

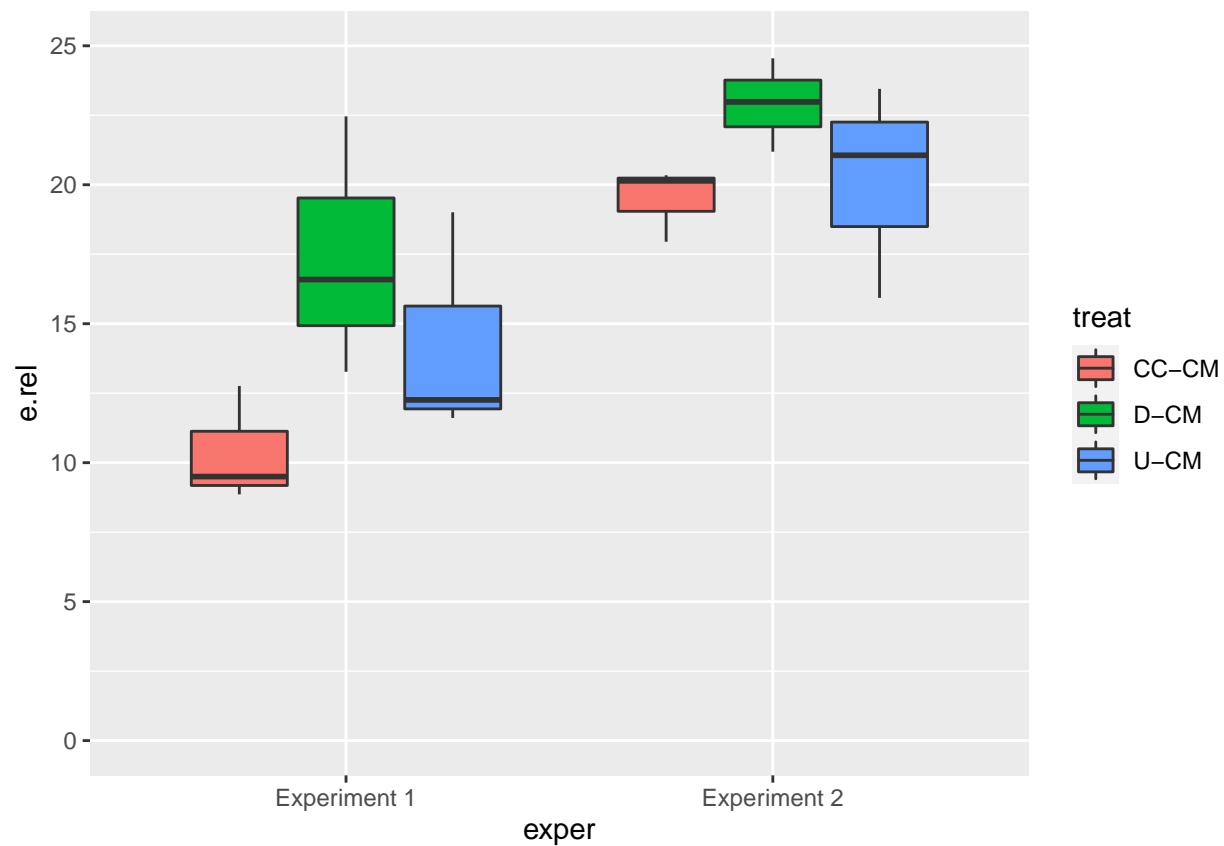
# Data analysis of cumulative NH3 for digestate experiments

Sasha D. Hafner

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## NH3 plots

```
ggplot(dat, aes(exper, e.rel, fill = treat)) +  
  geom_boxplot() +  
  ylim(0, 25)
```



## NH3 stats

Set reference to untreated cattle manure.

```
dat$treat <- factor(dat$treat, levels = c('U-CM', 'CC-CM', 'D-CM'))  
dat$exper <- factor(dat$exper)
```

First model, with interaction, no transformation.

```
m1 <- aov(e.rel ~ treat * exper, data = dat)
summary(m1)
```

```
##              Df Sum Sq Mean Sq F value    Pr(>F)
## treat         2  83.07   41.53    4.009 0.046418 *
## exper         1 208.56  208.56   20.128 0.000744 ***
## treat:exper    2   11.97    5.98    0.578 0.576130
## Residuals     12 124.34   10.36
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary.lm(m1)
```

```
##
## Call:
## aov(formula = e.rel ~ treat * exper, data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.2167 -1.6692 -0.3883  1.4608  5.0200
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      14.2933     1.8584   7.691 5.61e-06 ***
## treatCC-CM        -3.9200     2.6282  -1.491  0.1616
## treatD-CM         3.1467     2.6282   1.197  0.2543
## experExperiment 2    5.8533     2.6282   2.227  0.0459 *
## treatCC-CM:experExperiment 2  3.2500     3.7169   0.874  0.3991
## treatD-CM:experExperiment 2 -0.3867     3.7169  -0.104  0.9189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.219 on 12 degrees of freedom
## Multiple R-squared:  0.7094, Adjusted R-squared:  0.5884
## F-statistic:  5.86 on 5 and 12 DF,  p-value: 0.005746
```

Without interaction.

```
m2 <- aov(e.rel ~ treat + exper, data = dat)
summary(m2)
```

```
##              Df Sum Sq Mean Sq F value    Pr(>F)
## treat         2  83.07   41.53    4.266 0.035753 *
## exper         1 208.56  208.56   21.421 0.000391 ***
## Residuals     14 136.31    9.74
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary.lm(m2)
```

```
##
## Call:
## aov(formula = e.rel ~ treat + exper, data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

```
## -4.6939 -2.1599 -0.2792 1.6681 5.6906
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      13.816      1.471   9.393 2.02e-07 ***
## treatCC-CM       -2.295      1.801  -1.274 0.223428
## treatD-CM        2.953      1.801   1.639 0.123404
## experExperiment 2    6.808      1.471   4.628 0.000391 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.12 on 14 degrees of freedom
## Multiple R-squared:  0.6815, Adjusted R-squared:  0.6132
## F-statistic: 9.984 on 3 and 14 DF,  p-value: 0.0008875
```

**This model is the one we should use in the paper.** Diagnostic plots look better, and the boxplot above shows smaller differences for experiment 2 (not larger as expected if there were a fixed relative effect).

```
m3 <- aov(log10(e.rel) ~ treat * exper, data = dat)
summary(m3)
```

```
##              Df Sum Sq Mean Sq F value    Pr(>F)
## treat         2  0.06369  0.03184    4.396 0.036958 *
## exper         1  0.15725  0.15725   21.708 0.000552 ***
## treat:exper    2  0.01940  0.00970    1.339 0.298643
## Residuals     12  0.08692  0.00724
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
m4 <- aov(log10(e.rel) ~ treat + exper, data = dat)
summary(m4)
```

```
##              Df Sum Sq Mean Sq F value    Pr(>F)
## treat         2  0.06369  0.03184    4.193 0.037415 *
## exper         1  0.15725  0.15725   20.706 0.000453 ***
## Residuals     14  0.10632  0.00759
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary.lm(m4)
```

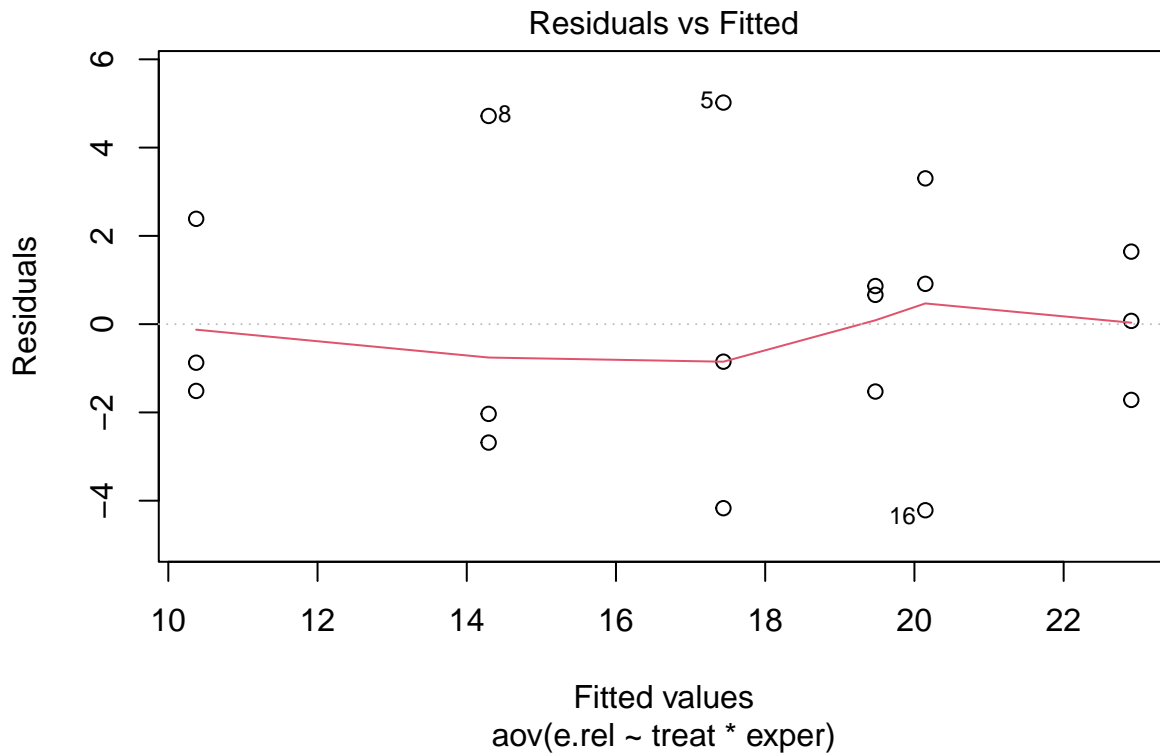
```
##
## Call:
## aov(formula = log10(e.rel) ~ treat + exper, data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.112604 -0.062945  0.004974  0.053927  0.151094
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1.12789     0.04108  27.455 1.42e-13 ***
## treatCC-CM      -0.07177     0.05031  -1.427 0.175637
## treatD-CM       0.07392     0.05031   1.469 0.163876
## experExperiment 2  0.18693     0.04108   4.550 0.000453 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

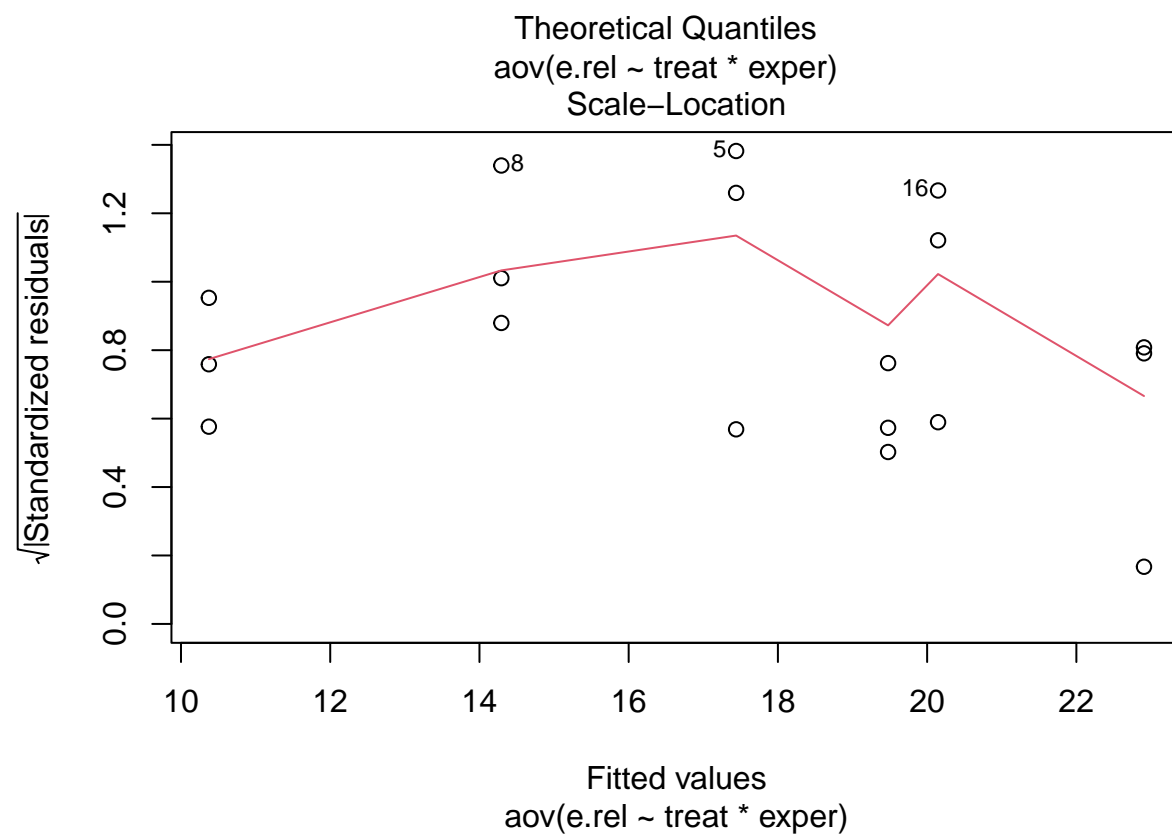
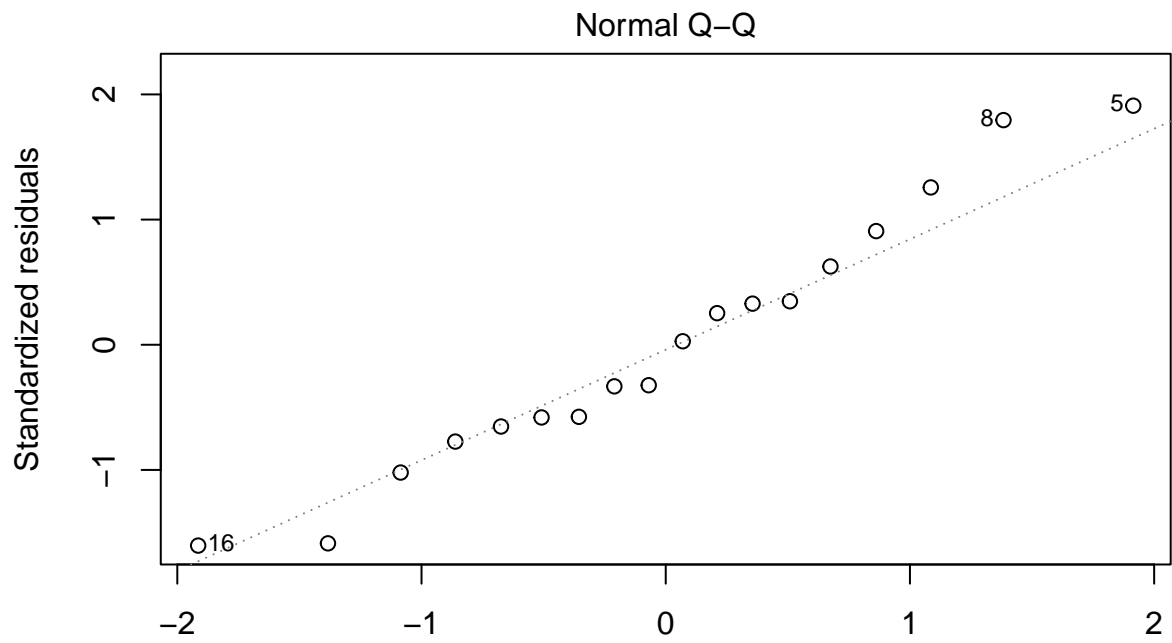
```
##
## Residual standard error: 0.08715 on 14 degrees of freedom
## Multiple R-squared:  0.6751, Adjusted R-squared:  0.6055
## F-statistic: 9.697 on 3 and 14 DF,  p-value: 0.001015
```

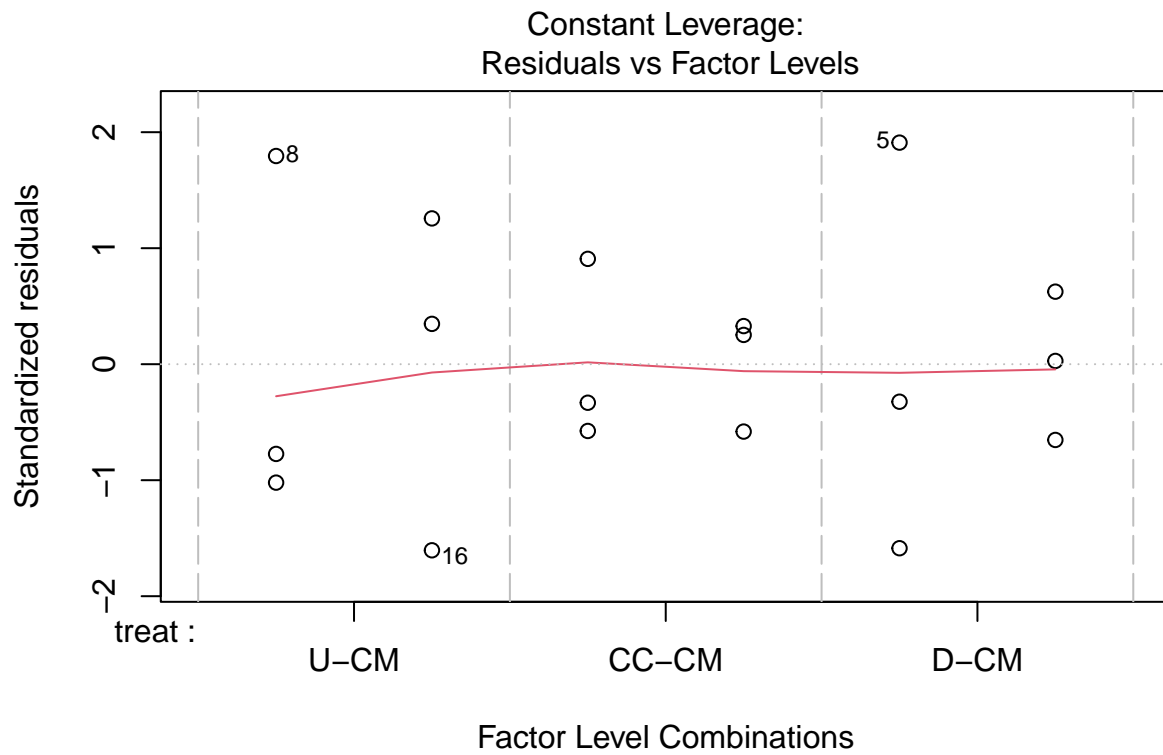
CC-CM and D-CM are clearly different. But neither is clearly different from the reference. Makes interpretation just a bit tricky but not terrible. Some evidence of a difference but presumably digestion pH effect is moderated by low DM, and variability was high, so power is low.

Check diagnostic plots.

```
plot(m1, ask = FALSE)
```

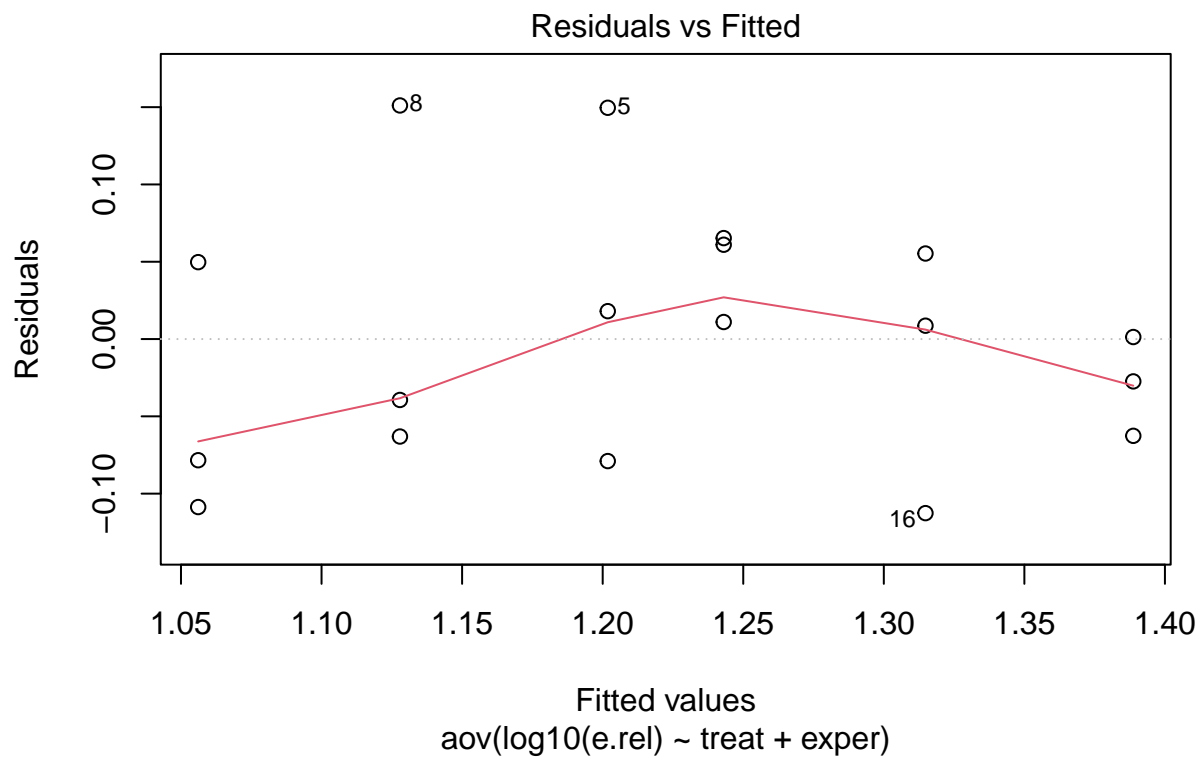


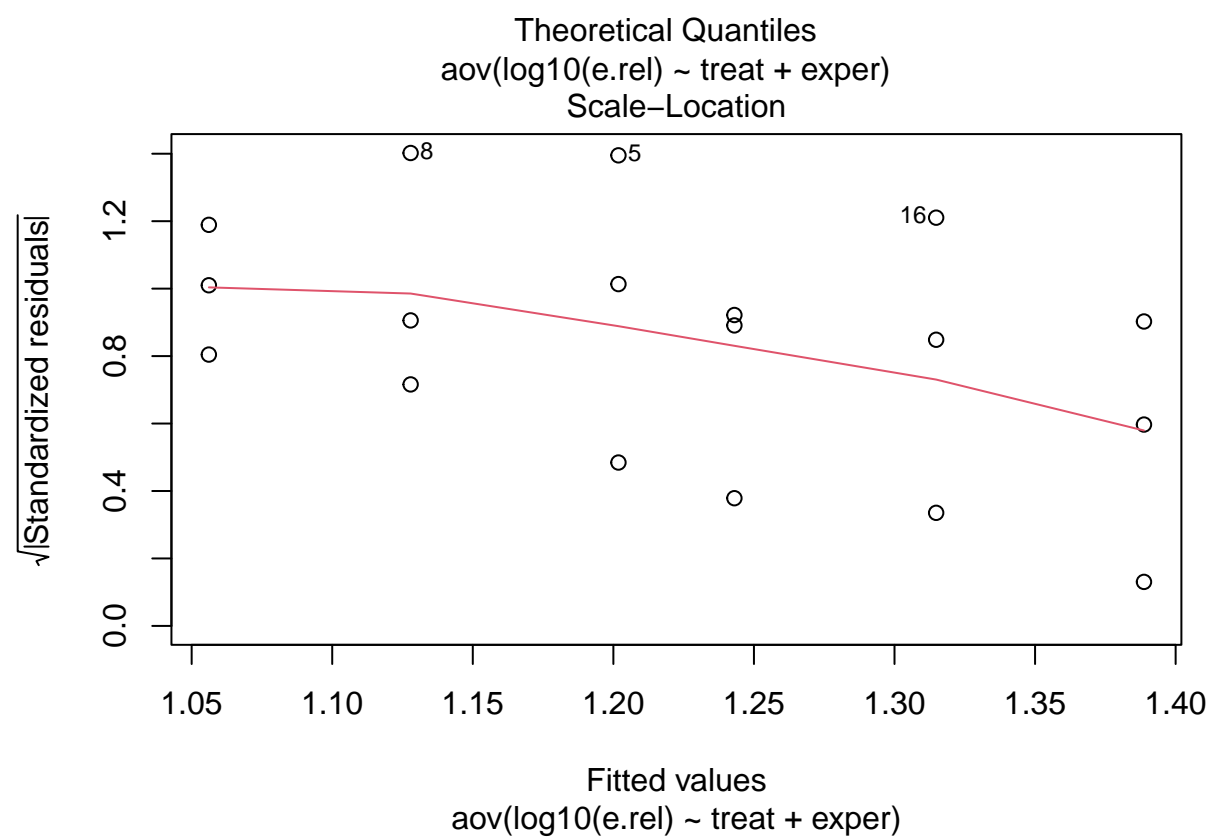
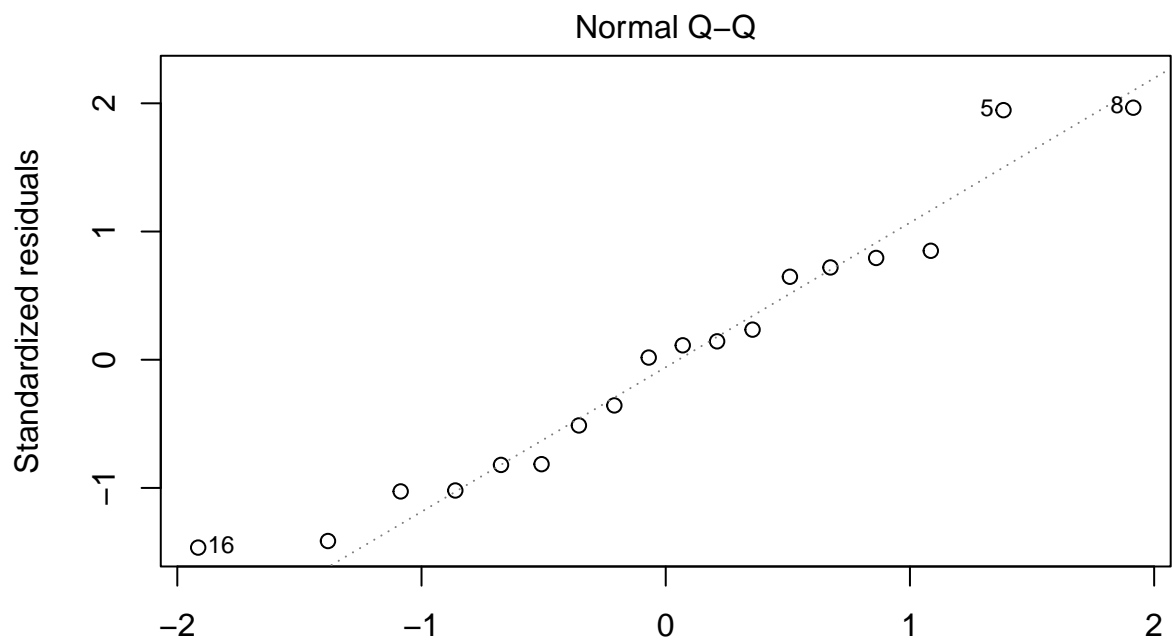


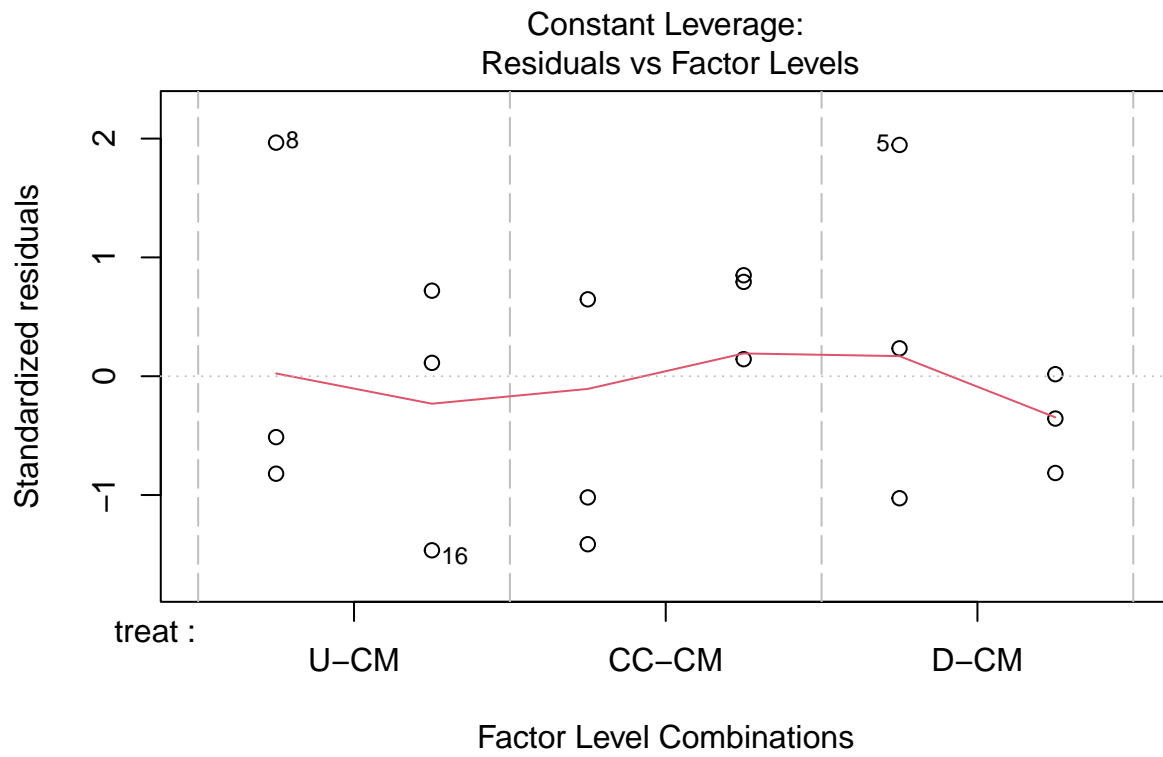


Diagnostic plots with transformation.

```
plot(m4, ask = FALSE)
```







Actually looks better without the transformation.