

Multiple Comparisons and Contrasts on Tubes data

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/***** tubes97f.sas *****/
/* One-way analysis of tubes data */
/*****/

%include 'tuberead2.sas';
title2 'One-way analysis of tubes data';
title3 ' with multiple comparisons and contrasts';

proc freq;
  tables mcg;

proc glm;
  class mcg;
  model length10 = mcg;
  means mcg;
  means mcg / Tukey Bon Scheffe;
  /* Test custom contrasts, or "planned comparisons" */
  contrast '198vs205'      mcg  1  -1   0  0  0  0;
  contrast '223vs225'      mcg  0  0   0  0  1 -1;
  contrast '223n225vsRest' mcg -1  -1  -1 -1  2  2;;
  /* Test equality of mcgs excluding 198: a COLLECTION of contrasts */
  contrast 'AllBut198'     mcg  0  1  -1  0  0  0,
                          mcg  0  0  1  -1  0  0,
                          mcg  0  0  0  1  -1  0,
                          mcg  0  0  0  0  1  -1;
  /* Replicate overall F test just to check. */
  contrast 'OverallF=78.34' mcg  1  -1  0  0  0  0,
                          mcg  0  1  -1  0  0  0,
                          mcg  0  0  1  -1  0  0,
                          mcg  0  0  0  1  -1  0,
                          mcg  0  0  0  0  1  -1;
  /* Estimate will print the value of a sample contrast and do a t-test */
  /* F = t-squared */
  estimate '223n225vsRest' mcg -.25 -.25 -.25 -.25 .5 .5;
  estimate 'AnotherWay'     mcg -3  -3  -3  -3  6  6 / divisor=12;

```

Fungus Tube data with line1=113 eliminated 1
 One-way analysis of tubes data
 with multiple comparisons and contrasts

The FREQ Procedure

Mycelial Compatibility Group

mcg	Frequency	Percent	Cumulative Frequency	Cumulative Percent
198	4	17.39	4	17.39
205	4	17.39	8	34.78
213	3	13.04	11	47.83
221	4	17.39	15	65.22
223	4	17.39	19	82.61
225	4	17.39	23	100.00

Fungus Tube data with line1=113 eliminated
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The GLM Procedure

Class Level Information

Class	Levels	Values
mcg	6	198 205 213 221 223 225

Number of observations 23

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The GLM Procedure

Dependent Variable: length10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	52.94360507	10.58872101	78.34	<.0001
Error	17	2.29791667	0.13517157		
Corrected Total	22	55.24152174			

R-Square	Coeff Var	Root MSE	length10 Mean
0.958402	1.479116	0.367657	24.85652

Source	DF	Type I SS	Mean Square	F Value	Pr > F
mcg	5	52.94360507	10.58872101	78.34	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
mcg	5	52.94360507	10.58872101	78.34	<.0001

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The GLM Procedure

Level of mcg	N	-----length10----- Mean	Std Dev
198	4	27.7750000	0.30956959
205	4	25.3375000	0.30923292
213	3	24.4666667	0.20207259
221	4	22.9500000	0.45643546
223	4	24.3500000	0.18708287
225	4	24.1625000	0.55132416

Rearranged in order of the means, with gaps corresponding to the results of the Tukey tests

Level of mcg	N	-----length10----- Mean	Std Dev
221	4	22.9500000	0.45643546
225	4	24.1625000	0.55132416
223	4	24.3500000	0.18708287
213	3	24.4666667	0.20207259
205	4	25.3375000	0.30923292
198	4	27.7750000	0.30956959

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The GLM Procedure

Tukey's Studentized Range (HSD) Test for length10

NOTE: This test controls the Type I experimentwise error rate.

Alpha 0.05
 Error Degrees of Freedom 17
 Error Mean Square 0.135172
 Critical Value of Studentized Range 4.52365

Comparisons significant at the 0.05 level are indicated by ***.

mcg Comparison	Difference Between Means	Simultaneous 95% Confidence Limits			
198 - 205	2.4375	1.6059	3.2691	***	
198 - 213	3.3083	2.4101	4.2065	***	
198 - 223	3.4250	2.5934	4.2566	***	
198 - 225	3.6125	2.7809	4.4441	***	
198 - 221	4.8250	3.9934	5.6566	***	
205 - 198	-2.4375	-3.2691	-1.6059	***	
205 - 213	0.8708	-0.0274	1.7690		
205 - 223	0.9875	0.1559	1.8191	***	
205 - 225	1.1750	0.3434	2.0066	***	
205 - 221	2.3875	1.5559	3.2191	***	
213 - 198	-3.3083	-4.2065	-2.4101	***	
213 - 205	-0.8708	-1.7690	0.0274		
213 - 223	0.1167	-0.7815	1.0149		
213 - 225	0.3042	-0.5940	1.2024		
213 - 221	1.5167	0.6185	2.4149	***	
223 - 198	-3.4250	-4.2566	-2.5934	***	
223 - 205	-0.9875	-1.8191	-0.1559	***	
223 - 213	-0.1167	-1.0149	0.7815		
223 - 225	0.1875	-0.6441	1.0191		
223 - 221	1.4000	0.5684	2.2316	***	
225 - 198	-3.6125	-4.4441	-2.7809	***	
225 - 205	-1.1750	-2.0066	-0.3434	***	
225 - 213	-0.3042	-1.2024	0.5940		
225 - 223	-0.1875	-1.0191	0.6441		
225 - 221	1.2125	0.3809	2.0441	***	
221 - 198	-4.8250	-5.6566	-3.9934	***	
221 - 205	-2.3875	-3.2191	-1.5559	***	
221 - 213	-1.5167	-2.4149	-0.6185	***	
221 - 223	-1.4000	-2.2316	-0.5684	***	
221 - 225	-1.2125	-2.0441	-0.3809	***	

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The GLM Procedure

Bonferroni (Dunn) t Tests for length10

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons.

Alpha 0.05
 Error Degrees of Freedom 17
 Error Mean Square 0.135172
 Critical Value of t 3.41020

Comparisons significant at the 0.05 level are indicated by ***.

mcg Comparison	Difference Between Means	Simultaneous 95% Confidence Limits			
198 - 205	2.4375	1.5509	3.3241	***	
198 - 213	3.3083	2.3507	4.2659	***	
198 - 223	3.4250	2.5384	4.3116	***	
198 - 225	3.6125	2.7259	4.4991	***	
198 - 221	4.8250	3.9384	5.7116	***	
205 - 198	-2.4375	-3.3241	-1.5509	***	
205 - 213	0.8708	-0.0868	1.8284		
205 - 223	0.9875	0.1009	1.8741	***	
205 - 225	1.1750	0.2884	2.0616	***	
205 - 221	2.3875	1.5009	3.2741	***	
213 - 198	-3.3083	-4.2659	-2.3507	***	
213 - 205	-0.8708	-1.8284	0.0868		
213 - 223	0.1167	-0.8409	1.0743		
213 - 225	0.3042	-0.6534	1.2618		
213 - 221	1.5167	0.5591	2.4743	***	
223 - 198	-3.4250	-4.3116	-2.5384	***	
223 - 205	-0.9875	-1.8741	-0.1009	***	
223 - 213	-0.1167	-1.0743	0.8409		
223 - 225	0.1875	-0.6991	1.0741		
223 - 221	1.4000	0.5134	2.2866	***	
225 - 198	-3.6125	-4.4991	-2.7259	***	
225 - 205	-1.1750	-2.0616	-0.2884	***	
225 - 213	-0.3042	-1.2618	0.6534		
225 - 223	-0.1875	-1.0741	0.6991		
225 - 221	1.2125	0.3259	2.0991	***	
221 - 198	-4.8250	-5.7116	-3.9384	***	
221 - 205	-2.3875	-3.2741	-1.5009	***	
221 - 213	-1.5167	-2.4743	-0.5591	***	
221 - 223	-1.4000	-2.2866	-0.5134	***	
221 - 225	-1.2125	-2.0991	-0.3259	***	

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The GLM Procedure

Scheffe's Test for length10

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons.

Alpha 0.05
 Error Degrees of Freedom 17
 Error Mean Square 0.135172
 Critical Value of F 2.81000

Comparisons significant at the 0.05 level are indicated by ***.

mcg Comparison	Difference Between Means	Simultaneous 95% Confidence Limits			
198 - 205	2.4375	1.4630	3.4120	***	
198 - 213	3.3083	2.2558	4.3609	***	
198 - 223	3.4250	2.4505	4.3995	***	
198 - 225	3.6125	2.6380	4.5870	***	
198 - 221	4.8250	3.8505	5.7995	***	
205 - 198	-2.4375	-3.4120	-1.4630	***	
205 - 213	0.8708	-0.1817	1.9234		
205 - 223	0.9875	0.0130	1.9620	***	
205 - 225	1.1750	0.2005	2.1495	***	
205 - 221	2.3875	1.4130	3.3620	***	
213 - 198	-3.3083	-4.3609	-2.2558	***	
213 - 205	-0.8708	-1.9234	0.1817		
213 - 223	0.1167	-0.9359	1.1692		
213 - 225	0.3042	-0.7484	1.3567		
213 - 221	1.5167	0.4641	2.5692	***	
223 - 198	-3.4250	-4.3995	-2.4505	***	
223 - 205	-0.9875	-1.9620	-0.0130	***	
223 - 213	-0.1167	-1.1692	0.9359		
223 - 225	0.1875	-0.7870	1.1620		
223 - 221	1.4000	0.4255	2.3745	***	
225 - 198	-3.6125	-4.5870	-2.6380	***	
225 - 205	-1.1750	-2.1495	-0.2005	***	
225 - 213	-0.3042	-1.3567	0.7484		
225 - 223	-0.1875	-1.1620	0.7870		
225 - 221	1.2125	0.2380	2.1870	***	
221 - 198	-4.8250	-5.7995	-3.8505	***	
221 - 205	-2.3875	-3.3620	-1.4130	***	
221 - 213	-1.5167	-2.5692	-0.4641	***	
221 - 223	-1.4000	-2.3745	-0.4255	***	
221 - 225	-1.2125	-2.1870	-0.2380	***	

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The GLM Procedure

Dependent Variable: length10

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
198vs205	1	11.88281250	11.88281250	87.91	<.0001
223vs225	1	0.07031250	0.07031250	0.52	0.4806
223n225vsRest	1	3.98243806	3.98243806	29.46	<.0001
AllBut198	4	11.70089912	2.92522478	21.64	<.0001
OverallF=78.34	5	52.94360507	10.58872101	78.34	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > t
223n225vsRest	-0.87604167	0.16139606	-5.43	<.0001
AnotherWay	-0.87604167	0.16139606	-5.43	<.0001