Laboratorio-Anova3.R

DELL LATITUDE 3510

2025-10-02

```
#Carlos Guadalupe Andrade Peña
##anova
###2025-23-09
#Comparación de concentraciones de estroncio en cuerpos de agua
#datos
library(datapasta)
library(readr)
file.exists("Estroncio.CSV")
```

```
## [1] TRUE
```

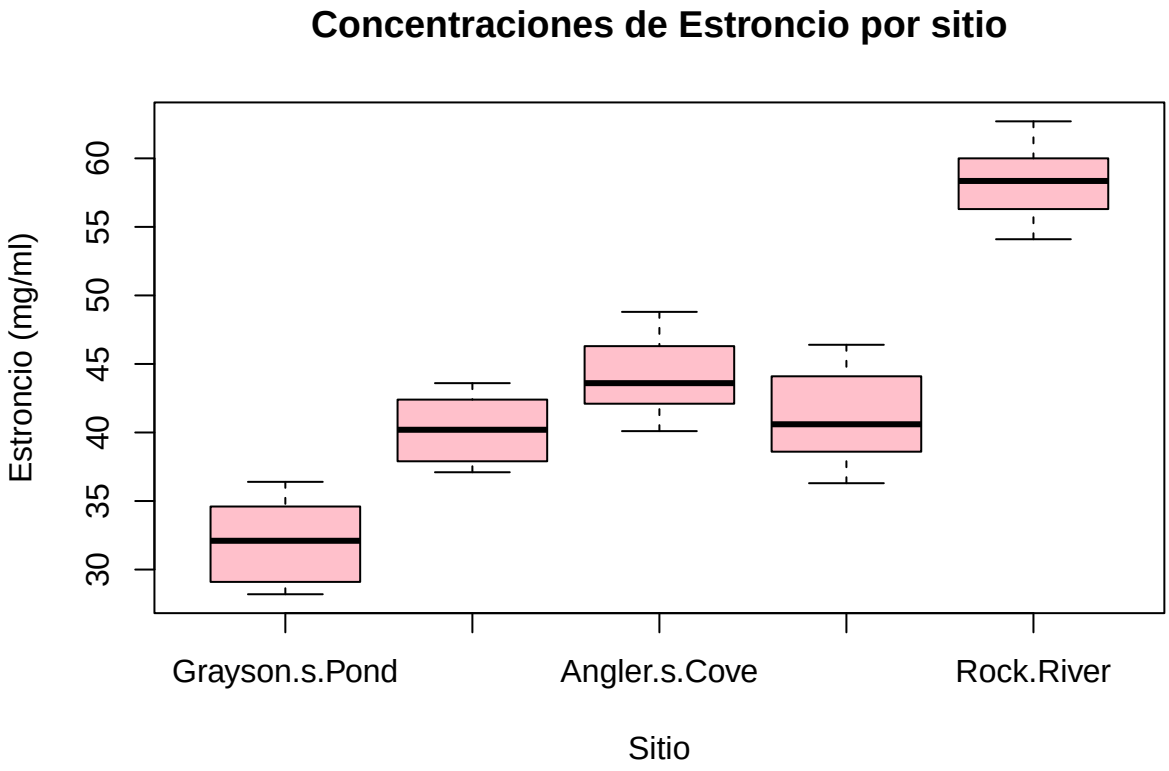
```
Estroncio <- read.csv("Estroncio.csv", header = TRUE)
#transformación de datos
Estroncio_log <- stack (Estroncio[,-1])
colnames(Estroncio_log) <- c("Estroncio","Sitio")
Estroncio_log$Sitio <- as.factor(Estroncio_log$Sitio)
#Estadísticas descritivas
tapply(Estroncio_log$Estroncio,Estroncio_log$Sitio, mean)
```

```
## Grayson.s.Pond    Beaver.Lake  Angler.s.Cove Appletree.Lake     Rock.River
##       32.08333       40.23333       44.08333       41.10000       58.30000
```

```
tapply(Estroncio_log$Estroncio,Estroncio_log$Sitio,var)
```

```
## Grayson.s.Pond    Beaver.Lake  Angler.s.Cove Appletree.Lake     Rock.River
##      10.273667       6.402667       9.489667      13.440000       9.220000
```

```
#Boxplot
boxplot(Estroncio ~ Sitio, data = Estroncio_log,
        col = "pink",
        main = "Concentraciones de Estroncio por sitio",
        ylab = "Estroncio (mg/ml)")
```




```
#Pruebas de normalidad
shapiro.test(Estroncio_log$Estroncio)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Estroncio_log$Estroncio
## W = 0.94235, p-value = 0.1052
```

```
by(Estroncio_log$Estroncio,Estroncio_log$Sitio,shapiro.test)
```

```
## Estroncio_log$Sitio: Grayson.s.Pond
##
##  Shapiro-Wilk normality test
##
## data:  dd[x, ]
## W = 0.95674, p-value = 0.7943
##
## ------------------------------------------------------------
## Estroncio_log$Sitio: Beaver.Lake
##
##  Shapiro-Wilk normality test
##
## data:  dd[x, ]
## W = 0.96163, p-value = 0.8322
```

```
##
## ------------------------------------------------------------
## Estroncio_log$Sitio: Angler.s.Cove
##
##  Shapiro-Wilk normality test
##
## data:  dd[x, ]
## W = 0.97181, p-value = 0.9044
##
## ------------------------------------------------------------
## Estroncio_log$Sitio: Appletree.Lake
##
##  Shapiro-Wilk normality test
##
## data:  dd[x, ]
## W = 0.9784, p-value = 0.9433
##
## ------------------------------------------------------------
## Estroncio_log$Sitio: Rock.River
##
##  Shapiro-Wilk normality test
##
## data:  dd[x, ]
## W = 0.98937, p-value = 0.9876
```

```
#Homogeneidad de varianzas
bartlett.test(Estroncio ~ Sitio, data = Estroncio_log)
```

```
##
##  Bartlett test of homogeneity of variances
##
## data:  Estroncio by Sitio
## Bartlett's K-squared = 0.63895, df = 4, p-value = 0.9586
```

```
#Anova
Estroncio.aov <-aov(Estroncio ~ Sitio, data = Estroncio_log)
summary(Estroncio.aov)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## Sitio        4 2193.4   548.4   56.16 3.95e-12 ***
## Residuals   25  244.1     9.8
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Prueba LSD
library(agricolae)
lsd_resultados <- LSD.test(Estroncio.aov, "Sitio", p.adj = "none")
print(lsd_resultados)
```

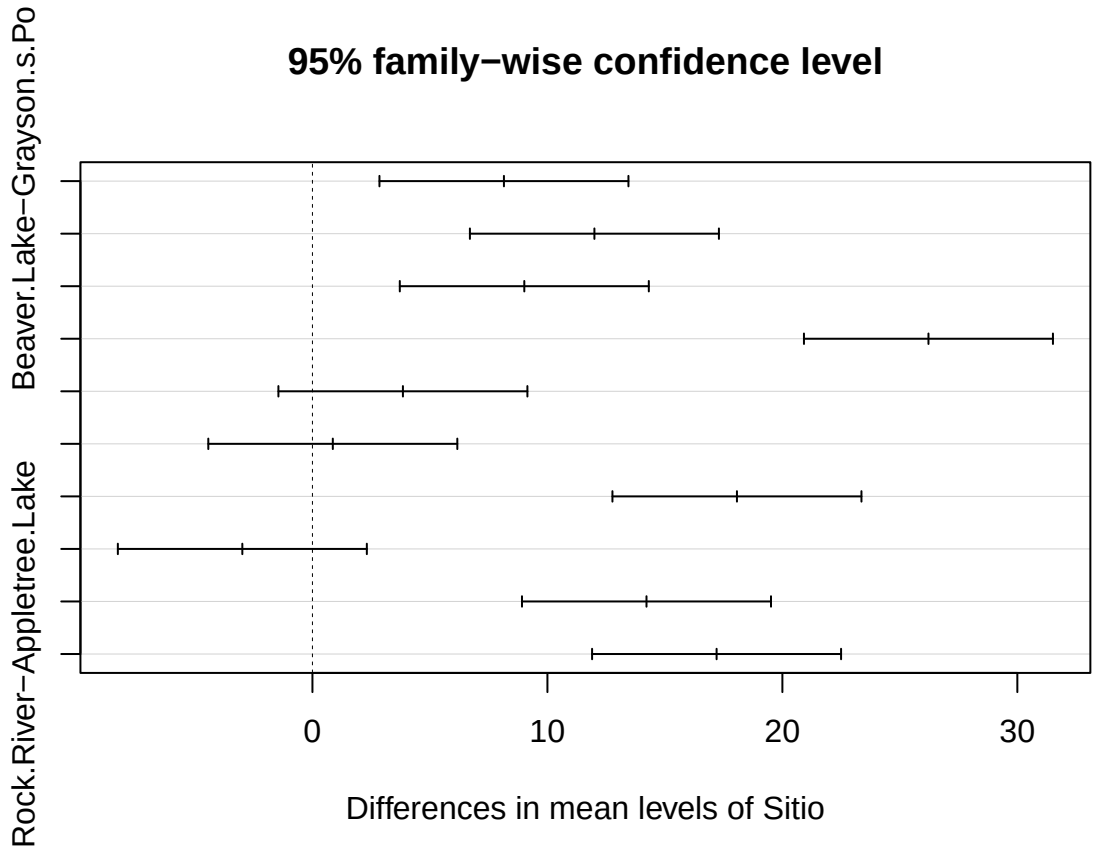
```
## $statistics
##   MSerror Df  Mean       CV  t.value      LSD
##    9.7652 25 43.16 7.240343 2.059539 3.715779
```

```
##
## $parameters
##         test p.ajusted name.t ntr alpha
##   Fisher-LSD      none  Sitio   5  0.05
##
## $means
##                Estroncio      std r       se      LCL      UCL  Min  Max    Q25
## Angler.s.Cove   44.08333 3.080530 6 1.275748 41.45588 46.71079 40.1 48.8 42.450
## Appletree.Lake  41.10000 3.666061 6 1.275748 38.47255 43.72745 36.3 46.4 39.000
## Beaver.Lake     40.23333 2.530349 6 1.275748 37.60588 42.86079 37.1 43.6 38.325
## Grayson.s.Pond  32.08333 3.205256 6 1.275748 29.45588 34.71079 28.2 36.4 29.575
## Rock.River      58.30000 3.036445 6 1.275748 55.67255 60.92745 54.1 62.7 56.550
##                  Q50    Q75
## Angler.s.Cove  43.60 45.650
## Appletree.Lake 40.60 43.325
## Beaver.Lake    40.20 42.000
## Grayson.s.Pond 32.10 34.250
## Rock.River     58.35 59.850
##
## $comparison
## NULL
##
## $groups
##                Estroncio groups
## Rock.River      58.30000      a
## Angler.s.Cove   44.08333      b
## Appletree.Lake  41.10000     bc
## Beaver.Lake     40.23333      c
## Grayson.s.Pond  32.08333      d
##
## attr(,"class")
## [1] "group"
```

```
#Prueba Turkey
tukey_resultados<- TukeyHSD(Estroncio.aov,conf.level = 0.95)
print(tukey_resultados)
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = Estroncio ~ Sitio, data = Estroncio_log)
##
## $Sitio
##                                     diff       lwr       upr     p adj
## Beaver.Lake-Grayson.s.Pond     8.1500000  2.851355 13.448645 0.0011293
## Angler.s.Cove-Grayson.s.Pond  12.0000000  6.701355 17.298645 0.0000053
## Appletree.Lake-Grayson.s.Pond  9.0166667  3.718021 14.315312 0.0003339
## Rock.River-Grayson.s.Pond     26.2166667 20.918021 31.515312 0.0000000
## Angler.s.Cove-Beaver.Lake      3.8500000 -1.448645  9.148645 0.2376217
## Appletree.Lake-Beaver.Lake     0.8666667 -4.431979  6.165312 0.9884803
## Rock.River-Beaver.Lake        18.0666667 12.768021 23.365312 0.0000000
## Appletree.Lake-Angler.s.Cove  -2.9833333 -8.281979  2.315312 0.4791100
## Rock.River-Angler.s.Cove      14.2166667  8.918021 19.515312 0.0000003
## Rock.River-Appletree.Lake     17.2000000 11.901355 22.498645 0.0000000
```

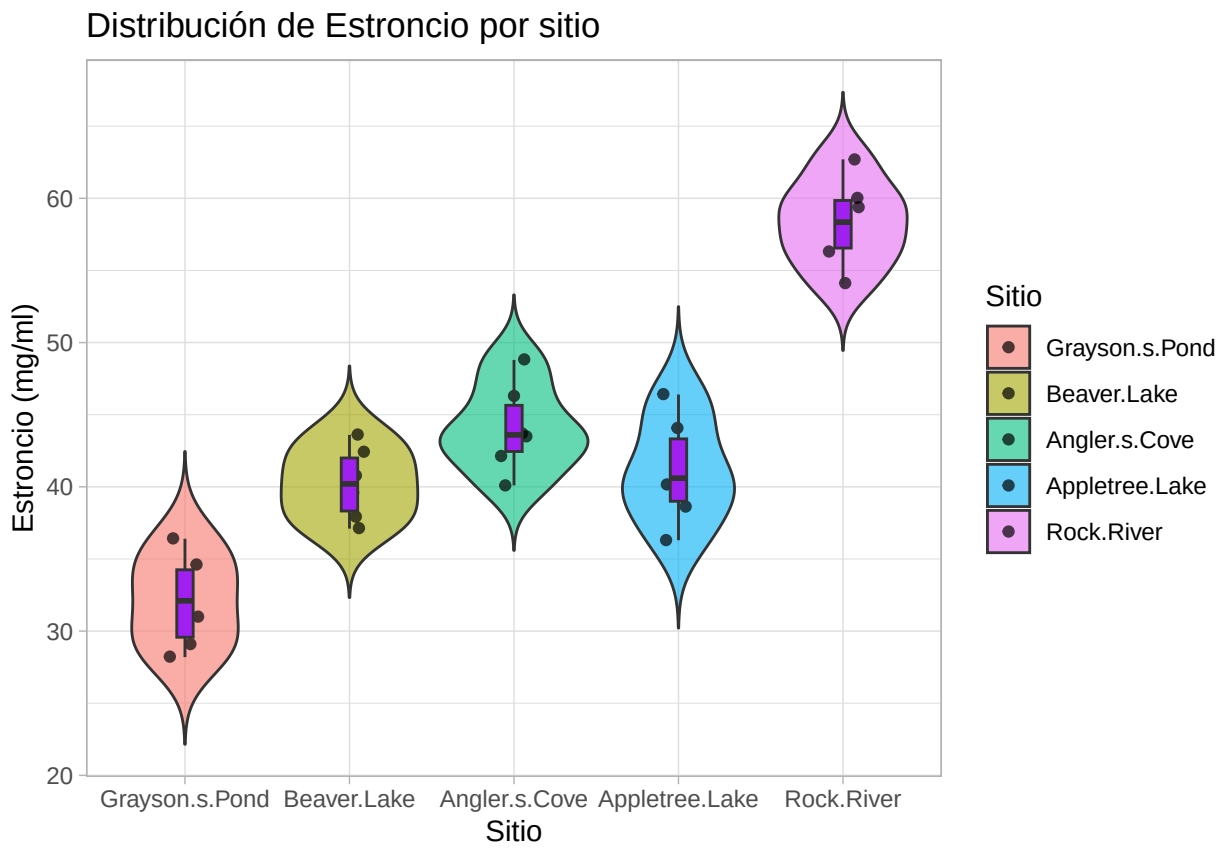
```r
plot(tukey_resultados)
```




```r
#Diferencias mínima significativa (MSD) con Tukey
n<- 6
glerror <- Estroncio.aov$df.residual
MSE <- summary(Estroncio.aov)[[1]][["Mean Sq"]][2]
k <- length(levels(Estroncio_log$Sitio))
qcrit <- qtukey(0.95, nmeans = k, df = glerror)
MSD <- qcrit * sqrt(MSE/2 * (2/n))
MSD
```

```
## [1] 5.298645
```

```r
#Visualizacion con ggplot2
library(ggplot2)
ggplot(Estroncio_log, aes(x = Sitio, y = Estroncio, fill = Sitio)) +
geom_violin(trim = FALSE, alpha = 0.6) +
geom_jitter(width = 0.1, alpha = 0.7) +
geom_boxplot(width = 0.1, fill = "purple", outlier.shape = NA) +
theme_light() +
labs(title = "Distribución de Estroncio por sitio",
y = "Estroncio (mg/ml)",
x = "Sitio")
```




```
install.packages("datapasta")
```

```
## Warning: package 'datapasta' is in use and will not be installed
```