

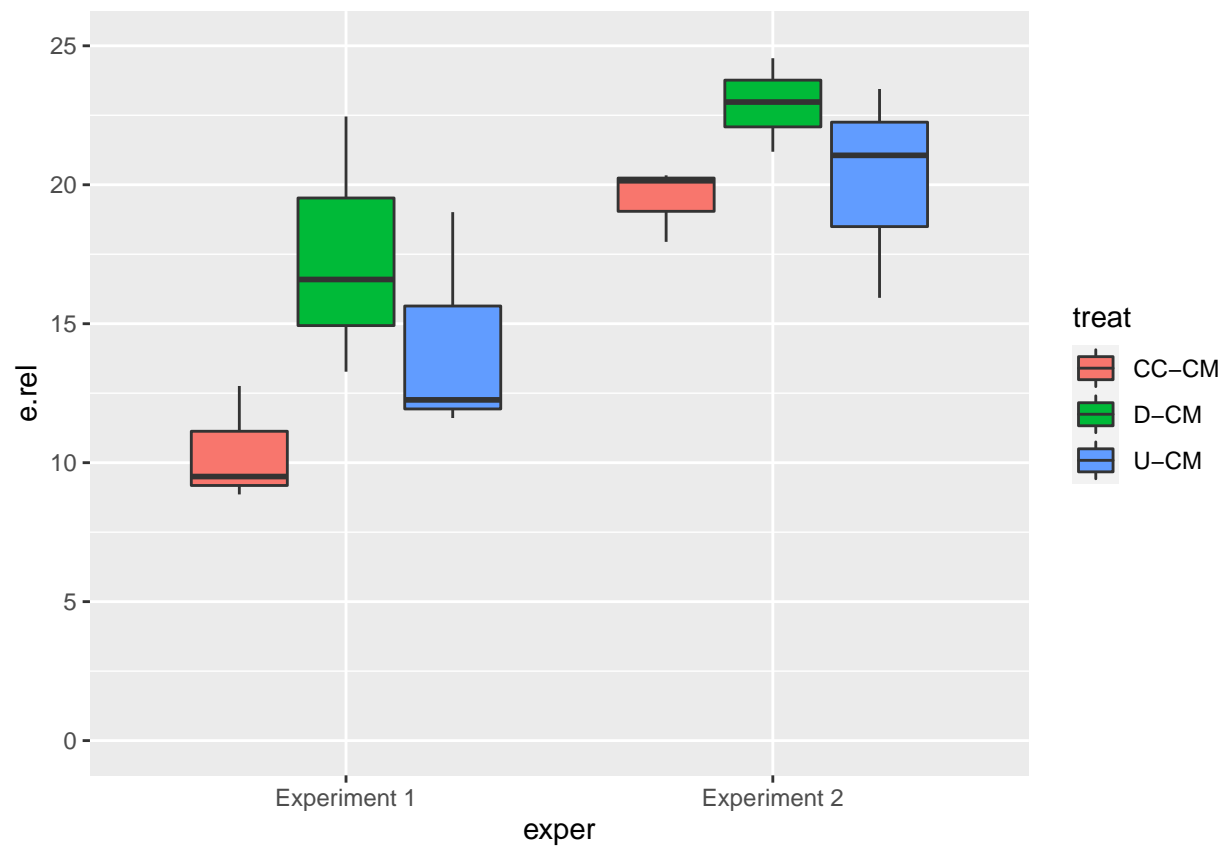
# Data analysis of cumulative NH3 for digestate experiments

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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  83.08   41.54    4.010 0.046379 *
## exper         1 208.47  208.47   20.123 0.000745 ***
## treat:exper    2   11.98    5.99    0.578 0.575891
## Residuals     12 124.31   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
## -4.2133 -1.6710 -0.3892  1.4638  5.0157
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      14.2934     1.8583   7.692 5.61e-06 ***
## treatCC-CM        -3.9205     2.6280  -1.492  0.1616
## treatD-CM         3.1470     2.6280   1.198  0.2542
## experExperiment 2    5.8514     2.6280   2.227  0.0459 *
## treatCC-CM:experExperiment 2  3.2511     3.7165   0.875  0.3989
## treatD-CM:experExperiment 2  -0.3865     3.7165  -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: 0.005747
```

Without interaction.

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

```
##              Df Sum Sq Mean Sq F value    Pr(>F)
## treat         2  83.08   41.54    4.267 0.035726 *
## exper         1 208.47  208.47   21.414 0.000391 ***
## Residuals     14 136.29    9.73
## ---
## 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
```

```
## -4.6907 -2.1620 -0.2802 1.6716 5.6864
##
## 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 0.223413
## treatD-CM         2.954      1.801   1.640 0.123328
## experExperiment 2    6.806      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:  0.6814, Adjusted R-squared:  0.6132
## F-statistic: 9.983 on 3 and 14 DF,  p-value: 0.000888
```

**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  0.06371  0.03185    4.397 0.036927 *
## exper          1  0.15720  0.15720   21.701 0.000552 ***
## treat:exper    2  0.01940  0.00970    1.339 0.298511
## Residuals     12  0.08693  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  0.06371  0.03185    4.194 0.037390 *
## exper          1  0.15720  0.15720   20.698 0.000454 ***
## Residuals     14  0.10633  0.00759
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

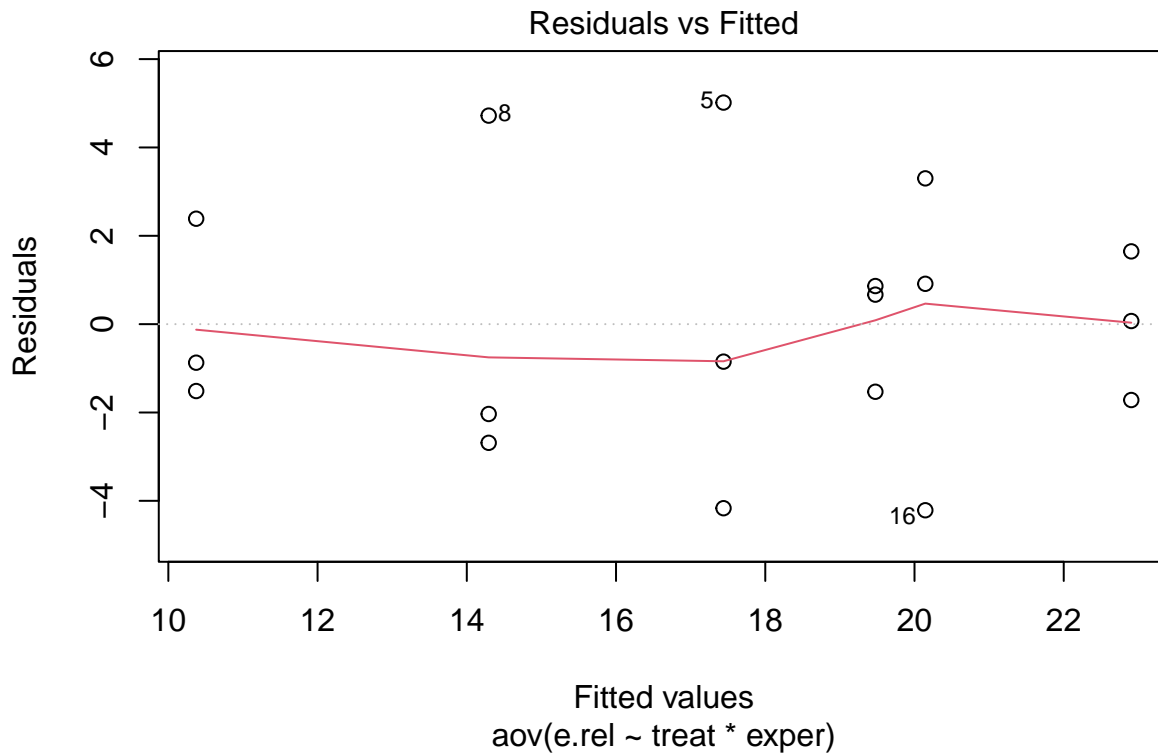
```
##
## Call:
## aov(formula = log10(e.rel) ~ treat + exper, data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.112523 -0.063034  0.005001  0.053887  0.151202
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1.12788    0.04108  27.454 1.42e-13 ***
## treatCC-CM       -0.07177    0.05032  -1.426 0.175652
## treatD-CM        0.07395    0.05032   1.470 0.163762
## experExperiment 2  0.18691    0.04108   4.550 0.000454 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

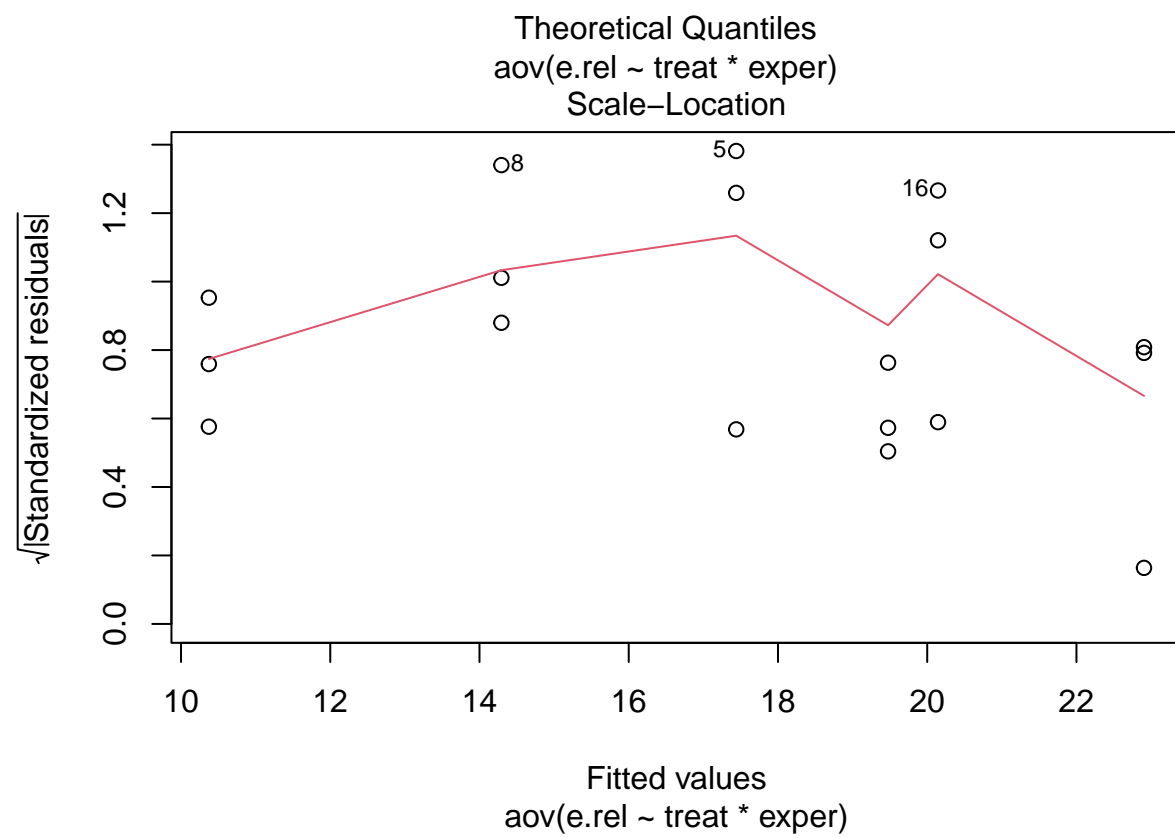
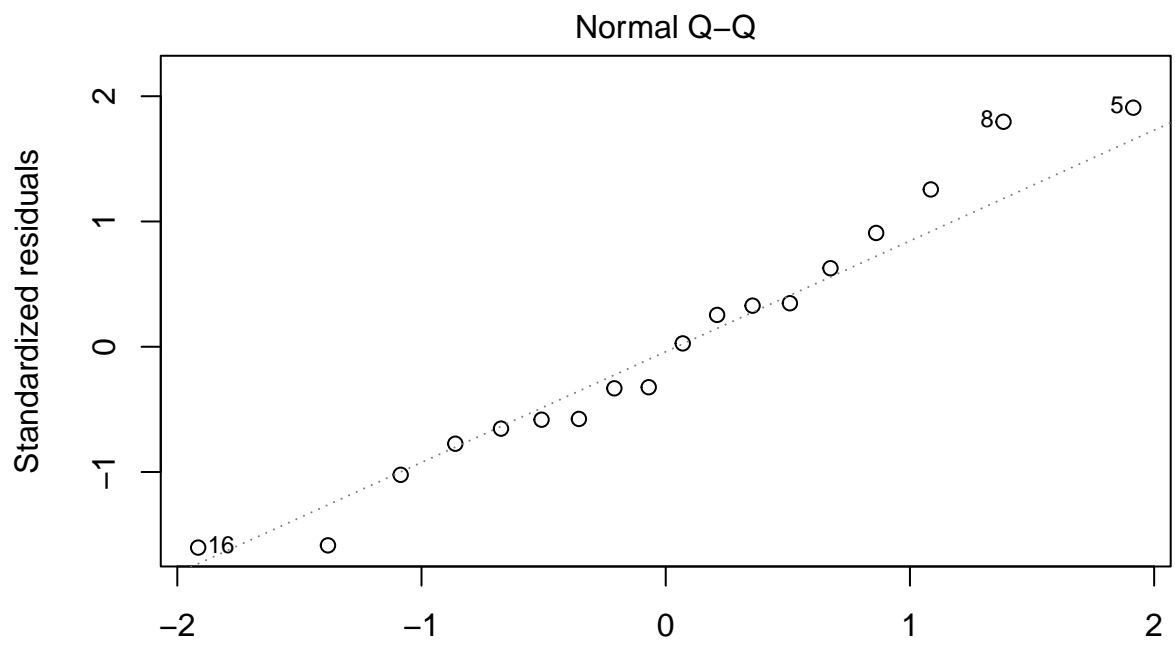
```
##
## Residual standard error: 0.08715 on 14 degrees of freedom
## Multiple R-squared:  0.6751, Adjusted R-squared:  0.6054
## F-statistic: 9.695 on 3 and 14 DF,  p-value: 0.001016
```

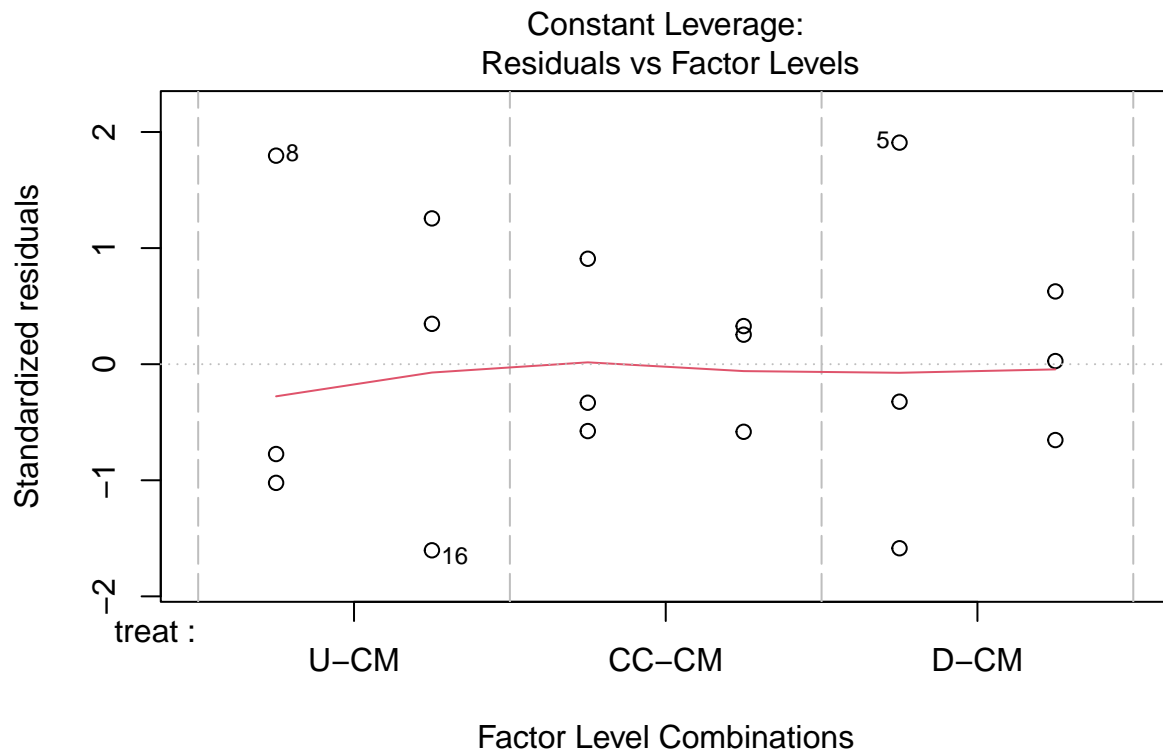
CC-CM and D-CM are clearly different. But neither is clearly different from the reference. Makes interpretation just a bit tricky but not terrible. Some evidence of a difference but presumably digestion pH effect is moderated by low DM, and variability was high, so power is low.

Check diagnostic plots.

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

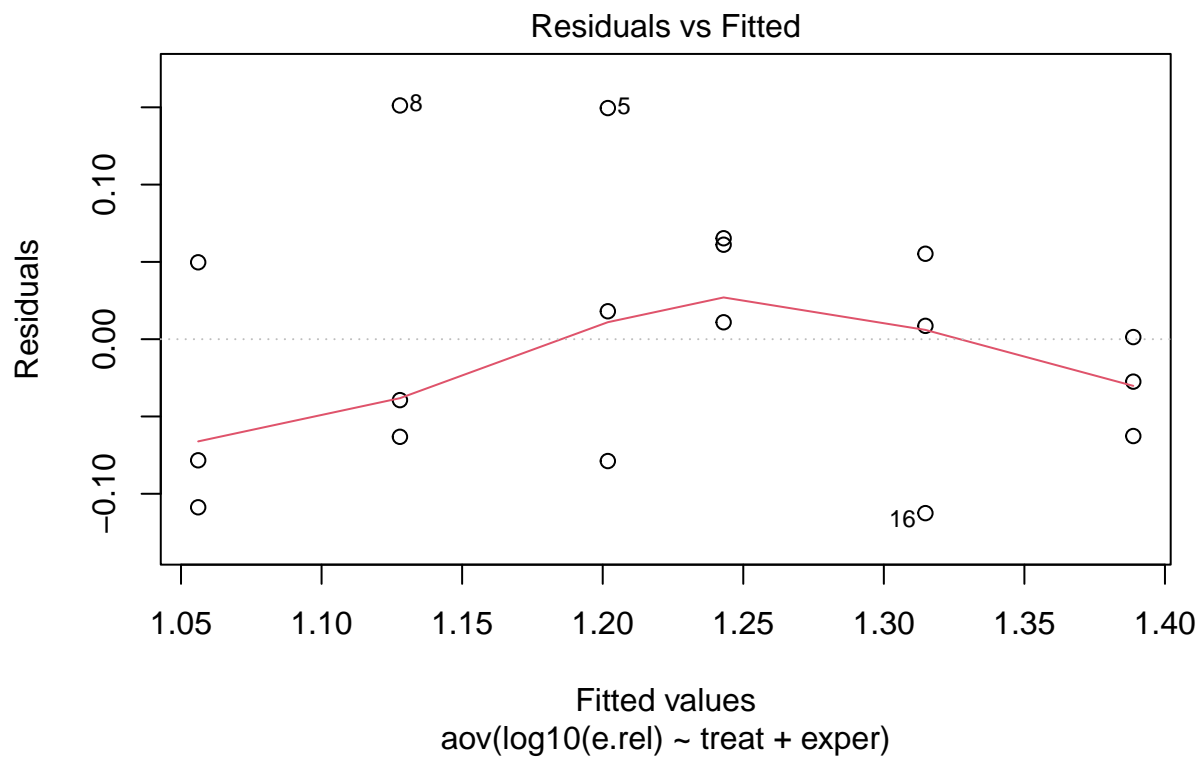


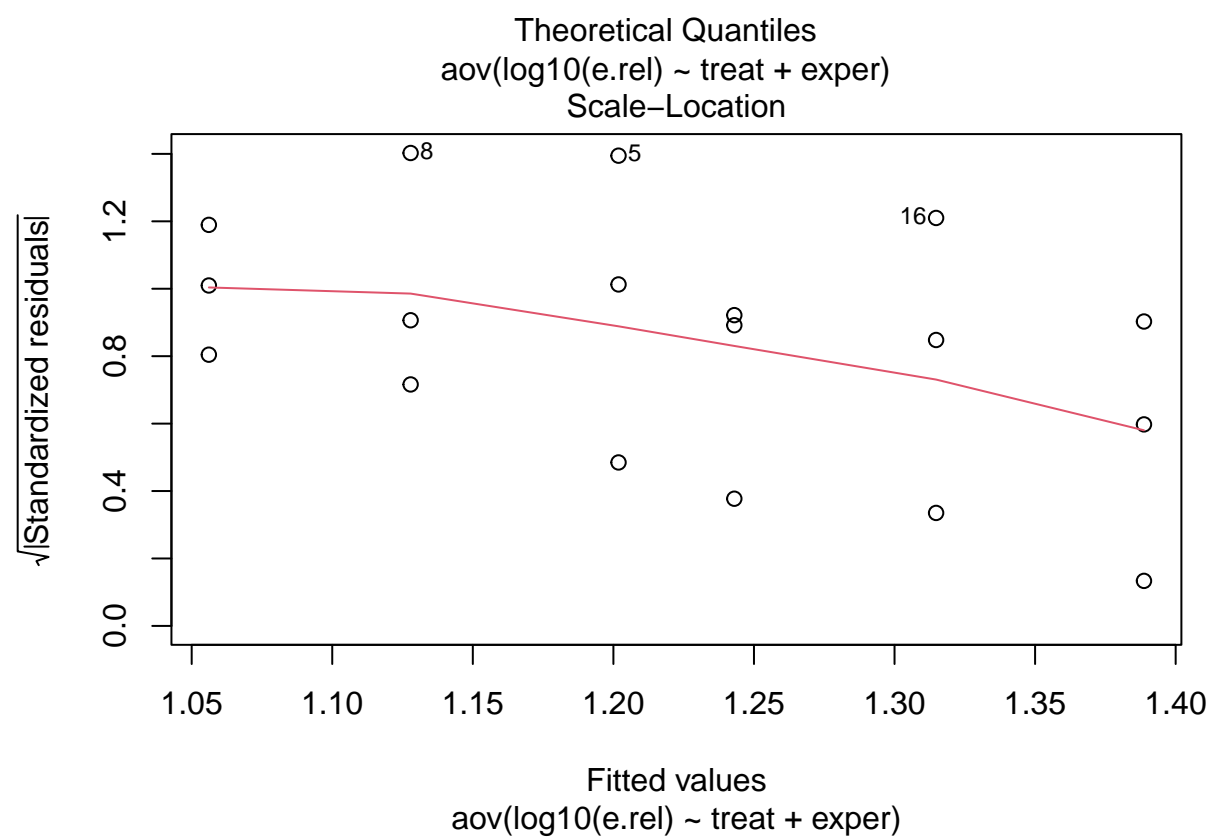
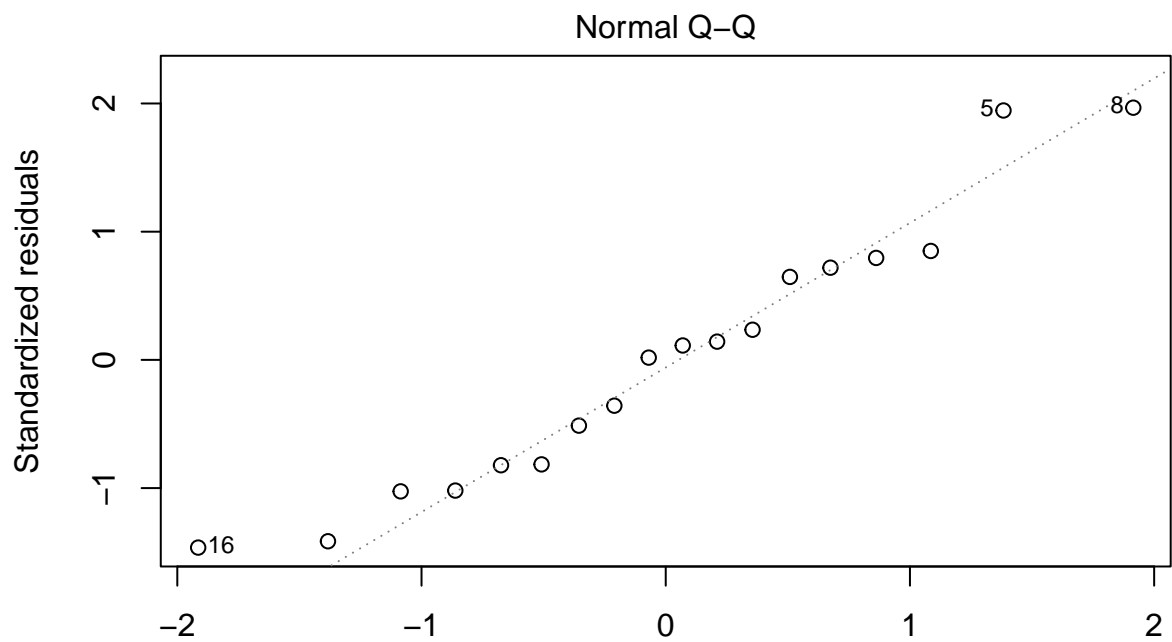


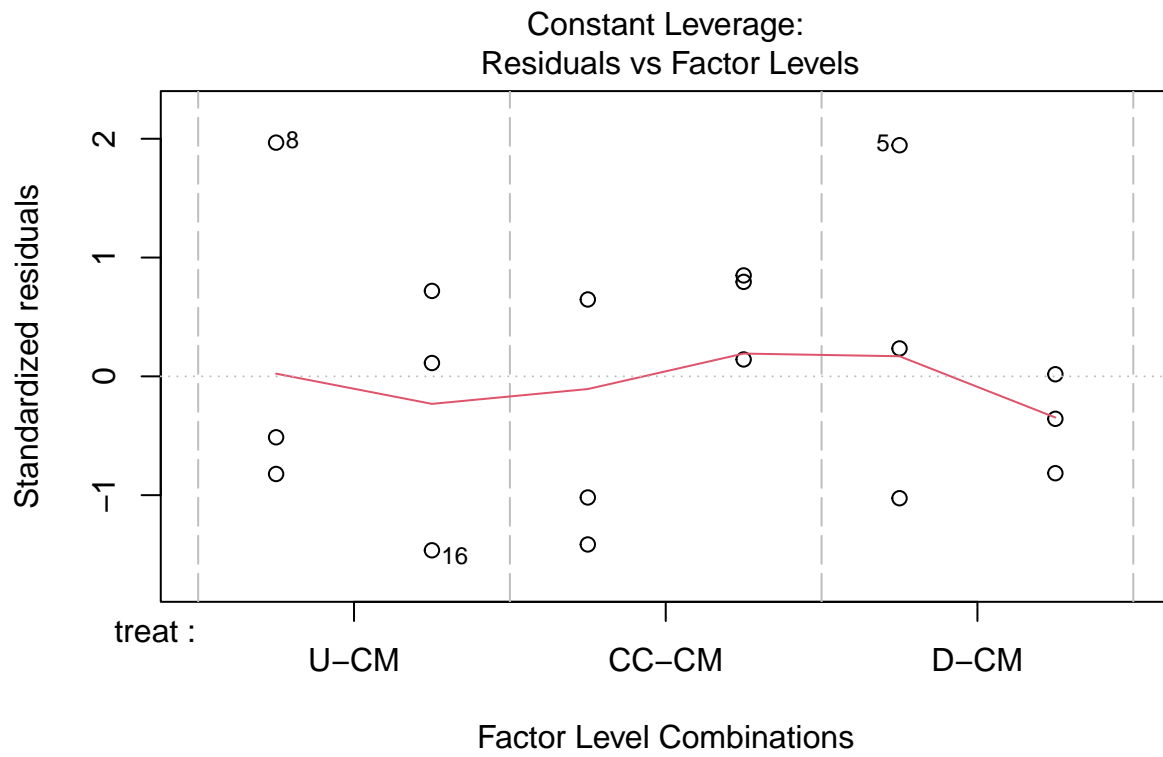


Diagnostic plots with transformation.

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







Actually looks better without the transformation.