PROJECT 5

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Factorial Experiment-Two-Factor

A)To ascertain the stability of vitamin C in reconstituted frozen orange juice concentrate stored in a refrigerator for a period of up to one week, three types of frozen orange concentrate were tested using three different time periods. The time periods refer to the number of days from when the orange juice was blended until it was tested. The results in milligrams of ascorbic acid per liter, are recorded in **641PROJ5A.sav**. Use a **Two-Factor design** and 0.05 level of significance.

1)Identify the response variable and factors. Write the model for the two-factor experimental design. What are the values of 'a', 'b' and 'n' in this design? Determine the number of treatment combinations.

a=3

b=3

n=4

Number of treatment combinations are 9

Richfood and 0 Days	**Richfood and 3 Days**	**Richfood and 7 Days**
Brand Sealed-Sweet and 0 Days	**Brand Sealed-Sweet and 3 Days**	**Brand Sealed-Sweet and 7 Days**
Minute Maid and 0 Days	**Minute Maid and 3 Days**	**Minute Maid and 7 Days**

2)Test if the response variable is normally distributed in all levels of the two factors.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	trtcomb	Statistic	df	Sig.	Statistic	df	Sig.
mg of ascorbic acid per liter	1	.205	4	.	.967	4	.822
	2	.301	4	.	.924	4	.561
	3	.253	4	.	.912	4	.493
	4	.345	4	.	.778	4	.068
	5	.364	4	.	.840	4	.195
	6	.325	4	.	.854	4	.239
	7	.238	4	.	.895	4	.407
	8	.250	4	.	.963	4	.798
	9	.231	4	.	.948	4	.704

a. Lilliefors Significance Correction

H0: 'Ascorbic acid per liter (mg)' is normally distributed among all nine treatments (three OJbrands and Time (0,3,7)) combinations.

H1: 'Ascorbic acid per lite (mg)r' is not normally distributed among all nine treatments (three OJbrands and Time (0,3,7)) combinations.

Richfood and 0 Days (1): Shapiro-Wilk test statics 0.967 and p-value 0.822 >0.05

Richfood and 3 Days (2): Shapiro-Wilk test statics 0.924 and p-value 0.561 >0.05

Richfood and 7 Days (3): Shapiro-Wilk test statics 0.912 and p-value 0.493 >0.05

Brand Sealed-Sweet and 0 Days (4): Shapiro-Wilk test statics 0.778 and p-value 0.068 >0.05(borderline)

Brand Sealed-Sweet and 3 Days (5): Shapiro-Wilk test statics 0.840 and p-value 0.195 >0.05

Brand Sealed-Sweet and 7 Days (6): Shapiro-Wilk test statics 0.854 and p-value 0.239 >0.05

Minute Maid and 0 Days (7): Shapiro-Wilk test statics 0.895 and p-value 0.407 >0.05

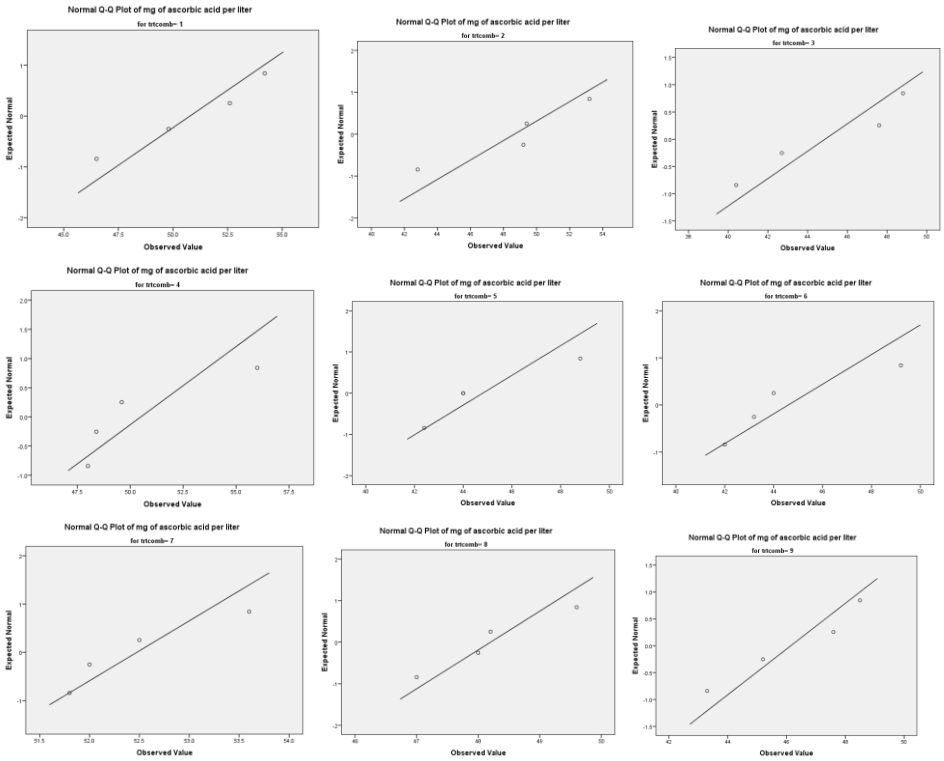
Minute Maid and 3 Days (8): Shapiro-Wilk test statics 0.963 and p-value 0.798 >0.05

Minute Maid and 7 Days (9): Shapiro-Wilk test statics 0.948 and p-value 0.704 >0.05

All the p-values > 0.05

Do not reject the H0

At 0.05 level of significant 'Ascorbic acid per liter (mg)' is normally distributed among all nine treatments (three foods and time (0,3,7)) combinations.



All the data points are fitting onto the line. Which means 'Ascorbic acid per liter (mg)' is randomly distributed among all nine treatments (three foods and time (0,1,2)) combinations.

3)Test if the response variable has homogeneous variance in all treatment combinations.
(Use Cochran's Test)

H0: $\sigma^2 1 = \sigma^2 2 = \sigma^2 3 = \sigma^2 4 = \sigma^2 5 = \sigma^2 6 = \sigma^2 7 = \sigma^2 8 = \sigma^2 9$
H1: At least one of the $\sigma^2 i$ of 'Ascorbic acid per liter (mg)' is different among nine treatments (three OJbrands and Time (0,3,7)) combinations.

$S^2 1$ (1) = 11.429
$S^2 2$ (2) = 18.597
$S^2 3$ (3) = 15.862
$S^2 4$ (4) = 13.907
$S^2 5$ (5) = 7.680
$S^2 6$ (6) = 10.080
$S^2 7$ (7) = 0.649
$S^2 8$ (8) = 1.147
$S^2 9$ (9) = 5.550

$$G = \frac{\text{largest } S_i^2}{\sum_{i=1}^{k} S_i^2},$$

Total of $S^2 i$ = 84.901
G=18.597/84.901 = 0.2190433
g (0.05 k=9 n=4) =0.4027 G (0.2190433) <g (0.4027) Do not reject H0
All variances of ' Ascorbic acid per liter (mg)' are same among the all nine treatment combinations.

Descriptive Statistics

trtcomb		N	Variance
1	mg of ascorbic acid per liter	4	11.429
	Valid N (listwise)	4	
2	mg of ascorbic acid per liter	4	18.597
	Valid N (listwise)	4	
3	mg of ascorbic acid per liter	4	15.862
	Valid N (listwise)	4	
4	mg of ascorbic acid per liter	4	13.907
	Valid N (listwise)	4	
5	mg of ascorbic acid per liter	4	7.680
	Valid N (listwise)	4	
6	mg of ascorbic acid per liter	4	10.080
	Valid N (listwise)	4	
7	mg of ascorbic acid per liter	4	.649
	Valid N (listwise)	4	
8	mg of ascorbic acid per liter	4	1.147
	Valid N (listwise)	4	
9	mg of ascorbic acid per liter	4	5.550
	Valid N (listwise)	4	

Descriptives

	trtcomb			Statistic	Std. Error
mg of ascorbic acid per liter	1	Mean		50.775	1.6904
		95% Confidence Interval for Mean	Lower Bound	45.396	
			Upper Bound	56.154	
		5% Trimmed Mean		50.822	
		Median		51.200	
		Variance		11.429	
		Std. Deviation		3.3807	
		Minimum		46.5	
		Maximum		54.2	
		Range		7.7	
		Interquartile Range		6.5	
		Skewness		-.566	1.014
		Kurtosis		-1.159	2.619
	2	Mean		48.650	2.1562
		95% Confidence Interval for Mean	Lower Bound	41.788	
			Upper Bound	55.512	
		5% Trimmed Mean		48.722	
		Median		49.300	
		Variance		18.597	
		Std. Deviation		4.3124	
		Minimum		42.8	
		Maximum		53.2	
		Range		10.4	
		Interquartile Range		7.9	
		Skewness		-.876	1.014
		Kurtosis		1.923	2.619

3	Mean		44.875	1.9914
	95% Confidence Interval for Mean	Lower Bound	38.538	
		Upper Bound	51.212	
	5% Trimmed Mean		44.906	
	Median		45.150	
	Variance		15.862	
	Std. Deviation		3.9828	
	Minimum		40.4	
	Maximum		48.8	
	Range		8.4	
	Interquartile Range		7.5	
	Skewness		-.203	1.014
	Kurtosis		-4.016	2.619
4	Mean		50.500	1.8646
	95% Confidence Interval for Mean	Lower Bound	44.566	
		Upper Bound	56.434	
	5% Trimmed Mean		50.333	
	Median		49.000	
	Variance		13.907	
	Std. Deviation		3.7292	
	Minimum		48.0	
	Maximum		56.0	
	Range		8.0	
	Interquartile Range		6.3	
	Skewness		1.809	1.014
	Kurtosis		3.292	2.619
5	Mean		44.800	1.3856
	95% Confidence Interval for Mean	Lower Bound	40.390	
		Upper Bound	49.210	
	5% Trimmed Mean		44.711	
	Median		44.000	
	Variance		7.680	
	Std. Deviation		2.7713	
	Minimum		42.4	
	Maximum		48.8	
	Range		6.4	
	Interquartile Range		4.8	
	Skewness		1.540	1.014
	Kurtosis		2.889	2.619
6	Mean		44.600	1.5875
	95% Confidence Interval for Mean	Lower Bound	39.548	
		Upper Bound	49.652	
	5% Trimmed Mean		44.489	
	Median		43.600	
	Variance		10.080	
	Std. Deviation		3.1749	
	Minimum		42.0	
	Maximum		49.2	
	Range		7.2	
	Interquartile Range		5.6	
	Skewness		1.600	1.014
	Kurtosis		2.818	2.619
7	Mean		52.475	.4029
	95% Confidence Interval for Mean	Lower Bound	51.193	
		Upper Bound	53.757	
	5% Trimmed Mean		52.450	
	Median		52.250	
	Variance		.649	
	Std. Deviation		.8057	
	Minimum		51.8	
	Maximum		53.6	
	Range		1.8	
	Interquartile Range		1.5	
	Skewness		1.286	1.014
	Kurtosis		1.215	2.619

8	Mean		48.200	.5354
	95% Confidence Interval for Mean	Lower Bound	46.496	
		Upper Bound	49.904	
	5% Trimmed Mean		48.189	
	Median		48.100	
	Variance		1.147	
	Std. Deviation		1.0708	
	Minimum		47.0	
	Maximum		49.6	
	Range		2.6	
	Interquartile Range		2.0	
	Skewness		.547	1.014
	Kurtosis		1.500	2.619
9	Mean		46.150	1.1779
	95% Confidence Interval for Mean	Lower Bound	42.401	
		Upper Bound	49.899	
	5% Trimmed Mean		46.178	
	Median		46.400	
	Variance		5.550	
	Std. Deviation		2.3558	
	Minimum		43.3	
	Maximum		48.5	
	Range		5.2	
	Interquartile Range		4.5	
	Skewness		-.407	1.014
	Kurtosis		-2.494	2.619

4)Test for differences in ascorbic acid contents among the different brands of orange juice concentrate.

Factor A: Ascorbic concentration in different brands of orange juice I =1,2,3 a=3

Factor B: Time (days) j =1,2,3 b=3

H0: $\alpha 1=\alpha 3=\alpha 3=0$

H1: At least one of the OJbrands treatment effect (α_i) is not equal to zero.

Tests of Between-Subjects Effects

Dependent Variable: mg of ascorbic acid per liter

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	277.285[a]	8	34.661	3.674	.005
Intercept	82570.022	1	82570.022	8752.920	.000
OJbrand	32.752	2	16.376	1.736	.195
Time	227.212	2	113.606	12.043	.000
OJbrand * Time	17.322	4	4.330	.459	.765
Error	254.703	27	9.433		
Total	83102.010	36			
Corrected Total	531.987	35			

a. R Squared = .521 (Adjusted R Squared = .379)

F statistic (OJbrands) = 1.736 p-value=0.195

p-value (0.195) > 0.05 Do not reject H0

At 0.05 level of significant there is no evidence to say that at least one of the treatment (OJbrands) effect (α_i) is not equal to zero. Which means Ascorbic acid mean concentration among all OJbrands are the same.

5)Test for differences in ascorbic acid contents among the different time periods.

Factor A: Ascorbic concentration in different brands of orange juice I =1,2,3 a=3

Factor B: Time (days) I =1,2,3 b=3

H0: $ß1=ß3=ß3=0$

H1: At least one of the treatment (Time) effect ($ß_i$) is not equal to zero.

F statistic (Time) = 12.043 p-value=0.000

p-value (0.000) < 0.05 Reject H0

At 0.05 level of significant at least one of the treatment (Time) effect ($ß_i$) is not equal to zero. Which means Ascorbic acid mean concentration among all three Time levels are not the same.

6)Test for interaction between orange juice brand and time period.

H0: $(\alpha*ß)_{11} = (\alpha*ß)_{12} = \ldots\ldots\ldots\ldots = (\alpha*ß)_{33} = 0$ a=1,2,3 b=1,2,3

H1: At least one of the treatment interaction (Time*OJbrands) effect $((\alpha*ß)_{ij})$ is not equal to zero.

F statistic (Time*OJbrands) = 0.459 p-value=0.765

p-value (0.765) > 0.05 Do not reject H0

At 0.05 level of significant there is no evidence to say that at least one of the treatment interaction (Time*OJbrands) effect $((\alpha*ß)_{ij})$ is not equal to zero.

7)Conduct appropriate multiple comparisons tests.

1. 3 OJ Brands

Dependent Variable: mg of ascorbic acid per liter

3 OJ Brands	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Rich Food	48.100	.887	46.281	49.919
Brand Sealed-Sweet	46.633	.887	44.814	48.453
Minute Maid	48.942	.887	47.122	50.761

2. 3 Time (days)

Dependent Variable: mg of ascorbic acid per liter

3 Time (days)	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
0 days	51.250	.887	49.431	53.069
3 days	47.217	.887	45.397	49.036
7 days	45.208	.887	43.389	47.028

3. 3 OJ Brands * 3 Time (days)

Dependent Variable: mg of ascorbic acid per liter

3 OJ Brands	3 Time (days)	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Rich Food	0 days	50.775	1.536	47.624	53.926
	3 days	48.650	1.536	45.499	51.801
	7 days	44.875	1.536	41.724	48.026
Brand Sealed-Sweet	0 days	50.500	1.536	47.349	53.651
	3 days	44.800	1.536	41.649	47.951
	7 days	44.600	1.536	41.449	47.751
Minute Maid	0 days	52.475	1.536	49.324	55.626
	3 days	48.200	1.536	45.049	51.351
	7 days	46.150	1.536	42.999	49.301

OJbrands

Multiple Comparisons

Dependent Variable: mg of ascorbic acid per liter

	(I) 3 OJ Brands	(J) 3 OJ Brands	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Rich Food	Brand Sealed-Sweet	1.467	1.2539	.481	-1.642	4.576
		Minute Maid	-.842	1.2539	.782	-3.951	2.267
	Brand Sealed-Sweet	Rich Food	-1.467	1.2539	.481	-4.576	1.642
		Minute Maid	-2.308	1.2539	.176	-5.417	.801
	Minute Maid	Rich Food	.842	1.2539	.782	-2.267	3.951
		Brand Sealed-Sweet	2.308	1.2539	.176	-.801	5.417
Bonferroni	Rich Food	Brand Sealed-Sweet	1.467	1.2539	.757	-1.734	4.667
		Minute Maid	-.842	1.2539	1.000	-4.042	2.359
	Brand Sealed-Sweet	Rich Food	-1.467	1.2539	.757	-4.667	1.734
		Minute Maid	-2.308	1.2539	.230	-5.509	.892
	Minute Maid	Rich Food	.842	1.2539	1.000	-2.359	4.042
		Brand Sealed-Sweet	2.308	1.2539	.230	-.892	5.509

Based on observed means.
The error term is Mean Square(Error) = 9.433.

H0: $\mu_i = \mu_j$ i, j=1,2,3
H1: $\mu_i \neq \mu_j$ i≠j

α=0.05

Tukey HSD: Means differences of "ascorbic acid per litter (mg) "in between three OJbrands 'Rich Food' ,'Brand Sealed-Sweet' and 'Minute Maid' are not significant. Which means:

OJbrands: 'Rich Food' – 'Brand sealed-sweet', 'ascorbic acid per litter (mg)'differences 1.467
p-value =0.481>0.05 Do not reject H0. Not Significant.
OJbrands: 'Rich Food' – 'Minute Maid', 'ascorbic acid per litter (mg)'differences -0.842
p-value =0.782>0.05 Do not reject H0. Not Significant.

Same for all others, differences are very small and p-values are very large. So we do not reject H0. Which means mean differences of 'ascorbic acid per litter' in different OJbrands are not significant.

Bonferroni: Means differences of "ascorbic acid per litter (mg) "in between three OJbrands 'Rich Food' ,'Brand Sealed-Sweet' and 'Minute Maid' are not significant. Which means:

OJbrands: 'Rich Food' – 'Brand sealed-sweet', 'ascorbic acid per litter (mg)'differences 1.467
p-value =0.757>0.05 Do not reject H0. Not Significant.
OJbrands: 'Rich Food' – 'Minute Maid', 'ascorbic acid per litter (mg)'differences -0.842
p-value =1.0>0.05 Do not reject H0. Not Significant.

Same all others, differences are very small and p-values are very large. So we do not reject H0. Which means mean differences of 'ascorbic acid per litter' in different OJbrands are not significant.

Time

Multiple Comparisons

Dependent Variable: mg of ascorbic acid per liter

	(I) 3 Time (days)	(J) 3 Time (days)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	0 days	3 days	4.033*	1.2539	.009	.924	7.142
		7 days	6.042*	1.2539	.000	2.933	9.151
	3 days	0 days	-4.033*	1.2539	.009	-7.142	-.924
		7 days	2.008	1.2539	.262	-1.101	5.117
	7 days	0 days	-6.042*	1.2539	.000	-9.151	-2.933
		3 days	-2.008	1.2539	.262	-5.117	1.101
Bonferroni	0 days	3 days	4.033*	1.2539	.010	.833	7.234
		7 days	6.042*	1.2539	.000	2.841	9.242
	3 days	0 days	-4.033*	1.2539	.010	-7.234	-.833
		7 days	2.008	1.2539	.363	-1.192	5.209
	7 days	0 days	-6.042*	1.2539	.000	-9.242	-2.841
		3 days	-2.008	1.2539	.363	-5.209	1.192

Based on observed means.
The error term is Mean Square(Error) = 9.433.

*. The mean difference is significant at the .05 level.

H0: $\mu_i = \mu_j$ i, j=1,2,3
H1: $\mu_i \neq \mu_j$ i≠j α=0.05

Tukey HSD: Means differences of "ascorbic acid per litter (mg)" in 'Time' between '0 days', '3 days' and '0 days' '7 days' are significant.

Means difference of "ascorbic acid per litter (mg) "between "0 days" and "3 days" (p-value= 0.009 <0.05 and difference= 4.033, Reject H0) is significant.

Means difference of "ascorbic acid per litter (mg) "between "0 days" and "7 days" (p-value= 0.000 <0.05 and difference= 6.042, Reject H0) is significant.

Means difference of “ascorbic acid per litter (mg) “between “3 days” and “7 days” (p-value= 0.262 >0.05 and difference= 2.008, Do not reject H0) is not significant.

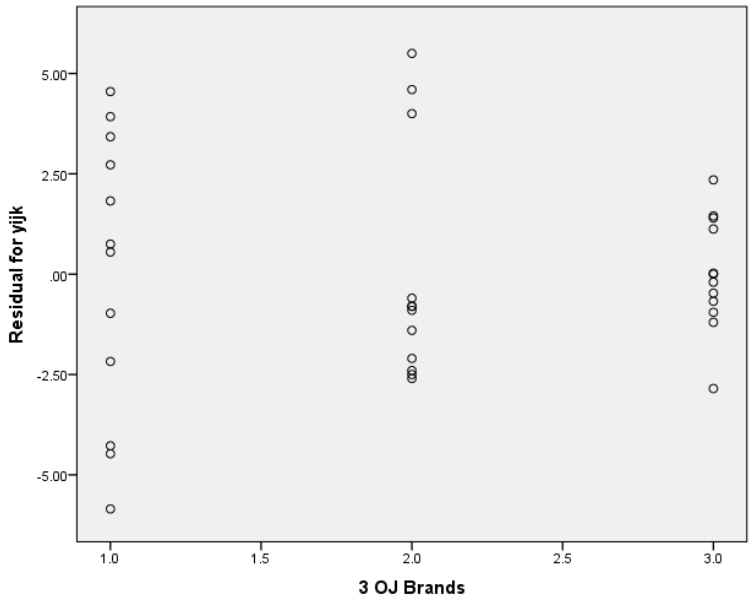
Bonferroni: Means differences of “ascorbic acid per litter (mg)” in ‘Time’ between ‘0 days’, ‘3 days’ and ‘0 days’ ‘7 days’ are significant.

Means difference of “ascorbic acid per litter (mg) “between “0 days” and “3 days” (p-value= 0.01 <0.05 and difference= 4.033, Reject H0) is significant.

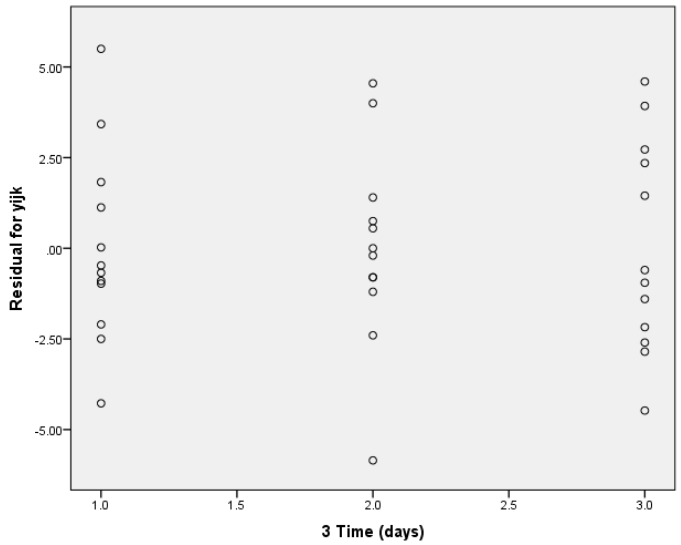
Means difference of “ascorbic acid per litter (mg) “between “0 days” and “7 days” (p-value= 0.000 <0.05 and difference= 6.042, Reject H0) is significant.

Means difference of “ascorbic acid per litter (mg) “between “3 days” and “7 days” (p-value= 0.363 >0.05 and difference= 2.008, Do not reject H0) is not significant.

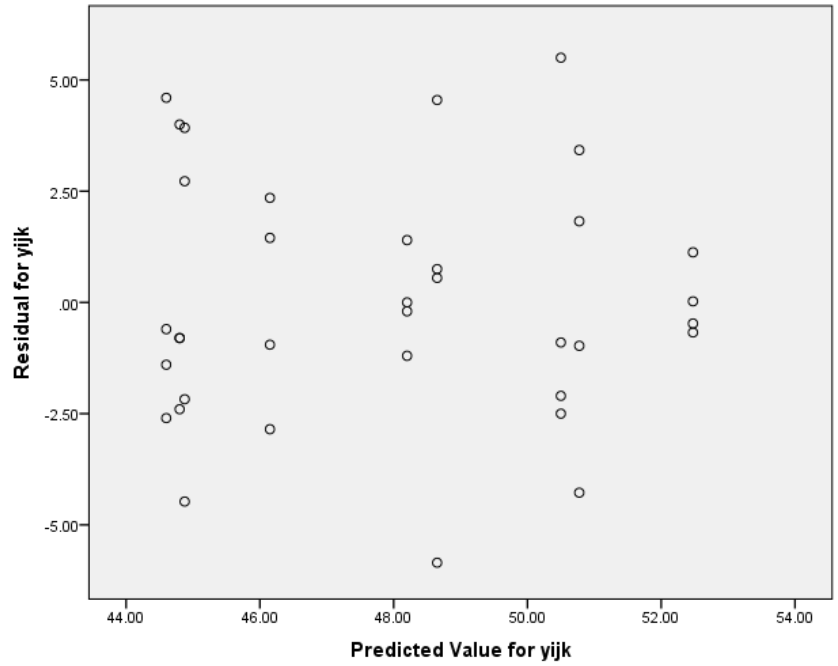
7)Comment on the homogeneity of variance of the residuals using the three residual plots.



The residual plot (3 OJ Brands vs residual for ascorbic acid per litter (mg)) show that most of the points are within the band -5 to +5. But residuals are showing a pattern. Variance of residuals with respect to OJbrand 3 (‘Minute Maid’) is very low compare with other OJbrands. And also variance of residuals with respect to OJbrands 1(‘Rich Food’) is very high compare with other OJbrands. Which means plot of residuals verses OJbrans indicate variance of residuals may not be the same for the different OJbrands. Therefore, variances of residuals are not homogeneous with respect to OJbrands.



The residual plot (Time vs residual for ascorbic acid per litter (mg)) show that most of the points are within the band -5 to +5. As well as residuals don't show a pattern. Which means plot of residuals verses 'Time' indicate variance of residuals may be the same for the different number of days. Therefore, variances of residuals are homogeneous with respect to 'Time'.



The residual plot (Predicted values for ascorbic acid per litter (mg) vs residual for ascorbic acid per litter (mg)) show that most of the points are within the band -5 to +5. As well as residuals don't show a pattern. Which means plot of residuals verses 'Predicted values for ascorbic acid per litter' indicate variance of residuals may be the same for the different predicted values. Therefore, variances of residuals are homogeneous with respect to 'Predicted values for ascorbic acid per litter'.

1. 3 OJ Brands

Dependent Variable: mg of ascorbic acid per liter

3 OJ Brands	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Rich Food	48.100	.887	46.281	49.919
Brand Sealed-Sweet	46.633	.887	44.814	48.453
Minute Maid	48.942	.887	47.122	50.761

2. 3 Time (days)

Dependent Variable: mg of ascorbic acid per liter

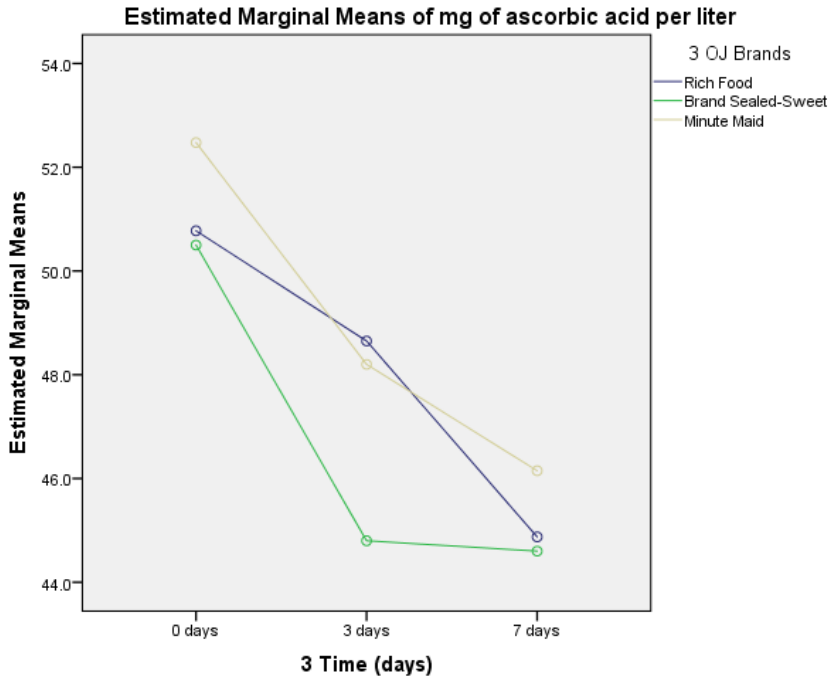
3 Time (days)	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
0 days	51.250	.887	49.431	53.069
3 days	47.217	.887	45.397	49.036
7 days	45.208	.887	43.389	47.028

3. 3 OJ Brands * 3 Time (days)

Dependent Variable: mg of ascorbic acid per liter

3 OJ Brands	3 Time (days)	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Rich Food	0 days	50.775	1.536	47.624	53.926
	3 days	48.650	1.536	45.499	51.801
	7 days	44.875	1.536	41.724	48.026
Brand Sealed-Sweet	0 days	50.500	1.536	47.349	53.651
	3 days	44.800	1.536	41.649	47.951
	7 days	44.600	1.536	41.449	47.751
Minute Maid	0 days	52.475	1.536	49.324	55.626
	3 days	48.200	1.536	45.049	51.351
	7 days	46.150	1.536	42.999	49.301

9)Comment on the interaction plot with support from the means table.



There is an intersection line. Therefore, there is an interaction between 'Time' and '3 OJ Brands'. 'OJbrands' 'Rich Food' and 'Minute Maid' have interaction with 'Time' '3 days' which mean one of the interaction effect 'OJbrands'*'Time' (α*ß)ij is not equal to zero. But when we test for the interaction effect in previous step it was not significant. But here it shows there is an interaction between 'Time' and '3 OJ Brands'.

At the '0 day' 'Minute Mald' has highest mean value for 'ascorbic acid per litter (mg)'. But at the '3 days' 'Rich Food' has highest mean value for 'ascorbic acid per litter (mg)'. When at '7 days' again 'Minute Mald' has highest mean value for'ascorbic acid per litter (mg)'.

Always 'Brand Sealed-Sweet' has lowest mean value for 'ascorbic acid per litter (mg)' among all the days. But it has highest mean value for 'ascorbic acid per litter (mg)' at '0 days' (50.5) and lowest at '7 days' (44.6).

All the brands have highest mean values of 'ascorbic acid per litter (mg)' at 0 days and lowest at 7 days.

B) The following is a partial analysis of variance table for a two-factor factorial experiment with factor A having four levels, factor B having three levels, and a sample of three observations of the response per treatment. If the sum of SSA, SSB, and SS(AB) is 170, complete the ANOVA table and determine if the main effects and the interaction effect are statistically significant.
For each test, include appropriate hypotheses, test statistic, p-value or tabled F value, decision and conclusion.

Source	Sum of Squares	Degrees of Freedom	Mean Square	Computed F	Tabled F or P-value
Factor A	120	3	40	16	F(0.05,3,24)=3.01
Factor B	20	2	10	4	F(0.05,2,24)=3.4
Interaction	30	6	5	2	F(0.05,6,24)=2.51
Error	60	24	2.5		
Total	230	35			

Factor A: I =1,2,3,4 a=4

Factor B: j =1,2,3 b=3

H0: $\alpha 1=\alpha 3=\alpha 3=\alpha 4=0$

H1: At least one of the (A) treatment effect (α_i) is not equal to zero.

F calculated =16 > F table = 3.01

Reject H0

At the 0.05 level of significant at least one of the (A) treatment effect (α_i) is not equal to zero. Which mean at least one mean value of response variable is different among the four level of factor A.

Factor A: I =1,2,3,4 a=4

Factor B: j =1,2,3 b=3

H0: ß1=ß3=ß3=0

H1: At least one of the (B) treatment effect ($ß_i$) is not equal to zero.

F calculated = 4 > F table = 3.4

Reject H0

At the 0.05 level of significant at least one of the (B) treatment effect ($ß_i$) is not equal to zero. Which mean at least one mean value of response variable is different among the three level of factor B.

Both main effect ‘A’ and ‘B’ are significant.

H0: $(\alpha*ß)_{11} = (\alpha*ß)_{12} = \ldots\ldots\ldots\ldots\ldots = (\alpha*ß)_{43} = 0$ a=1,2,3,4 b=1,2,3

H1: At least one of the treatment interaction (A*B) effect ($(\alpha*ß)_{ij}$) is not equal to zero.

F Calculated statistic (A*B) = 2 < F table =2.51

Do not reject Ho

At 0.05 level of significant there is no evidence to say that at least one of the treatment interaction (A*B) effect ($(\alpha*ß)_{ij}$) is not equal to zero.

Interaction effect is not significant