1. A student designed an experiment to determine if ants had a preference for the type of filling in a sandwich. He chose three types of sandwich fillings to compare: vegemite, peanut butter, and ham & pickles. He randomly chose a sandwich, broke off a piece, and left it on the ground near an ant hill. After several minutes, he placed a jar over the sandwich bit and counted the number of ants. He repeated the process, allowing time for ants to return to the hill after each trial, until he had eight samples for each of the sandwich fillings. The data are available in the worksheet **SandwichAnts.csv** in the data folder. We are interested in determining if the three fillings tend to attract different numbers of ants.
   1. Write of the null and alternative hypotheses that would be consistent with our research question.
   2. Complete the ANOVA F-test.

In Minitab:  
*Stat > ANOVA > One-way  
Enter Response (numerical) and Factor (categorical).  
Click “Graphs” and select Boxplot of Data.  
(Eventually we’ll add another step to this)*

**Analysis of Variance**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **Adj SS** | **Adj MS** | **F-Value** | **P-Value** |
| Filling | 2 | 1561 | 780.5 | 5.63 | 0.011 |
| Error | 21 | 2913 | 138.7 |  |  |
| Total | 23 | 4474 |  |  |  |

**Means**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Filling** | **N** | **Mean** | **StDev** | **95% CI** |
| Ham & Pickles | 8 | 49.25 | 10.79 | (40.59, 57.91) |
| Peanut Butter | 8 | 34.00 | 14.63 | (25.34, 42.66) |
| Vegemite | 8 | 30.75 | 9.25 | (22.09, 39.41) |

*Pooled StDev = 11.7777*

1. We will now perform a follow-up analysis to determine which pairs of fillings have significantly different means.

In Minitab:  
*Stat > ANOVA > One-way  
Enter Response (numerical) and Factor (categorical).  
Click “Comparisons” and check “Tukey”. Also have “Grouping Information” and “Tests” checked (uncheck “Interval Plot”).*

**Tukey Pairwise Comparisons**

**Grouping Information Using the Tukey Method and 95% Confidence**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Filling** | **N** | **Mean** | **Grouping** | |
| Ham & Pickles | 8 | 49.25 | A |  |
| Peanut Butter | 8 | 34.00 |  | B |
| Vegemite | 8 | 30.75 |  | B |

*Means that do not share a letter are significantly different.*

**Tukey Simultaneous Tests for Differences of Means**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Difference of Levels** | **Difference of Means** | **SE of Difference** | **95% CI** | **T-Value** | **Adjusted P-Value** |
| Peanut Butte - Ham & Pickle | -15.25 | 5.89 | (-30.07, -0.43) | -2.59 | 0.043 |
| Vegemite - Ham & Pickle | -18.50 | 5.89 | (-33.32, -3.68) | -3.14 | 0.013 |
| Vegemite - Peanut Butte | -3.25 | 5.89 | (-18.07, 11.57) | -0.55 | 0.847 |

*Individual confidence level = 98.00%*

1. Write a few sentences summarizing the interesting findings between the groups.