Analysis of the Effect of Vitamin C on Tooth Growth in Guinea Pigs

Overview

In this study, 60 guinea pigs received one of three dose levels of vitamin C (0.5, 1, and 2 mg/day) by one of two delivery methods:

- orange juice (OJ)
- ascorbic acid, a form of vitamin C (VC)

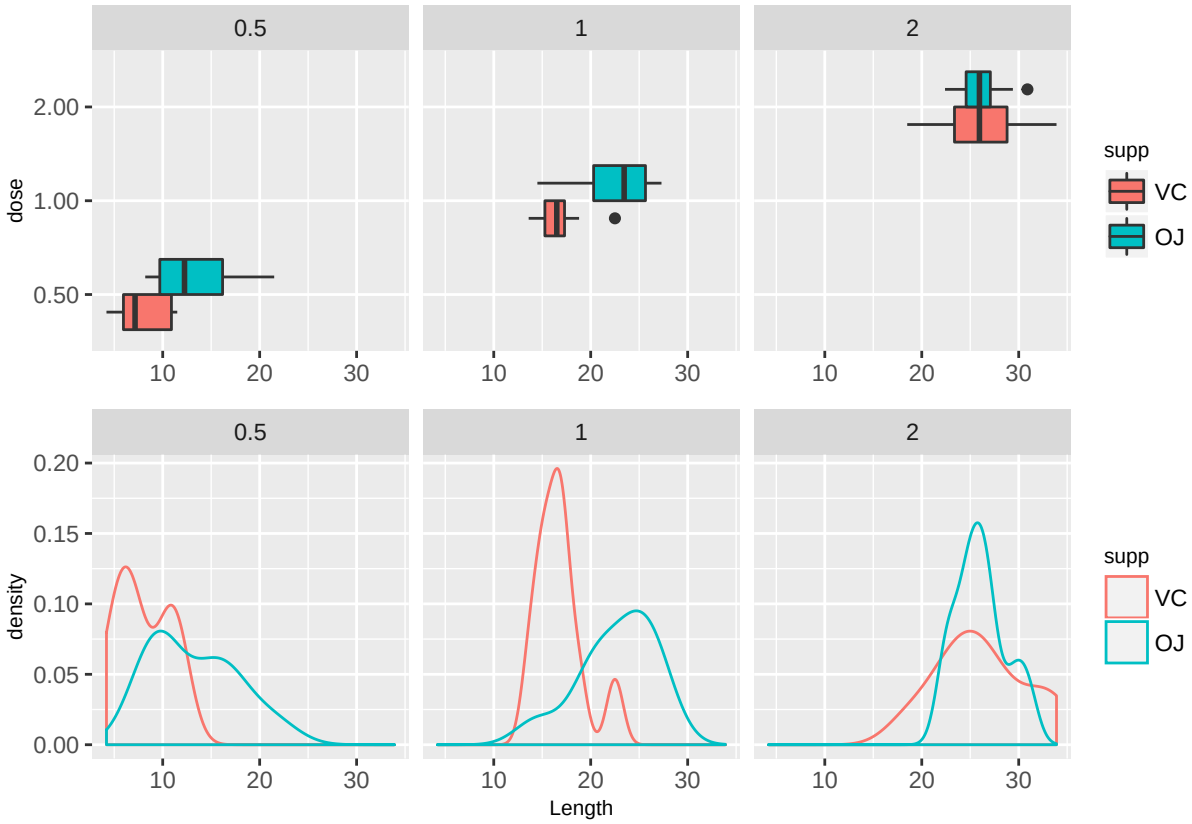
The result is the length of odontoblasts (cells responsible for tooth growth).

First look

Fig.1 shows the length of odontoblasts depending on the supplement and the daily dose of vitamin C.

- Increasing the dose seems to increase the Tooth Growth, regardless of the supplement used
- The orange juice seems to perfom better than pure vitamin C at small doses.
- For the highest daily dose, the average effect is similar in both supplements, but the orange juice seems to have a more consistent impact (smaller standard deviation).

Fig. 1: Odontoblasts length by dose (in mg/day)



T-test: OJ vs VC

We will perform a series of t-test to verify our hypothesis that the orange juice is more efficient than the pure vitamin C. The following table shows the difference in true means between OJ and VC, for each daily dose.

Results

```
# create an empty data frame
df <- data.frame(dose=numeric(),
                 confLower=numeric(),
                 confUpper=numeric(),
                 p.value=numeric())

# loop on doses
for (myDose in levels(ToothGrowth$dose)) {

  # build comp vectors
  x <- filter (ToothGrowth,dose==myDose & supp=='OJ') %>% select(len)
  y <- filter (ToothGrowth,dose==myDose & supp=='VC') %>% select(len)

  # perform t-test
  conf.int <- round(t.test(x,y,paired=FALSE)$conf, 3)
  pvalue <- round(t.test(x,y,paired=FALSE)$p.value, 5)

  #format data
  df1 <- as.data.frame(cbind(myDose, conf.int[1], conf.int[2], pvalue))
  df <- rbind(df, df1)

}

# properly name columns
names(df) <- c("dose", "confLower", "confUpper", "p.value")

# return result
print(df)
```

```
##   dose confLower confUpper p.value
## 1  0.5     1.719     8.781 0.00636
## 2    1     2.802     9.058 0.00104
## 3    2    -3.798     3.638 0.96385
```

Conclusion

The results confirm that for low doses, the orange juice outperforms the pure vitamin C ($P < 0.01$: strongly significant). For the highest dose however, we cannot draw a definitive conclusion about the relative efficiency of the two supplements.

T-test: doses

We will perform a series of t-test to verify our hypothesis that the higher doses lead to more Tooth Growth. The following table shows the difference in true means between doses.

Results

```
# create an empty data frame
df <- data.frame(dose=numeric(),
                 confLower=numeric(),
                 confUpper=numeric(),
                 p.value=numeric())

# loop on doses
for (myDose in list(c(0.5,1), c(0.5,2), c(1,2))) {

  # build comp vectors
  x <- filter (ToothGrowth,dose==myDose[2]) %>% select(len)
  y <- filter (ToothGrowth,dose==myDose[1]) %>% select(len)

  # perform t-test
  conf.int <- round(t.test(x,y,paired=FALSE)$conf, 3)
  pvalue <- round(t.test(x,y,paired=FALSE)$p.value, 5)

  #format data
  df1 <- as.data.frame(cbind(paste(myDose[2], "vs", myDose[1]), conf.int[1], conf.int[2], pvalue))
  df <- rbind(df, df1)
}

# properly name columns
names(df) <- c("dose", "confLower", "confUpper", "p.value")

# return result
print(df)
```

```
##       dose confLower confUpper p.value
## 1 1 vs 0.5     6.276    11.984       0
## 2 2 vs 0.5    12.834    18.156       0
## 3   2 vs 1     3.734     8.996   2e-05
```

Conclusion

The results confirm that regardless of the supplement, increasing the dose clearly has a positive impact on the Tooth Growth ($P < 0.001$: very significant).

Assumptions

The following assumptions were made to perform both series of t-tests:

- the variables are iid normal (fig.1 shows that this is roughly true)
- equal variances between all sample groups