Statistical analyses and plotting for *Xylaria necrophora* secondary metabolites experiments

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October 29, 2021

Install and load required packages

```
library(agricolae)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(plyr)
```

```
## ------------------------------------------------------------------------------

## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr first, then dplyr:
## library(plyr); library(dplyr)

## ------------------------------------------------------------------------------

##
## Attaching package: 'plyr'

## The following objects are masked from 'package:dplyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize
```

```
require(ggplot2)
```

```
## Loading required package: ggplot2
```

```r
library(readr)
library("ggpubr")
```

```
##
## Attaching package: 'ggpubr'

## The following object is masked from 'package:plyr':
##
##     mutate
```

```r
library("car")
```

```
## Loading required package: carData

##
## Attaching package: 'car'

## The following object is masked from 'package:dplyr':
##
##     recode
```

```r
library(rcompanion)
#install.packages("tidyverse")
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --

## v tibble  3.1.4     v stringr 1.4.0
## v tidyr   1.1.3     v forcats 0.5.1
## v purrr   0.3.4

## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x plyr::arrange()   masks dplyr::arrange()
## x purrr::compact()  masks plyr::compact()
## x plyr::count()     masks dplyr::count()
## x plyr::failwith()  masks dplyr::failwith()
## x dplyr::filter()   masks stats::filter()
## x plyr::id()        masks dplyr::id()
## x dplyr::lag()      masks stats::lag()
## x ggpubr::mutate()  masks plyr::mutate(), dplyr::mutate()
## x car::recode()     masks dplyr::recode()
## x plyr::rename()    masks dplyr::rename()
## x purrr::some()     masks car::some()
## x plyr::summarise() masks dplyr::summarise()
## x plyr::summarize() masks dplyr::summarize()
```

```r
library(reshape)
```

```
##
## Attaching package: 'reshape'
```

```
## The following objects are masked from 'package:tidyr':
##
##     expand, smiths

## The following objects are masked from 'package:plyr':
##
##     rename, round_any

## The following object is masked from 'package:dplyr':
##
##     rename
```

Set the working directory to where the directory where the output files will be saved.

In this case, we assume you have cloned/donwloaded this repository to your "Documents" folder.

Change directory on mac/linux:

setwd("/Users/YOURUSERNAME/Documents/X.necrophora.secondaryMetabolites/output")

Change directory on Windows (Windows 10 in this example):

setwd("C:/Users/YOURUSERNAME/Documents/X.necrophora.secondaryMetabolites/output")

```
setwd("/Users/tedggarcia/Documents/X.necrophora.secondaryMetabolites/output/")
```

Loading digital chl datasets (only one repetition of each experiment for illustration purposes)

ES2 = First experiment for 14 Days of exporuse (DOE) #ES4 = Repetetion for 14 DOE

ES5 = First experiment for 7 DOE #ES8 = Repetition for 7 DOE

#ES13A = Experiment testing potentially resistant cultivars (7DOE) ES13B = Repetition of ES13A

ES14A = Experiment testing effects among plant species (7DOE) #ES14B = Repetition of ES14A

```
ES2 <- read.csv("../raw_data/ES2.ChlorophyllContent.14DOE.Exp1.csv", header = T)
ES5 <- read.csv("../raw_data/ES5.ChlorophyllContent.7DOE.Exp1.csv", header = T)
ES13B <- read.csv("../raw_data/ES13B.ChlorophyllContent.7DOE.Exp2.Cultivars.csv", header = T)
ES14A <- read.csv("../raw_data/ES14A.ChlorophyllContent.7DOE.Exp1.PlantSpecies.csv", header = T)
```

Run Shapiro-Wilk Tests to check for normality

```
shapiro.test(ES2$chl)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  ES2$chl
## W = 0.74674, p-value < 2.2e-16
```

```r
shapiro.test(ES5$chl)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  ES5$chl
## W = 0.95514, p-value = 5.341e-10
```

```r
shapiro.test(ES13B$chl)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  ES13B$chl
## W = 0.95496, p-value = 2.7e-07
```

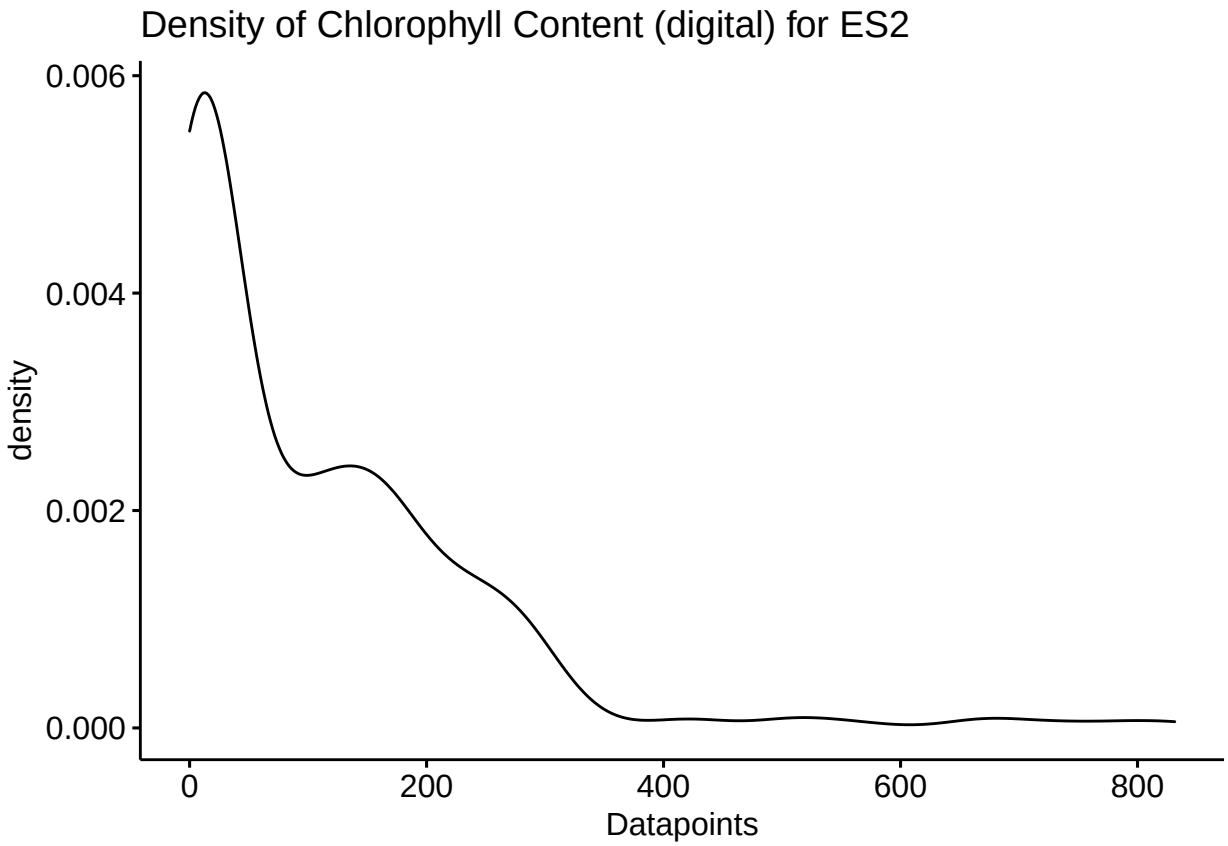
```r
shapiro.test(ES14A$chl)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  ES14A$chl
## W = 0.95203, p-value = 1.513e-06
```

Check the distribution of the data and assess if normalization is needed.

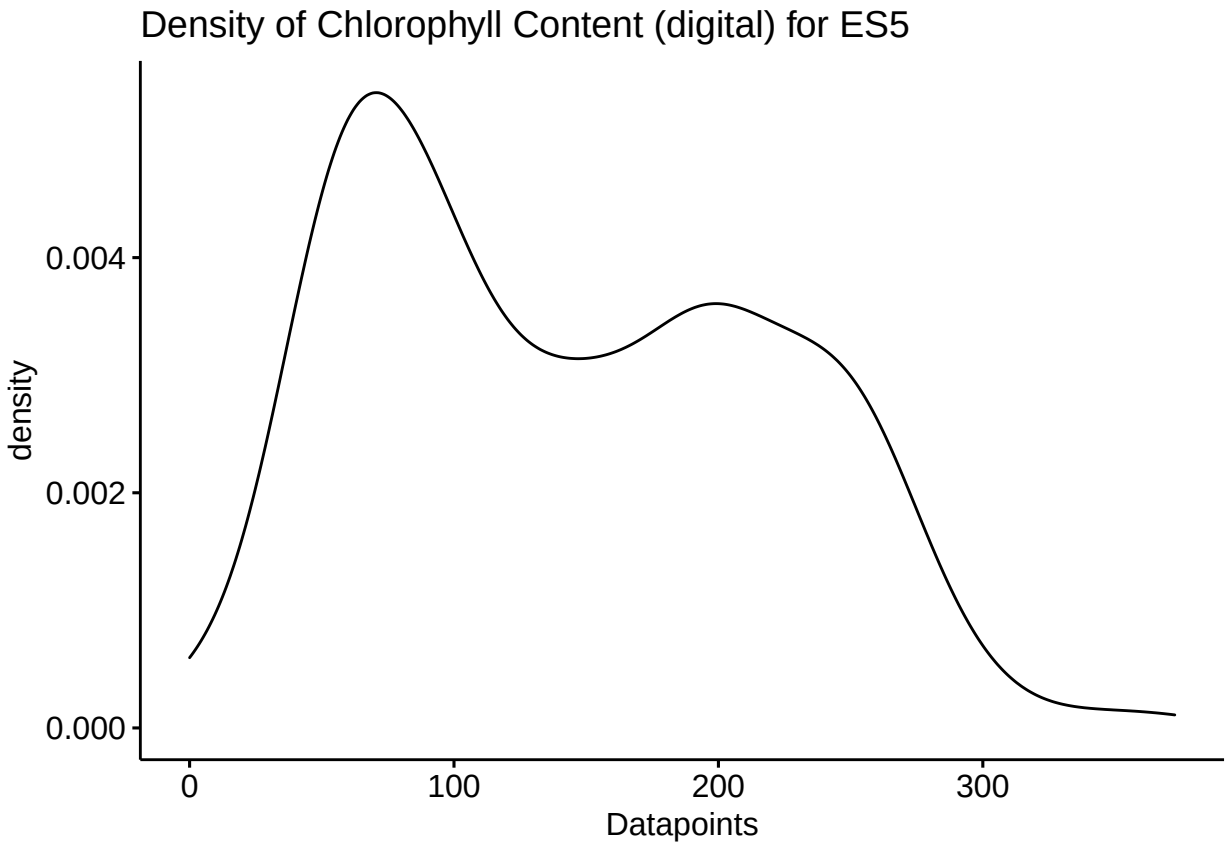
```r
ggdensity(ES2$chl, main = "Density of Chlorophyll Content (digital) for ES2", xlab = "Datapoints")
```

```
## Warning: Removed 60 rows containing non-finite values (stat_density).
```



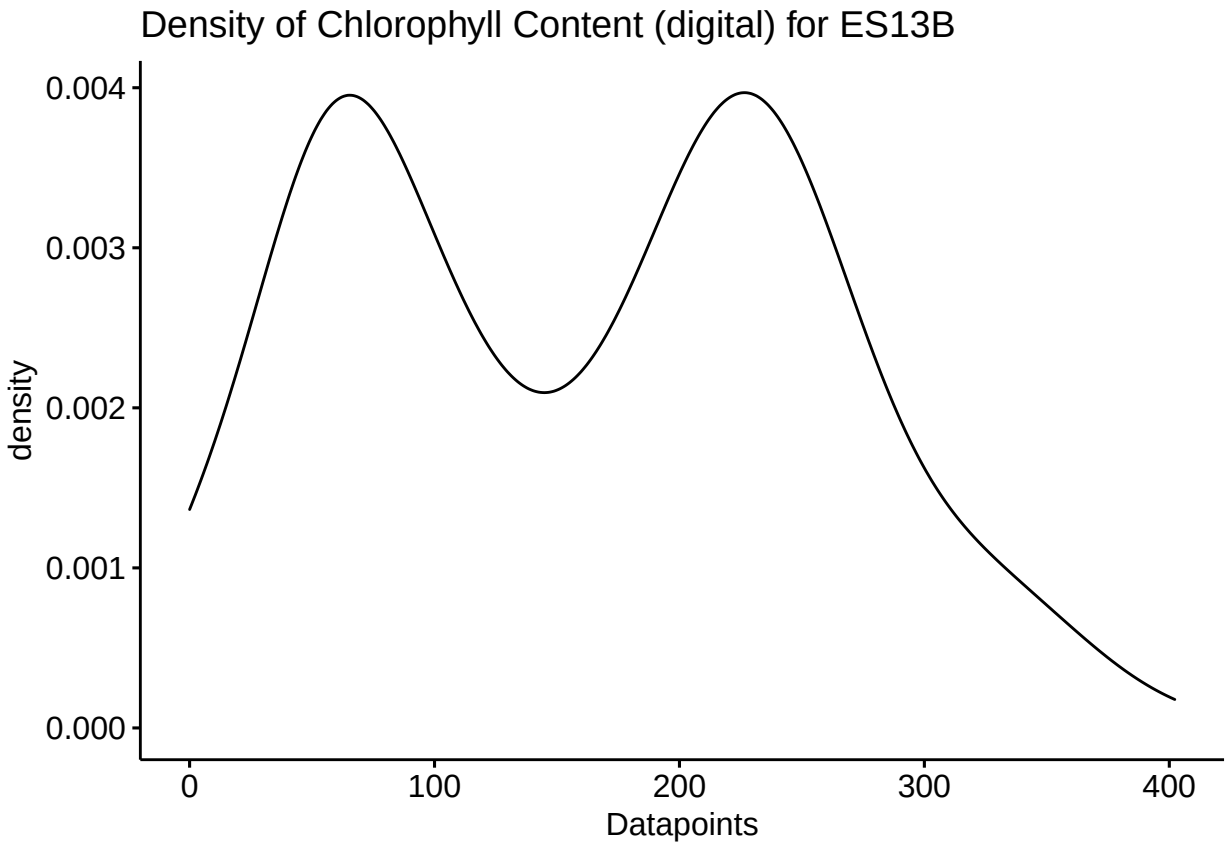

```
ggdensity(ES5$chl, main = "Density of Chlorophyll Content (digital) for ES5", xlab = "Datapoints")
```

```
## Warning: Removed 12 rows containing non-finite values (stat_density).
```



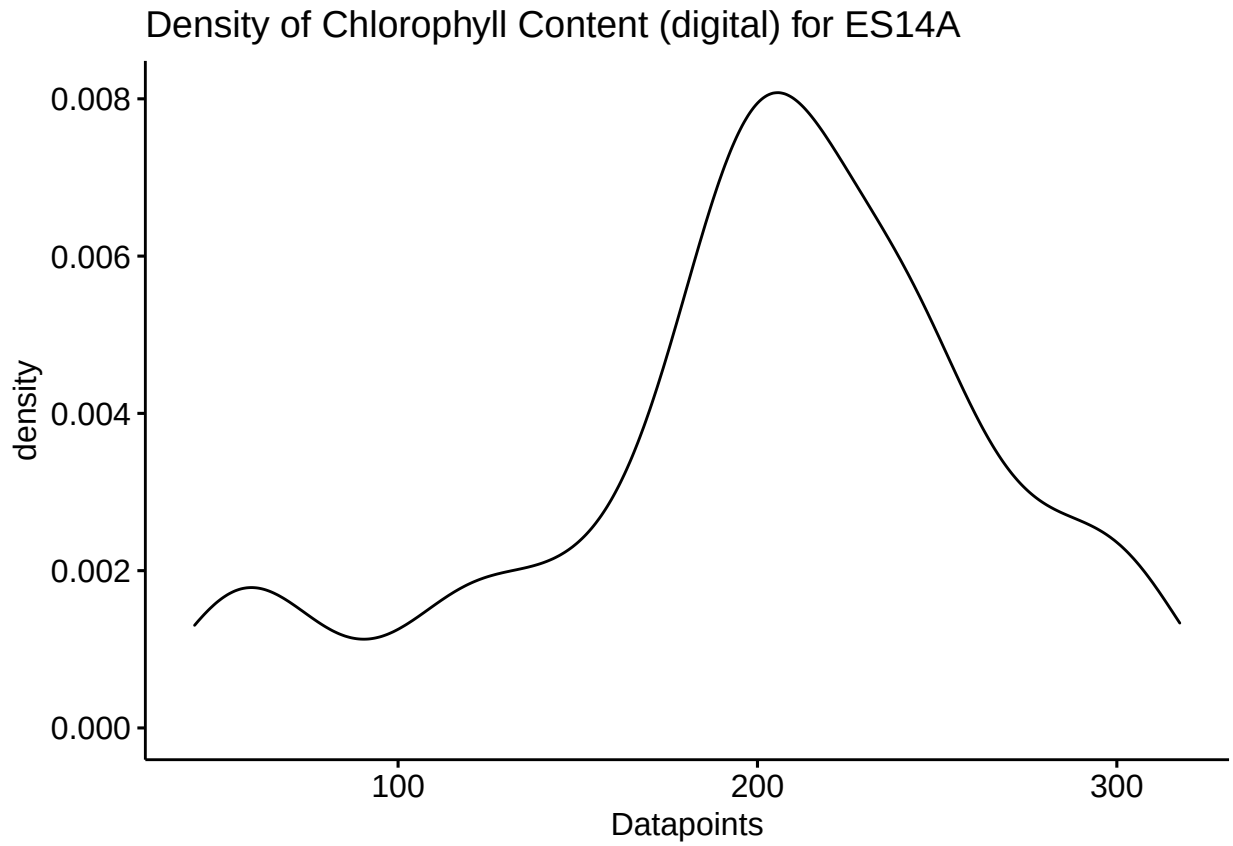

```
ggdensity(ES13B$chl, main = "Density of Chlorophyll Content (digital) for ES13B", xlab = "Datapoints")
```

```
## Warning: Removed 6 rows containing non-finite values (stat_density).
```




```
ggdensity(ES14A$chl, main = "Density of Chlorophyll Content (digital) for ES14A", xlab = "Datapoints")
```

```
## Warning: Removed 3 rows containing non-finite values (stat_density).
```

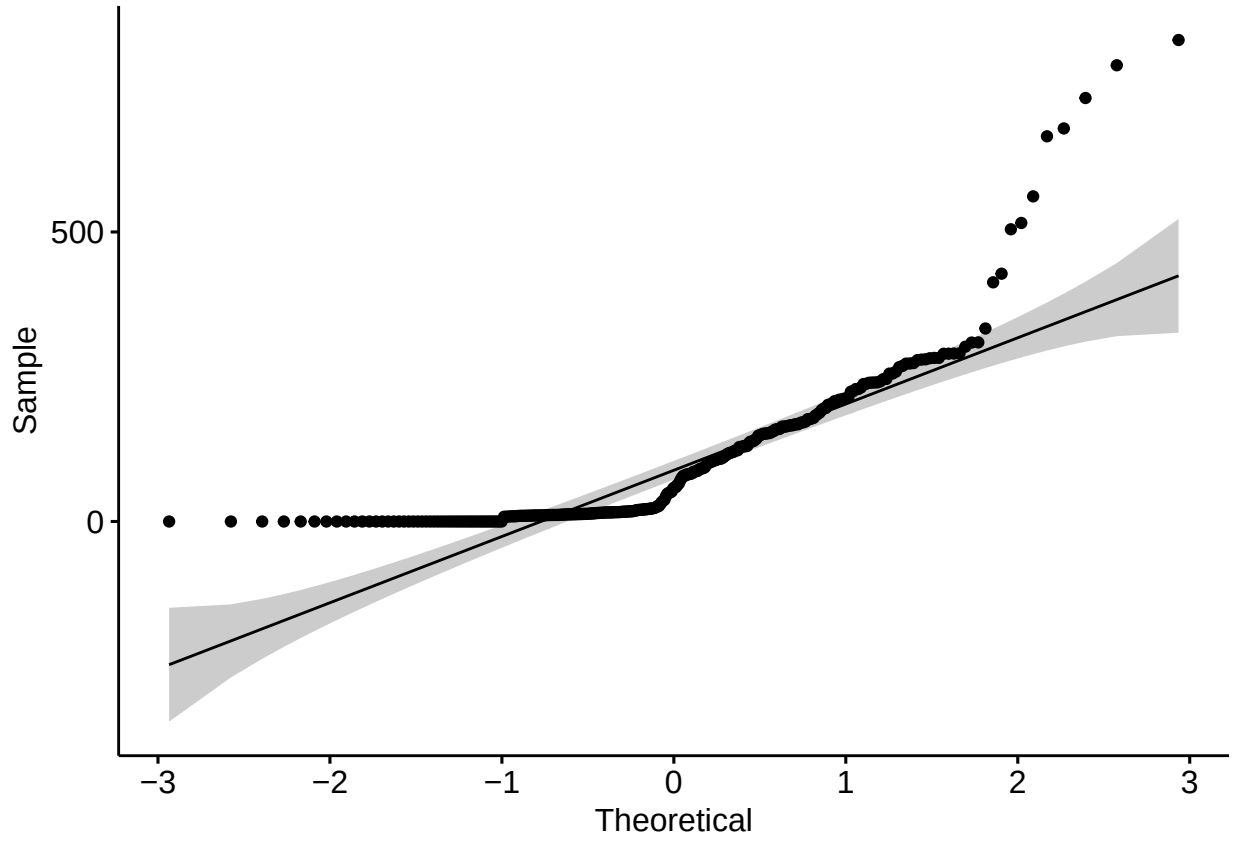



```
ggqqplot(ES2$chl)
```

```
## Warning: Removed 60 rows containing non-finite values (stat_qq).
```

```
## Warning: Removed 60 rows containing non-finite values (stat_qq_line).
```

```
## Warning: Removed 60 rows containing non-finite values (stat_qq_line).
```

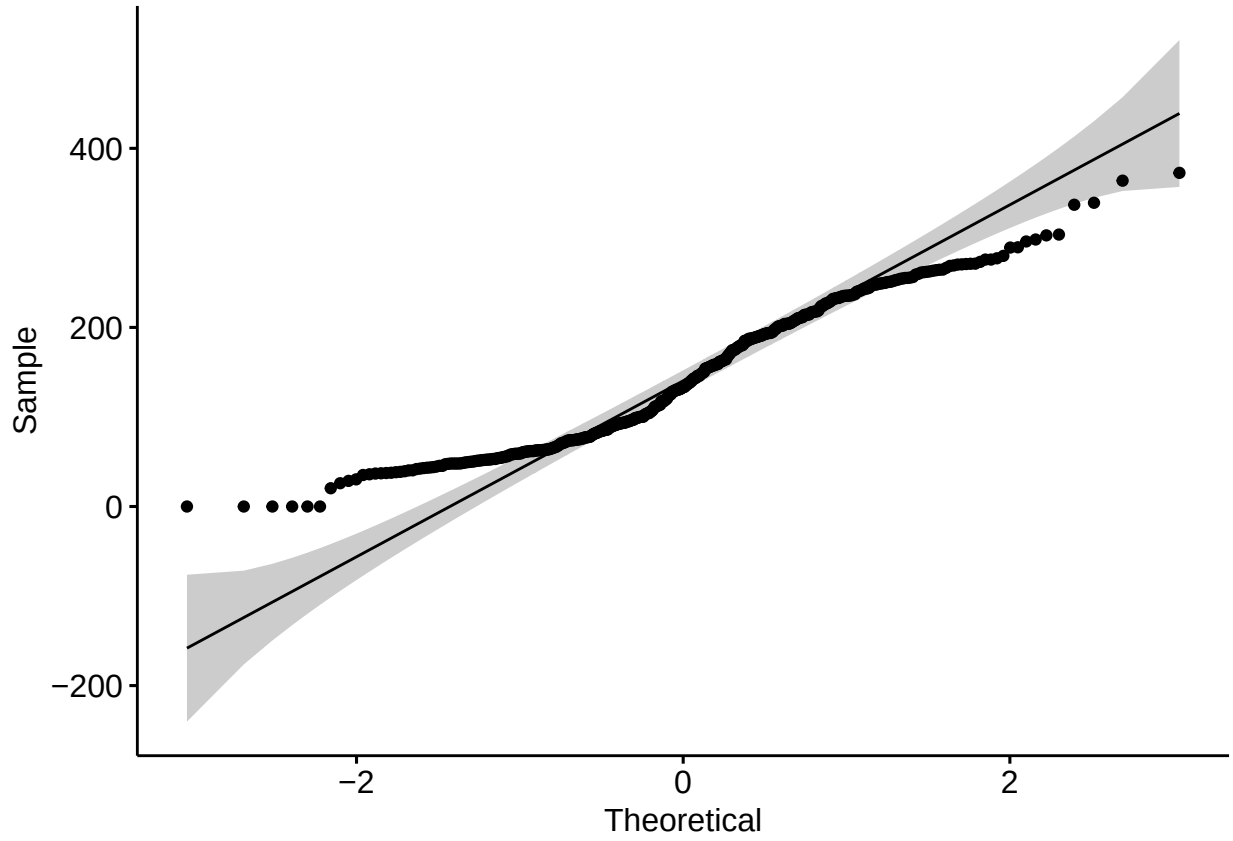



```
ggqqplot(ES5$chl)
```

```
## Warning: Removed 12 rows containing non-finite values (stat_qq).
```

```
## Warning: Removed 12 rows containing non-finite values (stat_qq_line).
```

```
## Warning: Removed 12 rows containing non-finite values (stat_qq_line).
```

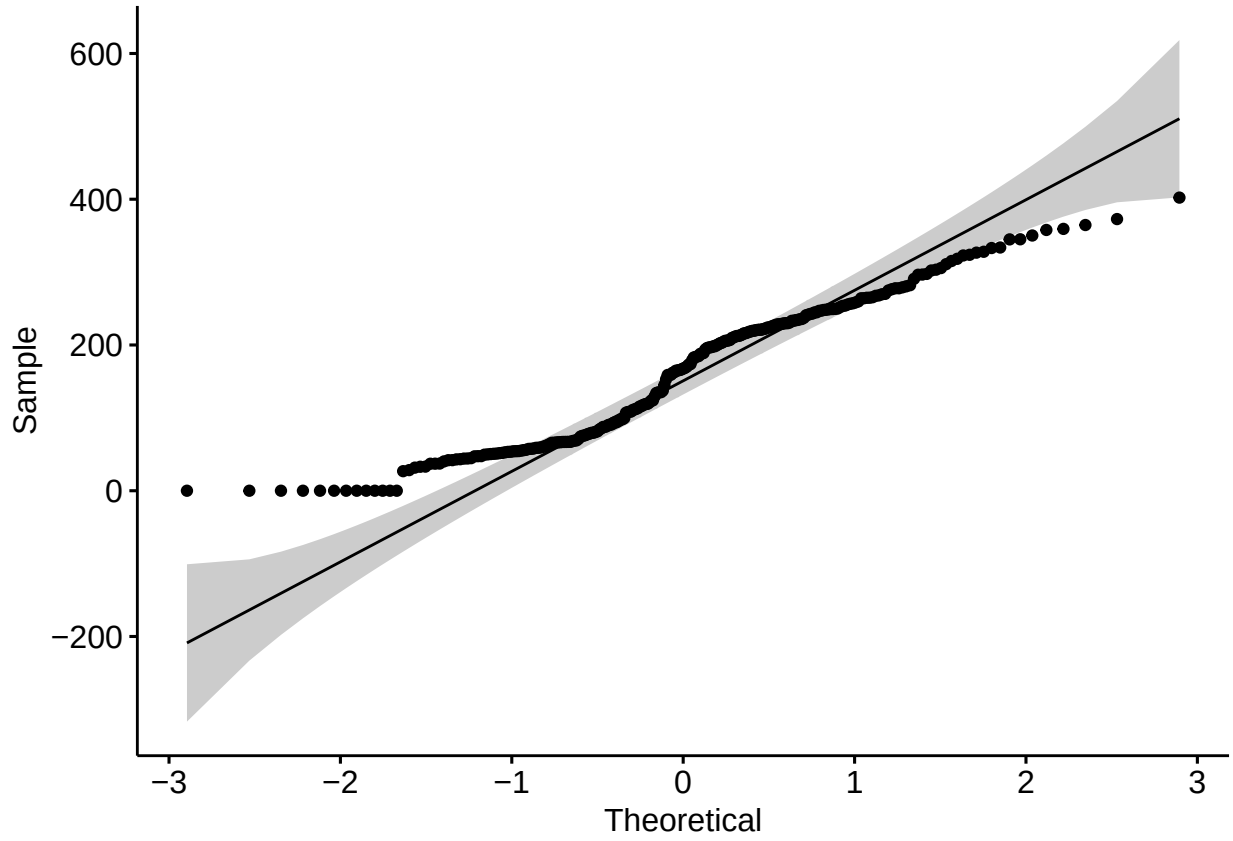



```
ggqqplot(ES13B$chl)
```

```
## Warning: Removed 6 rows containing non-finite values (stat_qq).
```

```
## Warning: Removed 6 rows containing non-finite values (stat_qq_line).
```

```
## Warning: Removed 6 rows containing non-finite values (stat_qq_line).
```

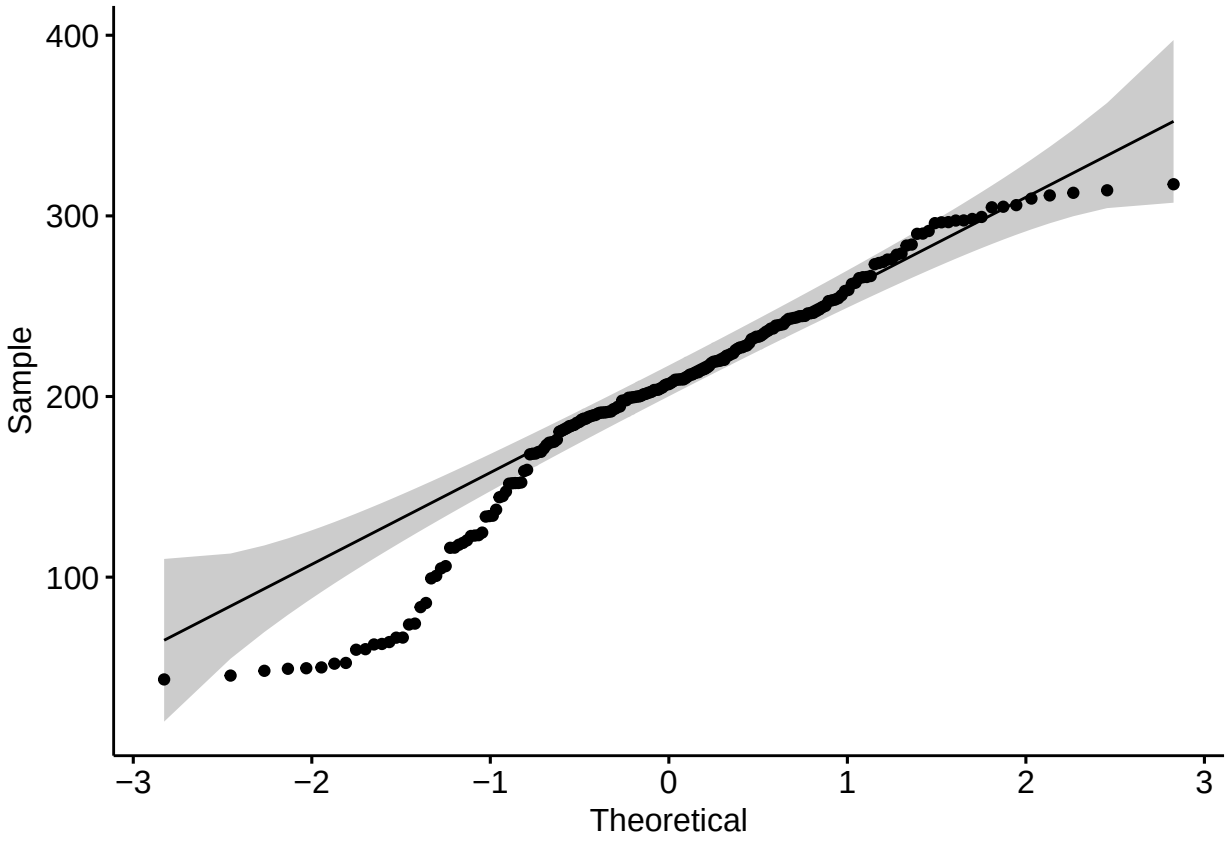



```
ggqqplot(ES14A$chl)
```

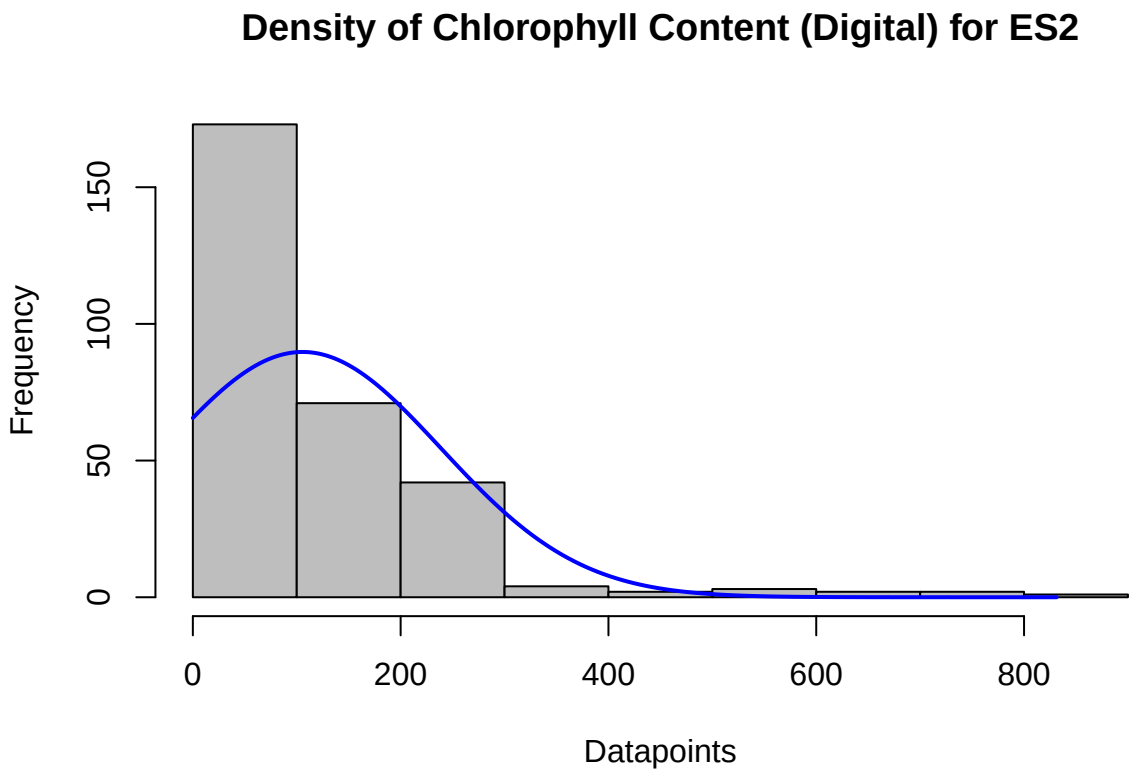
```
## Warning: Removed 3 rows containing non-finite values (stat_qq).
```

```
## Warning: Removed 3 rows containing non-finite values (stat_qq_line).
```

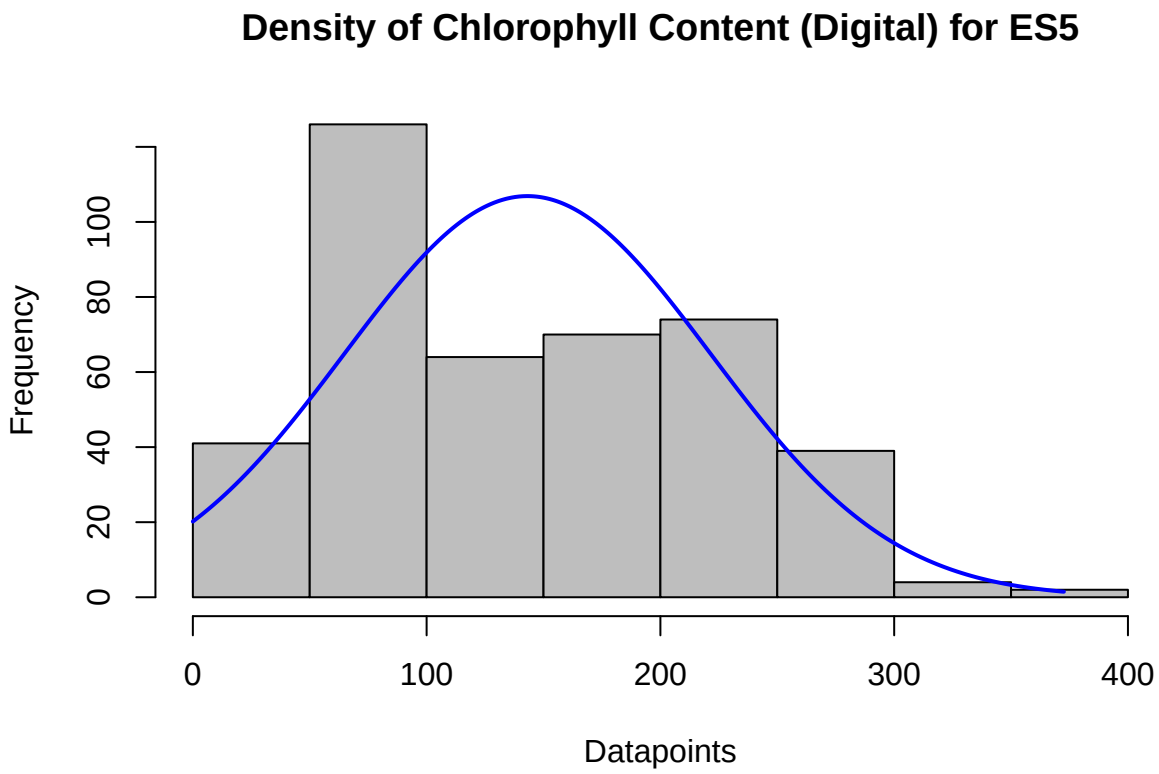
```
## Warning: Removed 3 rows containing non-finite values (stat_qq_line).
```



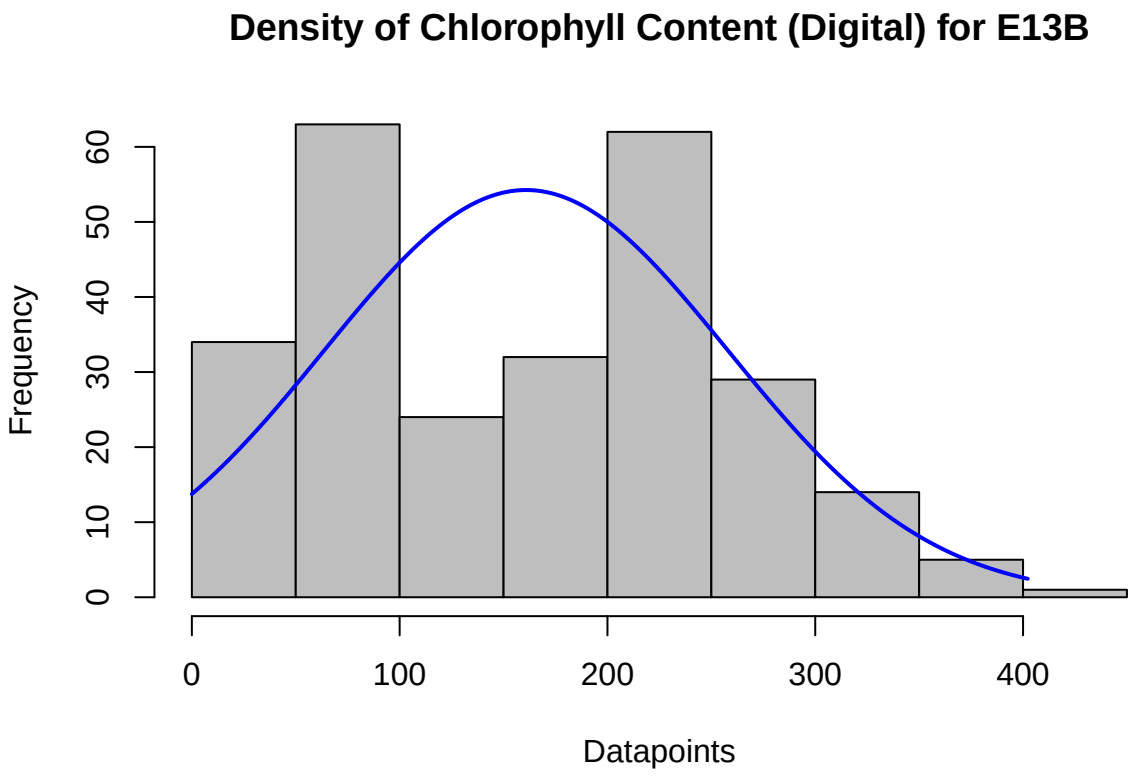

```
plotNormalHistogram(ES2$chl, main = "Density of Chlorophyll Content (Digital) for ES2", xlab = "Datapoi
```



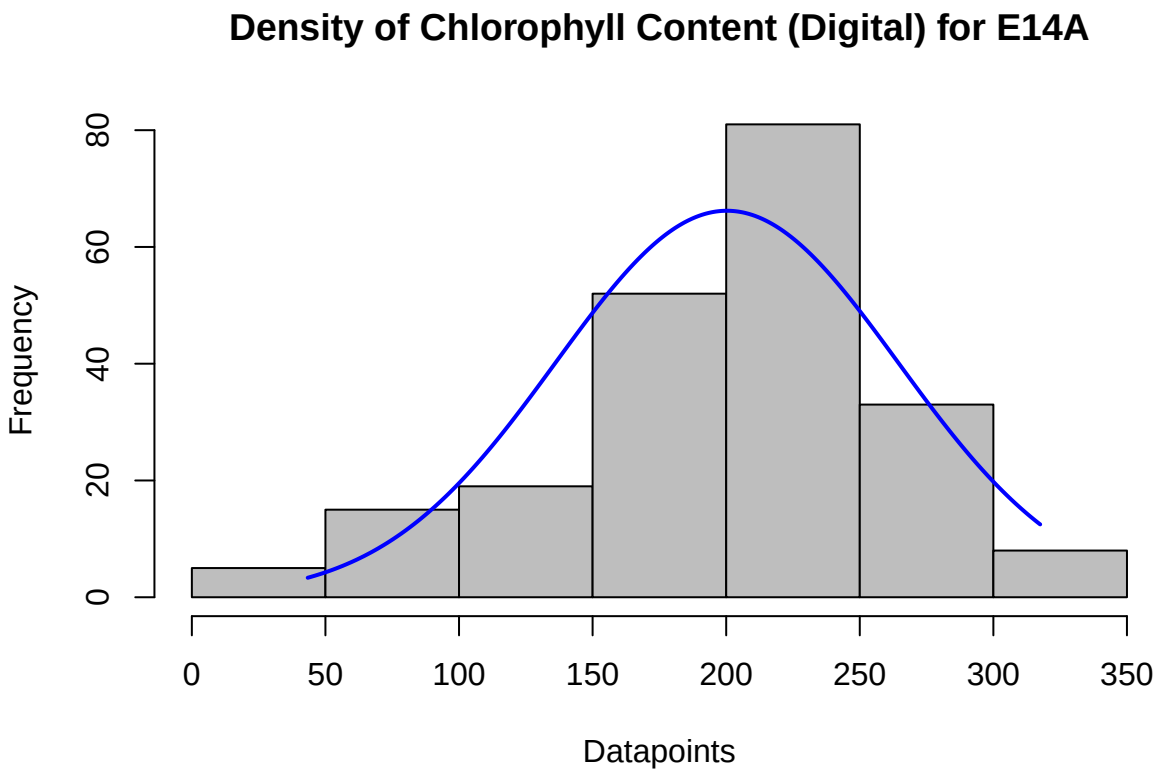

```
plotNormalHistogram(ES5$chl, main = "Density of Chlorophyll Content (Digital) for ES5", xlab = "Datapoi
```




```
plotNormalHistogram(ES13B$chl, main = "Density of Chlorophyll Content (Digital) for E13B", xlab = "Datap
```




```
plotNormalHistogram(ES14A$chl, main = "Density of Chlorophyll Content (Digital) for E14A", xlab = "Datap
```



Use the Tukey's tranformation method to normalize the distribution and append to datasets

```
ES2_chl.tuk = transformTukey(ES2$chl, plotit=FALSE)
```

```
##
##     lambda      W Shapiro.p.value
## 416  0.375 0.9449       3.664e-09
##
## if (lambda >  0){TRANS = x ^ lambda}
## if (lambda == 0){TRANS = log(x)}
## if (lambda <  0){TRANS = -1 * x ^ lambda}
```

```
ES5_chl.tuk = transformTukey(ES5$chl, plotit=FALSE)
```

```
##
##     lambda      W Shapiro.p.value
## 427   0.65 0.9695       1.098e-07
##
## if (lambda >  0){TRANS = x ^ lambda}
## if (lambda == 0){TRANS = log(x)}
## if (lambda <  0){TRANS = -1 * x ^ lambda}
```

```
ES13B_chl.tuk = transformTukey(ES13B$chl, plotit=FALSE)
```

```
##
```

```
##     lambda      W Shapiro.p.value
## 432  0.775 0.9604       1.226e-06
##
## if (lambda >  0){TRANS = x ^ lambda}
## if (lambda == 0){TRANS = log(x)}
## if (lambda <  0){TRANS = -1 * x ^ lambda}
```

```
ES14A_chl.tuk = transformTukey(ES14A$chl, plotit=FALSE)
```

```
##
##     lambda     W Shapiro.p.value
## 470  1.725 0.979         0.00282
##
## if (lambda >  0){TRANS = x ^ lambda}
## if (lambda == 0){TRANS = log(x)}
## if (lambda <  0){TRANS = -1 * x ^ lambda}
```

Append the transformed values to original datasets

```
ES2.mod <- cbind(ES2, ES2_chl.tuk)
ES5.mod <- cbind(ES5, ES5_chl.tuk)
ES13B.mod <- cbind(ES13B, ES13B_chl.tuk)
ES14A.mod <- cbind(ES14A, ES14A_chl.tuk)
```

Statistical analyses

Run ANOVA and Tukey's honest significance differences for raw chlorophyll content.

ES2 dataset (untransformed data)

As desribed above, this experiment was ran using cell-free culture filtrates (CFCFs) from three local strains of *Xylaria necrophora* (DMCC2126, DMCC2127, and DMCC2165) and one *Colletotrichum siamense* (DMCC2966) for 14 days (ES2)

```
###############ES2 analysis###################################
ES2.chl.anova <- lm (ES2$chl ~ ES2$Treatment + ES2$Dilution + ES2$Condition + ES2$isoRep + ES2$techRep +
ES2.chl.anova
```

```
##
## Call:
## lm(formula = ES2$chl ~ ES2$Treatment + ES2$Dilution + ES2$Condition +
##     ES2$isoRep + ES2$techRep + ES2$sampleNumber)
##
## Coefficients:
##              (Intercept)    ES2$TreatmentDMCC2126    ES2$TreatmentDMCC2127
##                  236.806                -140.175                -173.159
##   ES2$TreatmentDMCC2165    ES2$TreatmentDMCC2966       ES2$Dilution25fold
##                 -169.865                 -44.126                 -102.848
```

```
## ES2$ConditionStationary    ES2$isoRepisolateRep2         ES2$techRepStem2
##                  -8.823                   23.729                  -24.695
##        ES2$techRepStem3  ES2$sampleNumbersample2  ES2$sampleNumbersample3
##                  16.950                   26.386                   30.435
```

```
summary(ES2.chl.anova)
```

```
##
## Call:
## lm(formula = ES2$chl ~ ES2$Treatment + ES2$Dilution + ES2$Condition +
##     ES2$isoRep + ES2$techRep + ES2$sampleNumber)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -231.24  -49.47    1.55   41.40  536.42
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)               236.806     20.365  11.628  < 2e-16 ***
## ES2$TreatmentDMCC2126    -140.175     18.956  -7.395 1.70e-12 ***
## ES2$TreatmentDMCC2127    -173.159     19.204  -9.017  < 2e-16 ***
## ES2$TreatmentDMCC2165    -169.865     18.952  -8.963  < 2e-16 ***
## ES2$TreatmentDMCC2966     -44.126     18.481  -2.388   0.0176 *
## ES2$Dilution25fold       -102.848     11.998  -8.572 7.35e-16 ***
## ES2$ConditionStationary    -8.823     11.944  -0.739   0.4607
## ES2$isoRepisolateRep2      23.729     11.964   1.983   0.0483 *
## ES2$techRepStem2          -24.695     15.316  -1.612   0.1080
## ES2$techRepStem3           16.950     14.020   1.209   0.2277
## ES2$sampleNumbersample2    26.386     14.436   1.828   0.0687 .
## ES2$sampleNumbersample3    30.435     14.489   2.101   0.0366 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 100.5 on 276 degrees of freedom
##   (72 observations deleted due to missingness)
## Multiple R-squared:  0.4591, Adjusted R-squared:  0.4375
## F-statistic:  21.3 on 11 and 276 DF,  p-value: < 2.2e-16
```

```
anova(ES2.chl.anova)
```

```
## Analysis of Variance Table
##
## Response: ES2$chl
##                    Df  Sum Sq Mean Sq F value    Pr(>F)
## ES2$Treatment       4 1458908  364727 36.1018 < 2.2e-16 ***
## ES2$Dilution        1  732380  732380 72.4932 1.094e-15 ***
## ES2$Condition       1    3246    3246  0.3213   0.57128
## ES2$isoRep          1   38119   38119  3.7732   0.05310 .
## ES2$techRep         2   80731   40366  3.9955   0.01947 *
## ES2$sampleNumber    2   53280   26640  2.6369   0.07338 .
## Residuals         276 2788355   10103
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#Tukey's HSD for Variable chl (tukey trans) by Treament
ES2.chl.treatment.HSD.test <- HSD.test(ES2.chl.anova, 'ES2$Treatment', group = T)
ES2.chl.treatment.HSD.test
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   10102.73 276 105.3393 95.41771
##
## $parameters
##    test        name.t ntr StudentizedRange alpha
##   Tukey ES2$Treatment   5         3.883285  0.05
##
## $means
##            ES2$chl       std  r Min     Max       Q25     Q50       Q75
## control  206.91423 217.07353 57   0 831.472  26.54900 138.046 272.67000
## DMCC2126  73.25279  74.61783 57   0 281.899  11.31300  29.554 129.60000
## DMCC2127  37.91085  49.89550 54   0 167.994   8.52575  15.327  49.05425
## DMCC2165  30.48823  45.19861 57   0 187.945   8.36200  14.000  20.43000
## DMCC2966 167.98710  89.73008 63   0 309.266 119.20850 177.714 233.30650
##
## $comparison
## NULL
##
## $groups
##            ES2$chl groups
## control  206.91423      a
## DMCC2966 167.98710      a
## DMCC2126  73.25279      b
## DMCC2127  37.91085      b
## DMCC2165  30.48823      b
##
## attr(,"class")
## [1] "group"
```

```r
#Tukey's HSD for Variable chl (tukey trans) by Dilution
ES2.chl.dilution.HSD.test <- HSD.test(ES2.chl.anova, 'ES2$Dilution', group = T)
ES2.chl.dilution.HSD.test
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   10102.73 276 105.3393 95.41771
##
## $parameters
##    test       name.t ntr StudentizedRange alpha
##   Tukey ES2$Dilution   2         2.784016  0.05
##
## $means
##           ES2$chl       std   r Min     Max      Q25      Q50       Q75
## 100fold 157.13270 159.97363 138   0 831.472 36.10000 129.1440 206.71875
## 25fold   57.68939  79.35162 150   0 309.266  9.85425  15.6685  99.75575
##
## $comparison
## NULL
```

```
##
## $groups
##           ES2$chl groups
## 100fold 157.13270      a
## 25fold   57.68939      b
##
## attr(,"class")
## [1] "group"
```

```
#Tukey's HSD for Variable chl (tukey trans) by isoRep
ES2.chl.isoRep.HSD.test <- HSD.test(ES2.chl.anova, 'ES2$isoRep', group = T)
ES2.chl.isoRep.HSD.test
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   10102.73 276 105.3393 95.41771
##
## $parameters
##    test     name.t ntr StudentizedRange alpha
##   Tukey ES2$isoRep   2         2.784016  0.05
##
## $means
##               ES2$chl      std   r Min     Max     Q25    Q50      Q75
## isolateRep1  95.20639 127.0337 147   0 678.735 10.5195 24.386 138.3605
## isolateRep2 115.90342 140.6136 141   0 831.472 14.0000 85.555 171.1230
##
## $comparison
## NULL
##
## $groups
##               ES2$chl groups
## isolateRep2 115.90342      a
## isolateRep1  95.20639      a
##
## attr(,"class")
## [1] "group"
```

```
#Complete ANOVA for ES2 by treatment by dilution
ES2.comp.HSD.group <- HSD.test(ES2.chl.anova, c("ES2$Treatment", "ES2$Dilution"), group=TRUE,console=TRU
                                                main="ES2 - Xylaria Chl Contnent (Tukey's Ladder Transfo
```

```
##
## Study: ES2 - Xylaria Chl Contnent (Tukey's Ladder Transformed Data) by treatment  by dilution at 14 D
##
## HSD Test for ES2$chl
##
## Mean Square Error:  10102.73
##
## ES2$Treatment:ES2$Dilution,  means
##
##                      ES2.chl        std  r    Min     Max
## control:100fold  383.864000 223.675014 24 97.748 831.472
## control:25fold    78.223485  77.070835 33  0.000 268.776
```

```
## DMCC2126:100fold 127.480933  64.977439 30 10.433 281.899
## DMCC2126:25fold   12.999296  10.944223 27  0.000  51.676
## DMCC2127:100fold  58.980593  59.597226 27  0.000 167.994
## DMCC2127:25fold   16.841111  24.515869 27  0.000 112.319
## DMCC2165:100fold  58.801375  58.889805 24  0.000 187.945
## DMCC2165:25fold    9.896848   6.632284 33  0.000  19.414
## DMCC2966:100fold 171.013333  97.165275 33  0.000 301.867
## DMCC2966:25fold  164.658233  82.303611 30  0.000 309.266
##
## Alpha: 0.05 ; DF Error: 276
## Critical Value of Studentized Range: 4.511094
##
## Groups according to probability of means differences and alpha level( 0.05 )
##
## Treatments with the same letter are not significantly different.
##
##                      ES2$chl groups
## control:100fold  383.864000      a
## DMCC2966:100fold 171.013333      b
## DMCC2966:25fold  164.658233      b
## DMCC2126:100fold 127.480933     bc
## control:25fold    78.223485     cd
## DMCC2127:100fold  58.980593     cd
## DMCC2165:100fold  58.801375     cd
## DMCC2127:25fold   16.841111      d
## DMCC2126:25fold   12.999296      d
## DMCC2165:25fold    9.896848      d
```

```
ES2.comp.HSD.group
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   10102.73 276 105.3393 95.41771
##
## $parameters
##    test                      name.t ntr StudentizedRange alpha
##   Tukey ES2$Treatment:ES2$Dilution  10         4.511094  0.05
##
## $means
##                      ES2$chl        std  r    Min     Max       Q25      Q50
## control:100fold  383.864000 223.675014 24 97.748 831.472 244.69000 280.5385
## control:25fold    78.223485  77.070835 33  0.000 268.776  15.68300  59.4900
## DMCC2126:100fold 127.480933  64.977439 30 10.433 281.899  81.64425 129.1440
## DMCC2126:25fold   12.999296  10.944223 27  0.000  51.676   9.86550  11.3130
## DMCC2127:100fold  58.980593  59.597226 27  0.000 167.994  12.11000  35.6240
## DMCC2127:25fold   16.841111  24.515869 27  0.000 112.319   0.00000  11.9040
## DMCC2165:100fold  58.801375  58.889805 24  0.000 187.945  14.21225  25.3885
## DMCC2165:25fold    9.896848   6.632284 33  0.000  19.414   0.00000  12.2830
## DMCC2966:100fold 171.013333  97.165275 33  0.000 301.867 118.40500 176.8540
## DMCC2966:25fold  164.658233  82.303611 30  0.000 309.266 120.78250 181.5795
##                       Q75
## control:100fold  527.0058
## control:25fold   129.7670
## DMCC2126:100fold 159.8775
```

```
## DMCC2126:25fold   16.5335
## DMCC2127:100fold  90.5650
## DMCC2127:25fold   15.6860
## DMCC2165:100fold 105.9032
## DMCC2165:25fold   14.7740
## DMCC2966:100fold 241.9460
## DMCC2966:25fold  222.5877
##
## $comparison
## NULL
##
## $groups
##                      ES2$chl groups
## control:100fold  383.864000      a
## DMCC2966:100fold 171.013333      b
## DMCC2966:25fold  164.658233      b
## DMCC2126:100fold 127.480933     bc
## control:25fold    78.223485     cd
## DMCC2127:100fold  58.980593     cd
## DMCC2165:100fold  58.801375     cd
## DMCC2127:25fold   16.841111      d
## DMCC2126:25fold   12.999296      d
## DMCC2165:25fold    9.896848      d
##
## attr(,"class")
## [1] "group"
```

```
#Complete ANOVA for ES2 by treatment by condition, by dilution
ES2.comp.HSD.group <- HSD.test(ES2.chl.anova, c("ES2$Treatment", "ES2$Condition", "ES2$Dilution"), group
                                                main="ES2 - Xylaria Chl Contnent (Tukey's Ladder Transfo
```

```
##
## Study: ES2 - Xylaria Chl Contnent (Tukey's Ladder Transformed Data) by treatment  by dilution at 14 D
##
## HSD Test for ES2$chl
##
## Mean Square Error:  10102.73
##
## ES2$Treatment:ES2$Condition:ES2$Dilution,  means
##
##                                ES2.chl        std  r     Min     Max
## control:Shaking:100fold     365.312600 219.329463 15 117.742 787.887
## control:Shaking:25fold       83.216056  81.789480 18   0.000 268.776
## control:Stationary:100fold  414.783000 240.691662  9  97.748 831.472
## control:Stationary:25fold    72.232400  73.372023 15   0.000 237.395
## DMCC2126:Shaking:100fold    107.106250  88.648073 12  10.433 281.899
## DMCC2126:Shaking:25fold      11.166278   8.588222 18   0.000  29.554
## DMCC2126:Stationary:100fold 141.064056  40.361686 18  58.992 207.739
## DMCC2126:Stationary:25fold   16.665333  14.486460  9   0.000  51.676
## DMCC2127:Shaking:100fold     27.384333  29.312311 12   0.000  87.367
## DMCC2127:Shaking:25fold      12.535833   6.846127 12   0.000  23.493
## DMCC2127:Stationary:100fold  84.257600  66.188284 15   0.000 167.994
## DMCC2127:Stationary:25fold   20.285333  32.415599 15   0.000 112.319
## DMCC2165:Shaking:100fold     37.540750  46.913463 12   0.000 150.248
```

```
## DMCC2165:Shaking:25fold      11.067600   6.311390 15   0.000  19.414
## DMCC2165:Stationary:100fold  80.062000  63.751126 12   0.000 187.945
## DMCC2165:Stationary:25fold    8.921222   6.912163 18   0.000  17.639
## DMCC2966:Shaking:100fold    223.958000  61.555261 18 128.523 301.867
## DMCC2966:Shaking:25fold     203.815933  41.016531 15 123.094 282.574
## DMCC2966:Stationary:100fold 107.479733  95.130285 15   0.000 289.798
## DMCC2966:Stationary:25fold  125.500533  95.202754 15   0.000 309.266
##
## Alpha: 0.05 ; DF Error: 276
## Critical Value of Studentized Range: 5.061243
##
## Groups according to probability of means differences and alpha level( 0.05 )
##
## Treatments with the same letter are not significantly different.
##
##                               ES2$chl groups
## control:Stationary:100fold  414.783000      a
## control:Shaking:100fold     365.312600      a
## DMCC2966:Shaking:100fold    223.958000      b
## DMCC2966:Shaking:25fold     203.815933     bc
## DMCC2126:Stationary:100fold 141.064056    bcd
## DMCC2966:Stationary:25fold  125.500533   bcde
## DMCC2966:Stationary:100fold 107.479733   bcde
## DMCC2126:Shaking:100fold    107.106250   bcde
## DMCC2127:Stationary:100fold  84.257600    cde
## control:Shaking:25fold       83.216056    cde
## DMCC2165:Stationary:100fold  80.062000    cde
## control:Stationary:25fold    72.232400     de
## DMCC2165:Shaking:100fold     37.540750     de
## DMCC2127:Shaking:100fold     27.384333     de
## DMCC2127:Stationary:25fold   20.285333     de
## DMCC2126:Stationary:25fold   16.665333     de
## DMCC2127:Shaking:25fold      12.535833     de
## DMCC2126:Shaking:25fold      11.166278      e
## DMCC2165:Shaking:25fold      11.067600      e
## DMCC2165:Stationary:25fold    8.921222      e
```

```
ES2.comp.HSD.group
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   10102.73 276 105.3393 95.41771
##
## $parameters
##    test                                    name.t ntr StudentizedRange alpha
##   Tukey ES2$Treatment:ES2$Condition:ES2$Dilution  20         5.061243  0.05
##
## $means
##                               ES2$chl        std  r     Min     Max       Q25
## control:Shaking:100fold     365.312600 219.329463 15 117.742 787.887 234.01100
## control:Shaking:25fold       83.216056  81.789480 18   0.000 268.776  11.50550
## control:Stationary:100fold  414.783000 240.691662  9  97.748 831.472 272.67000
## control:Stationary:25fold    72.232400  73.372023 15   0.000 237.395  19.04600
## DMCC2126:Shaking:100fold    107.106250  88.648073 12  10.433 281.899  52.75425
```

```
## DMCC2126:Shaking:25fold      11.166278   8.588222 18   0.000  29.554   2.47200
## DMCC2126:Stationary:100fold 141.064056  40.361686 18  58.992 207.739 124.20750
## DMCC2126:Stationary:25fold   16.665333  14.486460  9   0.000  51.676  10.37600
## DMCC2127:Shaking:100fold     27.384333  29.312311 12   0.000  87.367   8.01525
## DMCC2127:Shaking:25fold      12.535833   6.846127 12   0.000  23.493  11.11275
## DMCC2127:Stationary:100fold  84.257600  66.188284 15   0.000 167.994  18.08300
## DMCC2127:Stationary:25fold   20.285333  32.415599 15   0.000 112.319   0.00000
## DMCC2165:Shaking:100fold     37.540750  46.913463 12   0.000 150.248   0.00000
## DMCC2165:Shaking:25fold      11.067600   6.311390 15   0.000  19.414   9.55700
## DMCC2165:Stationary:100fold  80.062000  63.751126 12   0.000 187.945  19.12150
## DMCC2165:Stationary:25fold    8.921222   6.912163 18   0.000  17.639   0.00000
## DMCC2966:Shaking:100fold    223.958000  61.555261 18 128.523 301.867 169.69900
## DMCC2966:Shaking:25fold     203.815933  41.016531 15 123.094 282.574 172.80800
## DMCC2966:Stationary:100fold 107.479733  95.130285 15   0.000 289.798   0.00000
## DMCC2966:Stationary:25fold  125.500533  95.202754 15   0.000 309.266  48.06800
##                                  Q50       Q75
## control:Shaking:100fold     273.5930 510.07500
## control:Shaking:25fold       74.7350 117.59850
## control:Stationary:100fold  413.0270 561.43300
## control:Stationary:25fold    26.5490 133.90650
## DMCC2126:Shaking:100fold     86.9630 129.27900
## DMCC2126:Shaking:25fold      11.0480  16.28075
## DMCC2126:Stationary:100fold 152.6480 165.71925
## DMCC2126:Stationary:25fold   12.4910  17.61900
## DMCC2127:Shaking:100fold     16.4120  36.10000
## DMCC2127:Shaking:25fold      13.0145  16.20800
## DMCC2127:Stationary:100fold  85.5550 147.53650
## DMCC2127:Stationary:25fold    9.7160  15.58600
## DMCC2165:Shaking:100fold     20.7445  53.31675
## DMCC2165:Shaking:25fold      12.9490  14.88350
## DMCC2165:Stationary:100fold 103.5510 109.77625
## DMCC2165:Stationary:25fold   10.8535  13.96450
## DMCC2966:Shaking:100fold    231.8610 279.95400
## DMCC2966:Shaking:25fold     211.9050 228.78400
## DMCC2966:Stationary:100fold 108.5790 170.38100
## DMCC2966:Stationary:25fold  120.0120 195.54450
##
## $comparison
## NULL
##
## $groups
##                               ES2$chl groups
## control:Stationary:100fold  414.783000      a
## control:Shaking:100fold     365.312600      a
## DMCC2966:Shaking:100fold    223.958000      b
## DMCC2966:Shaking:25fold     203.815933     bc
## DMCC2126:Stationary:100fold 141.064056    bcd
## DMCC2966:Stationary:25fold  125.500533   bcde
## DMCC2966:Stationary:100fold 107.479733   bcde
## DMCC2126:Shaking:100fold    107.106250   bcde
## DMCC2127:Stationary:100fold  84.257600    cde
## control:Shaking:25fold       83.216056    cde
## DMCC2165:Stationary:100fold  80.062000    cde
## control:Stationary:25fold    72.232400     de
```

```
## DMCC2165:Shaking:100fold     37.540750     de
## DMCC2127:Shaking:100fold     27.384333     de
## DMCC2127:Stationary:25fold   20.285333     de
## DMCC2126:Stationary:25fold   16.665333     de
## DMCC2127:Shaking:25fold      12.535833     de
## DMCC2126:Shaking:25fold      11.166278      e
## DMCC2165:Shaking:25fold      11.067600      e
## DMCC2165:Stationary:25fold    8.921222      e
##
## attr(,"class")
## [1] "group"
```

Same analysis using the transformed dataset

```
###############ES2 analysis###################################
ES2.mod.chl.anova <- lm (ES2.mod$ES2_chl.tuk ~ ES2.mod$Treatment + ES2.mod$Dilution + ES2.mod$Condition
ES2.mod.chl.anova
```

```
##
## Call:
## lm(formula = ES2.mod$ES2_chl.tuk ~ ES2.mod$Treatment + ES2.mod$Dilution +
##     ES2.mod$Condition + ES2.mod$isoRep + ES2.mod$techRep + ES2.mod$sampleNumber)
##
## Coefficients:
##                  (Intercept)    ES2.mod$TreatmentDMCC2126
##                      7.52662                     -2.19660
##   ES2.mod$TreatmentDMCC2127    ES2.mod$TreatmentDMCC2165
##                     -3.39025                     -3.45003
##   ES2.mod$TreatmentDMCC2966       ES2.mod$Dilution25fold
##                     -0.21011                     -2.34945
## ES2.mod$ConditionStationary    ES2.mod$isoRepisolateRep2
##                     -0.09975                      0.73788
##        ES2.mod$techRepStem2         ES2.mod$techRepStem3
##                     -0.70265                     -0.27113
## ES2.mod$sampleNumbersample2  ES2.mod$sampleNumbersample3
##                     -0.03389                     -0.09430
```

```
summary(ES2.mod.chl.anova)
```

```
##
## Call:
## lm(formula = ES2.mod$ES2_chl.tuk ~ ES2.mod$Treatment + ES2.mod$Dilution +
##     ES2.mod$Condition + ES2.mod$isoRep + ES2.mod$techRep + ES2.mod$sampleNumber)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7.1829 -1.1889  0.4416  1.2936  4.5838
##
## Coefficients:
##                              Estimate Std. Error t value Pr(>|t|)
## (Intercept)                   7.52662    0.44329  16.979  < 2e-16 ***
## ES2.mod$TreatmentDMCC2126    -2.19660    0.41262  -5.323 2.11e-07 ***
## ES2.mod$TreatmentDMCC2127    -3.39025    0.41803  -8.110 1.67e-14 ***
```

```
## ES2.mod$TreatmentDMCC2165   -3.45003    0.41254  -8.363 3.06e-15 ***
## ES2.mod$TreatmentDMCC2966   -0.21011    0.40229  -0.522  0.60190
## ES2.mod$Dilution25fold      -2.34945    0.26117  -8.996  < 2e-16 ***
## ES2.mod$ConditionStationary -0.09975    0.26000  -0.384  0.70152
## ES2.mod$isoRepisolateRep2    0.73788    0.26043   2.833  0.00495 **
## ES2.mod$techRepStem2        -0.70265    0.33340  -2.108  0.03597 *
## ES2.mod$techRepStem3        -0.27113    0.30518  -0.888  0.37510
## ES2.mod$sampleNumbersample2 -0.03389    0.31425  -0.108  0.91420
## ES2.mod$sampleNumbersample3 -0.09430    0.31539  -0.299  0.76518
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.188 on 276 degrees of freedom
##   (72 observations deleted due to missingness)
## Multiple R-squared:  0.4559, Adjusted R-squared:  0.4342
## F-statistic: 21.02 on 11 and 276 DF,  p-value: < 2.2e-16
```

```
anova(ES2.mod.chl.anova)
```

```
## Analysis of Variance Table
##
## Response: ES2.mod$ES2_chl.tuk
##                       Df  Sum Sq Mean Sq F value    Pr(>F)
## ES2.mod$Treatment      4  680.08  170.02 35.5165 < 2.2e-16 ***
## ES2.mod$Dilution       1  367.55  367.55 76.7802 < 2.2e-16 ***
## ES2.mod$Condition      1    0.63    0.63  0.1326  0.716072
## ES2.mod$isoRep         1   36.95   36.95  7.7190  0.005839 **
## ES2.mod$techRep        2   21.22   10.61  2.2166  0.110912
## ES2.mod$sampleNumber   2    0.44    0.22  0.0456  0.955457
## Residuals            276 1321.23    4.79
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Tukey's HSD for Variable chl (tukey trans) by Treament
ES2.mod.chl.treatment.HSD.test <- HSD.test(ES2.mod.chl.anova, 'ES2.mod$Treatment', group = T)
ES2.mod.chl.treatment.HSD.test
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   4.787063 276 4.479861 48.83937
##
## $parameters
##    test            name.t ntr StudentizedRange alpha
##   Tukey ES2.mod$Treatment   5         3.883285  0.05
##
## $means
##          ES2.mod$ES2_chl.tuk      std  r Min       Max      Q25      Q50
## control             6.207956 3.276161 57   0 12.443509 3.419937 6.346130
## DMCC2126            4.140619 2.307227 57   0  8.294402 2.483657 3.560255
## DMCC2127            2.929858 2.131941 54   0  6.831014 2.232076 2.783162
## DMCC2165            2.663168 1.976045 57   0  7.124617 2.217514 2.690283
## DMCC2966            6.195529 2.505798 63   0  8.587655 6.006381 6.976629
##               Q75
```

```
## control  8.191511
## DMCC2126 6.197648
## DMCC2127 4.305207
## DMCC2165 3.099921
## DMCC2966 7.725989
##
## $comparison
## NULL
##
## $groups
##          ES2.mod$ES2_chl.tuk groups
## control             6.207956      a
## DMCC2966            6.195529      a
## DMCC2126            4.140619      b
## DMCC2127            2.929858      c
## DMCC2165            2.663168      c
##
## attr(,"class")
## [1] "group"
```

```
#Tukey's HSD for Variable chl (tukey trans) by Dilution
ES2.mod.chl.dilution.HSD.test <- HSD.test(ES2.mod.chl.anova, 'ES2.mod$Dilution', group = T)
ES2.mod.chl.dilution.HSD.test
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   4.787063 276 4.479861 48.83937
##
## $parameters
##    test           name.t ntr StudentizedRange alpha
##   Tukey ES2.mod$Dilution   2         2.784016  0.05
##
## $means
##         ES2.mod$ES2_chl.tuk      std   r Min       Max      Q25      Q50
## 100fold            5.670079 2.877306 138   0 12.443509 3.837417 6.189452
## 25fold             3.384861 2.482893 150   0  8.587655 2.358352 2.806307
##              Q75
## 100fold 7.383524
## 25fold  5.616963
##
## $comparison
## NULL
##
## $groups
##         ES2.mod$ES2_chl.tuk groups
## 100fold            5.670079      a
## 25fold             3.384861      b
##
## attr(,"class")
## [1] "group"
```

```
#Tukey's HSD for Variable chl (tukey trans) by isoRep
ES2.mod.chl.isoRep.HSD.test <- HSD.test(ES2.mod.chl.anova, 'ES2.mod$isoRep', group = T)
ES2.mod.chl.isoRep.HSD.test
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   4.787063 276 4.479861 48.83937
##
## $parameters
##    test         name.t ntr StudentizedRange alpha
##   Tukey ES2.mod$isoRep   2         2.784016  0.05
##
## $means
##             ES2.mod$ES2_chl.tuk      std   r Min      Max      Q25      Q50
## isolateRep1            4.159075 2.958162 147   0 11.53155 2.416823 3.312666
## isolateRep2            4.814297 2.827923 141   0 12.44351 2.690283 5.303860
##                  Q75
## isolateRep1 6.351531
## isolateRep2 6.878451
##
## $comparison
## NULL
##
## $groups
##             ES2.mod$ES2_chl.tuk groups
## isolateRep2            4.814297      a
## isolateRep1            4.159075      b
##
## attr(,"class")
## [1] "group"
```

```
#Complete ANOVA for ES2.mod by treatment by dilution
ES2.mod.comp.HSD.group <- HSD.test(ES2.mod.chl.anova, c("ES2.mod$Treatment", "ES2.mod$Dilution"), group=
                                                    main="ES2.mod - Xylaria Chl Contnent (Tukey's Ladder Tra
```

```
##
## Study: ES2.mod - Xylaria Chl Contnent (Tukey's Ladder Transformed Data) by treatment  by dilution at
##
## HSD Test for ES2.mod$ES2_chl.tuk
##
## Mean Square Error:  4.787063
##
## ES2.mod$Treatment:ES2.mod$Dilution,  means
##
##                   ES2.mod.ES2_chl.tuk      std  r      Min       Max
## control:100fold             8.952842 2.033695 24 5.575585 12.443509
## control:25fold              4.211675 2.459674 33 0.000000  8.147445
## DMCC2126:100fold            5.904452 1.432971 30 2.409370  8.294402
## DMCC2126:25fold             2.180805 1.263683 27 0.000000  4.390190
## DMCC2127:100fold            3.720246 2.309541 27 0.000000  6.831014
## DMCC2127:25fold             2.139470 1.622868 27 0.000000  5.873811
## DMCC2165:100fold            3.677465 2.368645 24 0.000000  7.124617
## DMCC2165:25fold             1.925497 1.211620 33 0.000000  3.041187
## DMCC2966:100fold            6.114039 2.778697 33 0.000000  8.510026
## DMCC2966:25fold             6.285168 2.210961 30 0.000000  8.587655
##
## Alpha: 0.05 ; DF Error: 276
## Critical Value of Studentized Range: 4.511094
```

```
##
## Groups according to probability of means differences and alpha level( 0.05 )
##
## Treatments with the same letter are not significantly different.
##
##                  ES2.mod$ES2_chl.tuk groups
## control:100fold             8.952842      a
## DMCC2966:25fold             6.285168      b
## DMCC2966:100fold            6.114039      b
## DMCC2126:100fold            5.904452     bc
## control:25fold              4.211675     cd
## DMCC2127:100fold            3.720246     de
## DMCC2165:100fold            3.677465     de
## DMCC2126:25fold             2.180805      e
## DMCC2127:25fold             2.139470      e
## DMCC2165:25fold             1.925497      e
```

```
ES2.mod.comp.HSD.group
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   4.787063 276 4.479861 48.83937
##
## $parameters
##    test                              name.t ntr StudentizedRange alpha
##   Tukey ES2.mod$Treatment:ES2.mod$Dilution  10         4.511094  0.05
##
## $means
##                  ES2.mod$ES2_chl.tuk      std  r      Min       Max      Q25
## control:100fold             8.952842 2.033695 24 5.575585 12.443509 7.860042
## control:25fold              4.211675 2.459674 33 0.000000  8.147445 2.807281
## DMCC2126:100fold            5.904452 1.432971 30 2.409370  8.294402 5.211560
## DMCC2126:25fold             2.180805 1.263683 27 0.000000  4.390190 2.359361
## DMCC2127:100fold            3.720246 2.309541 27 0.000000  6.831014 2.547399
## DMCC2127:25fold             2.139470 1.622868 27 0.000000  5.873811 0.000000
## DMCC2165:100fold            3.677465 2.368645 24 0.000000  7.124617 2.700544
## DMCC2165:25fold             1.925497 1.211620 33 0.000000  3.041187 0.000000
## DMCC2966:100fold            6.114039 2.778697 33 0.000000  8.510026 5.991199
## DMCC2966:25fold             6.285168 2.210961 30 0.000000  8.587655 6.035946
##                       Q50       Q75
## control:100fold  8.279323 10.486003
## control:25fold   4.628247  6.200641
## DMCC2126:100fold 6.189452  6.705312
## DMCC2126:25fold  2.483657  2.863395
## DMCC2127:100fold 3.818594  5.417472
## DMCC2127:25fold  2.531540  2.807481
## DMCC2165:100fold 3.362478  5.745663
## DMCC2165:25fold  2.561469  2.745123
## DMCC2966:100fold 6.963949  7.832392
## DMCC2966:25fold  7.032779  7.590879
##
## $comparison
## NULL
##
```

```
## $groups
##                   ES2.mod$ES2_chl.tuk groups
## control:100fold              8.952842      a
## DMCC2966:25fold              6.285168      b
## DMCC2966:100fold             6.114039      b
## DMCC2126:100fold             5.904452     bc
## control:25fold               4.211675     cd
## DMCC2127:100fold             3.720246     de
## DMCC2165:100fold             3.677465     de
## DMCC2126:25fold              2.180805      e
## DMCC2127:25fold              2.139470      e
## DMCC2165:25fold              1.925497      e
##
## attr(,"class")
## [1] "group"
```

```
#Complete ANOVA for ES2.mod by treatment by condition, by dilution
ES2.mod.comp.HSD.group <- HSD.test(ES2.mod.chl.anova, c("ES2.mod$Treatment", "ES2.mod$Condition", "ES2.m
                                                    main="ES2.mod - Xylaria Chl Contnent (Tukey's Ladder Tra
```

```
##
## Study: ES2.mod - Xylaria Chl Contnent (Tukey's Ladder Transformed Data) by treatment  by dilution at
##
## HSD Test for ES2.mod$ES2_chl.tuk
##
## Mean Square Error:  4.787063
##
## ES2.mod$Treatment:ES2.mod$Condition:ES2.mod$Dilution,  means
##
##                               ES2.mod.ES2_chl.tuk       std  r      Min       Max
## control:Shaking:100fold                  8.798267 1.9828967 15 5.978597 12.194780
## control:Shaking:25fold                   4.289829 2.5912255 18 0.000000  8.147445
## control:Stationary:100fold               9.210468 2.2114466  9 5.575585 12.443509
## control:Stationary:25fold                4.117890 2.3786595 15 0.000000  7.776816
## DMCC2126:Shaking:100fold                 5.267468 1.9475065 12 2.409370  8.294402
## DMCC2126:Shaking:25fold                  1.990082 1.3058091 18 0.000000  3.560255
## DMCC2126:Stationary:100fold              6.329108 0.7558881 18 4.613679  7.397232
## DMCC2126:Stationary:25fold               2.562252 1.1493281  9 0.000000  4.390190
## DMCC2127:Shaking:100fold                 2.718108 1.8775300 12 0.000000  5.345709
## DMCC2127:Shaking:25fold                  2.287858 1.0938454 12 0.000000  3.266645
## DMCC2127:Stationary:100fold              4.521957 2.3636341 15 0.000000  6.831014
## DMCC2127:Stationary:25fold               2.020759 1.9791611 15 0.000000  5.873811
## DMCC2165:Shaking:100fold                 2.818319 2.3433519 12 0.000000  6.550935
## DMCC2165:Shaking:25fold                  2.131528 1.1204622 15 0.000000  3.041187
## DMCC2165:Stationary:100fold              4.536612 2.1515647 12 0.000000  7.124617
## DMCC2165:Stationary:25fold               1.753804 1.2887125 18 0.000000  2.933781
## DMCC2966:Shaking:100fold                 7.538945 0.8254875 18 6.178283  8.510026
## DMCC2966:Shaking:25fold                  7.310403 0.5695012 15 6.079094  8.301844
## DMCC2966:Stationary:100fold              4.404150 3.3283476 15 0.000000  8.380806
## DMCC2966:Stationary:25fold               5.259932 2.7475728 15 0.000000  8.587655
##
## Alpha: 0.05 ; DF Error: 276
## Critical Value of Studentized Range: 5.061243
##
```

```
## Groups according to probability of means differences and alpha level( 0.05 )
##
## Treatments with the same letter are not significantly different.
##
##                              ES2.mod$ES2_chl.tuk groups
## control:Stationary:100fold             9.210468      a
## control:Shaking:100fold                8.798267      a
## DMCC2966:Shaking:100fold               7.538945     ab
## DMCC2966:Shaking:25fold                7.310403    abc
## DMCC2126:Stationary:100fold            6.329108   abcd
## DMCC2126:Shaking:100fold               5.267468   bcde
## DMCC2966:Stationary:25fold             5.259932   bcde
## DMCC2165:Stationary:100fold            4.536612   cdef
## DMCC2127:Stationary:100fold            4.521957   cdef
## DMCC2966:Stationary:100fold            4.404150    def
## control:Shaking:25fold                 4.289829    def
## control:Stationary:25fold              4.117890    def
## DMCC2165:Shaking:100fold               2.818319     ef
## DMCC2127:Shaking:100fold               2.718108     ef
## DMCC2126:Stationary:25fold             2.562252     ef
## DMCC2127:Shaking:25fold                2.287858     ef
## DMCC2165:Shaking:25fold                2.131528      f
## DMCC2127:Stationary:25fold             2.020759      f
## DMCC2126:Shaking:25fold                1.990082      f
## DMCC2165:Stationary:25fold             1.753804      f
```

```
ES2.mod.comp.HSD.group
```

```
## $statistics
##    MSerror  Df     Mean       CV
##   4.787063 276 4.479861 48.83937
##
## $parameters
##    test                                                name.t ntr
##   Tukey ES2.mod$Treatment:ES2.mod$Condition:ES2.mod$Dilution  20
##   StudentizedRange alpha
##           5.061243  0.05
##
## $means
##                              ES2.mod$ES2_chl.tuk       std  r      Min       Max
## control:Shaking:100fold                 8.798267 1.9828967 15 5.978597 12.194780
## control:Shaking:25fold                  4.289829 2.5912255 18 0.000000  8.147445
## control:Stationary:100fold              9.210468 2.2114466  9 5.575585 12.443509
## control:Stationary:25fold               4.117890 2.3786595 15 0.000000  7.776816
## DMCC2126:Shaking:100fold                5.267468 1.9475065 12 2.409370  8.294402
## DMCC2126:Shaking:25fold                 1.990082 1.3058091 18 0.000000  3.560255
## DMCC2126:Stationary:100fold             6.329108 0.7558881 18 4.613679  7.397232
## DMCC2126:Stationary:25fold              2.562252 1.1493281  9 0.000000  4.390190
## DMCC2127:Shaking:100fold                2.718108 1.8775300 12 0.000000  5.345709
## DMCC2127:Shaking:25fold                 2.287858 1.0938454 12 0.000000  3.266645
## DMCC2127:Stationary:100fold             4.521957 2.3636341 15 0.000000  6.831014
## DMCC2127:Stationary:25fold              2.020759 1.9791611 15 0.000000  5.873811
## DMCC2165:Shaking:100fold                2.818319 2.3433519 12 0.000000  6.550935
## DMCC2165:Shaking:25fold                 2.131528 1.1204622 15 0.000000  3.041187
```

```
## DMCC2165:Stationary:100fold           4.536612 2.1515647 12 0.000000  7.124617
## DMCC2165:Stationary:25fold            1.753804 1.2887125 18 0.000000  2.933781
## DMCC2966:Shaking:100fold              7.538945 0.8254875 18 6.178283  8.510026
## DMCC2966:Shaking:25fold               7.310403 0.5695012 15 6.079094  8.301844
## DMCC2966:Stationary:100fold           4.404150 3.3283476 15 0.000000  8.380806
## DMCC2966:Stationary:25fold            5.259932 2.7475728 15 0.000000  8.587655
##                                  Q25      Q50       Q75
## control:Shaking:100fold     7.7274852 8.201898 10.359933
## control:Shaking:25fold      2.4878607 5.027823  5.972661
## control:Stationary:100fold  8.1915108 9.571763 10.739566
## control:Stationary:25fold   3.0157515 3.419937  6.273385
## DMCC2126:Shaking:100fold    4.2801750 5.335099  6.180383
## DMCC2126:Shaking:25fold     0.5903447 2.461623  2.846913
## DMCC2126:Stationary:100fold 6.0993511 6.589981  6.795896
## DMCC2126:Stationary:25fold  2.4044250 2.577650  2.932533
## DMCC2127:Shaking:100fold    1.8234010 2.839753  3.837417
## DMCC2127:Shaking:25fold     2.4670786 2.617529  2.841275
## DMCC2127:Stationary:100fold 2.9573845 5.303860  6.505797
## DMCC2127:Stationary:25fold  0.0000000 2.345891  2.800751
## DMCC2165:Shaking:100fold    0.0000000 3.114771  4.399467
## DMCC2165:Shaking:25fold     2.3281209 2.612694  2.752718
## DMCC2165:Stationary:100fold 3.0185079 5.697205  5.823266
## DMCC2165:Stationary:25fold  0.0000000 2.444908  2.687717
## DMCC2966:Shaking:100fold    6.8481012 7.707340  8.272894
## DMCC2966:Shaking:25fold     6.9031198 7.452517  7.669810
## DMCC2966:Stationary:100fold 0.0000000 5.799689  6.866089
## DMCC2966:Stationary:25fold  3.9450519 6.021563  7.231307
##
## $comparison
## NULL
##
## $groups
##                              ES2.mod$ES2_chl.tuk groups
## control:Stationary:100fold             9.210468      a
## control:Shaking:100fold                8.798267      a
## DMCC2966:Shaking:100fold               7.538945     ab
## DMCC2966:Shaking:25fold                7.310403    abc
## DMCC2126:Stationary:100fold            6.329108   abcd
## DMCC2126:Shaking:100fold               5.267468   bcde
## DMCC2966:Stationary:25fold             5.259932   bcde
## DMCC2165:Stationary:100fold            4.536612   cdef
## DMCC2127:Stationary:100fold            4.521957   cdef
## DMCC2966:Stationary:100fold            4.404150    def
## control:Shaking:25fold                 4.289829    def
## control:Stationary:25fold              4.117890    def
## DMCC2165:Shaking:100fold               2.818319     ef
## DMCC2127:Shaking:100fold               2.718108     ef
## DMCC2126:Stationary:25fold             2.562252     ef
## DMCC2127:Shaking:25fold                2.287858     ef
## DMCC2165:Shaking:25fold                2.131528      f
## DMCC2127:Stationary:25fold             2.020759      f
## DMCC2126:Shaking:25fold                1.990082      f
## DMCC2165:Stationary:25fold             1.753804      f
##
```

```
## attr(,"class")
## [1] "group"
```