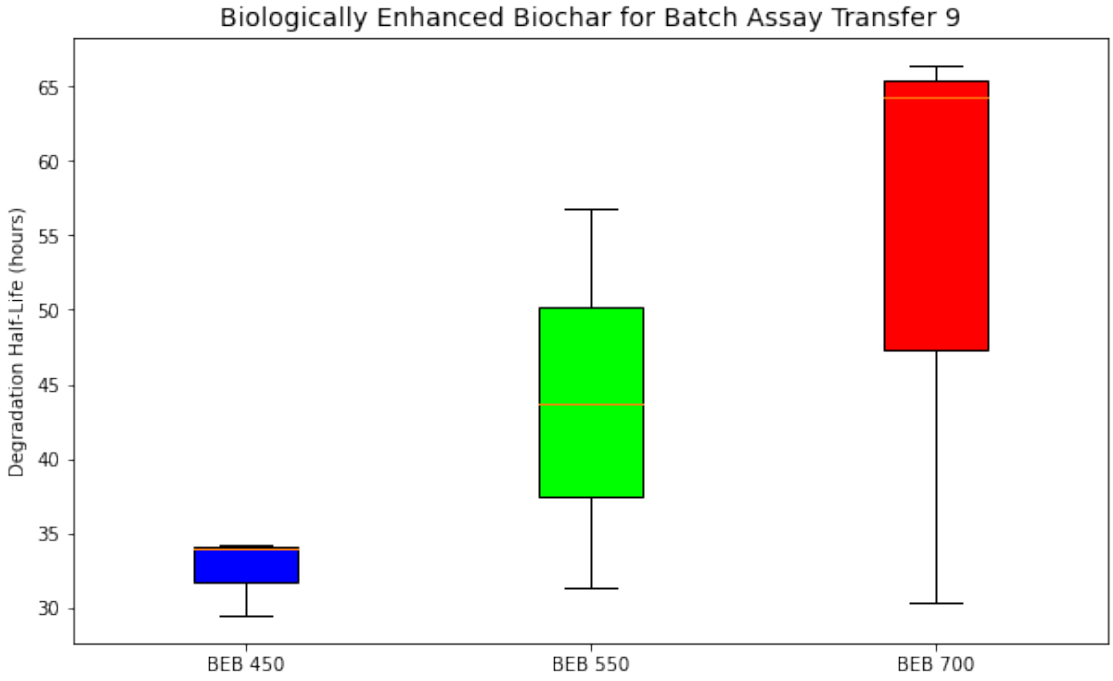

```
Assay: Transfer 7
ANOVA Results:
F-statistic: 6.011526247140887
p-value: 0.03689510139700024
Reject null hypothesis: There is a significant difference among at least one
pair of groups.
```




```
Assay: Transfer 8
ANOVA Results:
F-statistic: 0.0032206393222206776
p-value: 0.9967862633367921
Fail to reject null hypothesis: There is no significant difference among the
groups.
```




```
Assay: Transfer 9
ANOVA Results:
F-statistic: 1.736225900735174
p-value: 0.25413620405930454
Fail to reject null hypothesis: There is no significant difference among the
groups.
```



ANOVA p-value: 0.2541