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# **CHAPTER FOUR (4)**

## **4 RESULTS**

### 4.1 Isolation, identification and characterization of bacteria

#### 4.1.1 Relative abundance of bacteria in each of the colleges

The graph below illustrates the relative abundance of three types of bacteria—Staphylococcus, Streptococcus, and Bacillus—across five different colleges. In the College of Science, Staphylococcus has a relative abundance of 11, Streptococcus has 4, and Bacillus has 6. The College of Engineering shows the highest abundance of Staphylococcus at 12, with Streptococcus and Bacillus both at 5. The College of Arts and Built Environment has a relative abundance of 11 for Staphylococcus, 4 for Streptococcus, and 6 for Bacillus. In the College of Health Science, Staphylococcus has a relative abundance of 10, Streptococcus has 3, and Bacillus has 4, indicating the lowest presence of Streptococcus among all colleges. The College of Humanities and Social Sciences displays the highest abundance for both Staphylococcus and Bacillus at 12 and 7, respectively, and a relatively high presence of Streptococcus at 6. Overall, Staphylococcus is the most abundant bacterium across all colleges, particularly in the College of Humanities and Social Sciences and the College of Engineering. Streptococcus has the lowest relative abundance in the College of Health Science and the highest in the College of Humanities and Social Sciences. Bacillus shows moderate abundance across all colleges, peaking in the College of Humanities and Social Sciences and dipping in the College of Health Science. The College of Humanities and Social Sciences stands out with the highest diversity in bacterial abundance, followed by the College of Science and the College of Arts and Built Environment.

Figure 1: RELATIVE ABUNDANCE OF BACTERIA IN EACH OF THE COLLEGES

#### 4.1.2 Relative abundance of each bacterium in the colleges

The graph shows the overall relative abundance of three types of bacteria—Staphylococcus, Streptococcus, and Bacillus—across all the colleges. Staphylococcus has the highest relative abundance at 56, significantly outnumbering the other two bacteria. Bacillus follows with a relative abundance of 28, while Streptococcus has the lowest relative abundance at 22. This indicates that Staphylococcus is the most prevalent bacterium across all the colleges, whereas Streptococcus is the least prevalent. Bacillus shows a moderate relative abundance compared to the other two bacteria.

Figure 2: RELATIVE ABUNDANCE OF EACH BACTERIUM IN THE COLLEGES

#### 4.1.3 Total relative abundance of bacteria in each of the colleges

The graph displays the overall relative abundance of bacteria across five different colleges, presented in a bar chart format. The College of Science has a total relative abundance of 21, while the College of Engineering slightly surpasses it with a total relative abundance of 22. The College of Arts and Built Environment also shows a total relative abundance of 21, similar to the College of Science. In contrast, the College of Health Science has the lowest total relative abundance of bacteria at 17. The College of Humanities and Social Sciences stands out with the highest total relative abundance of bacteria, reaching 25. This data indicates that the College of Humanities and Social Sciences exhibits the greatest bacterial diversity, whereas the College of Health Science shows the least. The College of Engineering, with its higher total bacterial abundance, is slightly more diverse than both the College of Science and the College of Arts and Built Environment, which share the same total relative abundance.

Figure 3: TOTAL ABUNDANCE OF BACTERIA IN EACH OF THE COLLEGES

### 4.2 Comparing the bacterial load in the colleges

#### 4.2.1 Mean and standard Deviation

The table presents the mean and standard deviation of the log colony count of bacteria across different colleges. For the College of Science, the mean log colony count is 5.7583 with a standard deviation of 0.74140. The College of Engineering has a slightly higher mean log colony count of 5.8710 and a lower standard deviation of 0.67534, indicating less variability in its log colony counts compared to the College of Science. The College of Arts and Built Environment shows a mean log colony count of 5.6113 with a standard deviation of 0.69810. The College of Health Science has the highest mean log colony count at 5.8926 and the lowest standard deviation at 0.64023, suggesting that its log colony counts are relatively consistent. The College of Humanities and Social Sciences has a mean log colony count of 5.6138 with a standard deviation of 0.70249. The total mean log colony count across all colleges is 5.7494 with a standard deviation of 0.67456. This data indicates that the College of Health Science not only has the highest mean log colony count but also the least variability in its measurements, whereas the College of Science exhibits the highest variability among the colleges.

Table 1: Mean and standard Deviation of Bacterial Colony Counts

|  |  |  |
| --- | --- | --- |
| **MEAN** | | |
| Log\_Colony\_Count | | |
| College | Mean | Std. Deviation |
| College of Science | 5.7583 | 0.74140 |
| College of Engineering | 5.8710 | 0.67534 |
| College of Arts and Built Environment | 5.6113 | 0.69810 |
| College of Health Science | 5.8926 | 0.64023 |
| College of Humanities and Social Sciences | 5.6138 | 0.70249 |
| Total | 5.7494 | 0.67456 |

#### 4.2.2 ANOVA

The ANOVA table provides a statistical analysis of the log colony count of bacteria across different colleges to determine if there are significant differences between the groups. The Between Groups (Combined) analysis reveals that the sum of squares is 0.728 with 4 degrees of freedom, resulting in a mean square of 0.182. The F-statistic is 0.380, and the p-value (Sig.) is 0.822. Since the p-value is greater than the typical significance level of 0.05, it indicates that there is no significant difference in the log colony count of bacteria among the different colleges. The "Linearity" analysis shows a sum of squares of 0.071 with 1 degree of freedom, leading to a mean square of 0.071. The F-statistic is 0.149, and the p-value is 0.701. This suggests that the relationship between the log colony count and the colleges is not significantly linear. The Deviation from Linearity section indicates a sum of squares of 0.656 with 3 degrees of freedom, resulting in a mean square of 0.219. The F-statistic is 0.457, and the p-value is 0.714, showing that deviations from linearity are not significant. The "Within Groups" analysis provides a sum of squares of 21.568 with 45 degrees of freedom, leading to a mean square of 0.479. This represents the variance within each college group. Overall, the total variance, as represented by the "Total" sum of squares, is 22.296 with 49 degrees of freedom. The ANOVA results suggest that there is no significant difference in the log colony counts of bacteria across the different colleges, and the relationship is not significantly linear.

Table 2: ANOVA

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ANOVA Table** | | | | | | | |
|  | | | Sum of Squares | df | Mean Square | F | Sig. |
| Log\_Colony\_Count College | Between Groups | (Combined) | 0.728 | 4 | 0.182 | 0.380 | 0.822 |
| Linearity | 0.071 | 1 | 0.071 | 0.149 | 0.701 |
| Deviation from Linearity | 0.656 | 3 | 0.219 | 0.457 | 0.714 |
| Within Groups | | 21.568 | 45 | 0.479 |  |  |
| Total | | 22.296 | 49 |  |  |  |

### 4.3 Isolation, identification and characterization of fungi

#### 4.3.1 Relative abundance of fungi in each of the colleges

The graph below illustrates the distribution of various fungi types across five colleges. In the College of Science, the most abundant fungi are A. fugamitus and A. flavus, both with a relative abundance of 35, followed by A. niger with 19, and Penicillium with 9. Curvularia, Rhodototula, Yeast, and A. terreus each have a relative abundance of 1. The College of Engineering has A. fugamitus as the most prevalent fungi at 40, followed by A. niger at 29, Penicillium at 3, and Rhodototula at 1, with A. flavus, Curvularia, Yeast, and A. terreus each having 0. In the College of Arts and Built Environment, A. fugamitus is most abundant with a value of 27, followed by A. niger at 22, A. flavus at 21, Penicillium and Curvularia both at 9, and Rhodototula, Yeast, and A. terreus each at 1. The College of Health Science shows A. fugamitus as the most common with an abundance of 35, followed by A. niger at 19, and Penicillium, A. flavus, Curvularia, Rhodototula, Yeast, and A. terreus each at 1. Lastly, in the College of Humanities and Social Sciences, A. fugamitus again tops the list with 40, followed by A. flavus at 34, A. niger at 29, Penicillium at 17, Curvularia at 3, and Rhodototula, Yeast, and A. terreus all at 0.

Figure 4: RELATIVE ABUNDANCE OF FUNGI IN EACH OF THE COLLEGES

#### 4.3.2 Relative abundance of each fungus in the colleges

The figure below provides a comprehensive overview of the total abundance of various fungi types across all the colleges combined. The data shows that A. fugamitus is the most prevalent fungus with a relative abundance of 167, indicating it is significantly more common than other fungi. A. niger follows with an abundance of 125, suggesting it is also quite widespread. Yeast and A. terreus are next, with abundances of 74 and 62 respectively, highlighting their notable presence. Penicillium and Curvularia have moderate abundances of 61 and 53, respectively, indicating they are relatively common but not as dominant as A. fugamitus and A. niger. A. flavus shows a lower abundance of 36, while Rhodototula is the least abundant fungus with 23. This distribution suggests that certain fungi, such as A. fugamitus and A. niger, are more adaptable or have more favorable conditions for growth across the colleges, while others like Rhodototula are less prevalent.

Figure 5: RELATIVE ABUNDANCE OF EACH FUNGUS IN THE COLLEGES

#### 4.3.3 Total relative abundance of fungi in each of the colleges

The graph shows the total relative abundance of fungi across five different colleges. The College of Science has a total fungi abundance of 101, while the College of Engineering has a higher abundance of 138. The College of Arts and Built Environment has a total abundance of 120. The College of Health Science has the lowest abundance of fungi at 70. The College of Humanities and Social Sciences has the highest total fungi abundance at 172. This indicates that the College of Humanities and Social Sciences has the most diverse or plentiful fungi population, while the College of Health Science has the least.

Figure 6: TOTAL ABUNDANCE OF FUNGI IN EACH OF THE COLLEGES

### 4.4 Comparing the fungal load in the colleges

#### 4.4.1 Mean and standard Deviation

The table below presents the mean and standard deviation of the log counts of various fungal species across different colleges. For the College of Science, the mean log counts are as follows: 0.805751 for Aspergillus niger, 1.513678 for Aspergillus fumigatus, 0.422788 for Penicillium sp., 1.513678 for Curvularia sp., and 0.301030 for yeast, with standard deviations of 0.7497115, 0.8389642, 0.5107010, and 0.8389642 respectively. The counts for Aspergillus flavus, Rhodotorula sp., and Aspergillus terreus are absent in this college.

In the College of Engineering, the mean log counts are 0.953764 for Aspergillus niger, 1.551947 for Aspergillus fumigatus, 0.081189 for Penicillium sp., 0.100343 for Curvularia sp., 0.515080 for yeast, and 0.234939 for Aspergillus terreus, with standard deviations of 0.5443306, 0.5655323, 0.1885275, 0.1737997, 0.4075908, and 0.2037869 respectively. Data for Aspergillus flavus and Rhodotorula sp. is not available for this college.

For the College of Arts and Built Environment, the mean log counts are 0.847280 for Aspergillus niger, 1.568121 for Aspergillus fumigatus, 0.133791 for Penicillium sp., 0.172923 for Curvularia sp., 1.876871 for Rhodotorula sp., 0.501744 for yeast, and 0.263401 for Aspergillus terreus, with standard deviations of 0.5912784, 0.5675569, 0.1586567, 0.2143035, 0.4787715, 0.3350654, and 0.2426981 respectively. The log count for Aspergillus flavus is not available.

In the College of Health Science, the mean log counts are 0.805751 for Aspergillus niger, 1.513678 for Aspergillus fumigatus, 1.986772 for Aspergillus flavus, 0.422788 for Penicillium sp., and 0.301030 for yeast, with standard deviations of 0.7497115, 0.8389642, and 0.5107010 respectively. The counts for Curvularia sp., Rhodotorula sp., and Aspergillus terreus are absent in this college.

The College of Humanities and Social Sciences shows mean log counts of 0.953764 for Aspergillus niger, 1.551947 for Aspergillus fumigatus, 1.499764 for Aspergillus flavus, 0.081189 for Penicillium sp., 0.100343 for Curvularia sp., 0.515080 for yeast, and 0.234939 for Aspergillus terreus, with standard deviations of 0.5443306, 0.5655323, 0.8474717, 0.1885275, 0.1737997, 0.4075908, and 0.2037869 respectively. Data for Rhodotorula sp. is not available for this college.

Overall, the total mean log counts across all colleges are 0.884064 for Aspergillus niger, 1.537553 for Aspergillus fumigatus, 1.471632 for Aspergillus flavus, 0.189750 for Penicillium sp., 1.040323 for Curvularia sp., 1.713665 for Rhodotorula sp., 0.506051 for yeast, and 0.234706 for Aspergillus terreus. The total standard deviations are 0.6167692, 0.6856328, 0.8645205, 0.3395634, 0.9565707, 0.7076561, 0.3817076, and 0.2123679 respectively. This data reflects the variability and mean log counts of fungal species across the various colleges.

Table 3: Mean and standard Deviation of Fungal load

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MEAN** | | | | | | | | | | |
| College | | Log A. niger | Log A. fugamitus | Log A. flavus | Log Penicillin sp. | Log Curvularia sp. | Log Rhodototula sp. | Log Yeast | Log A terreus |
| College of Science | Mean | 0.805751 | 1.513678 |  | 0.422788 | 1.513678 | 0.000000 | 0.301030 | 0.000000 |
| Std. Deviation | 0.7497115 | 0.8389642 |  | 0.5107010 | 0.8389642 | - | - | - |
| College of Engineering | Mean | 0.953764 | 1.551947 |  | 0.081189 | 0.100343 | - | 0.515080 | 0.234939 |
| Std. Deviation | 0.5443306 | 0.5655323 |  | 0.1885275 | 0.1737997 | - | 0.4075908 | 0.2037869 |
| College of Arts and Built Environment | Mean | 0.847280 | 1.568121 | 0.000000 | 0.133791 | 0.172923 | 1.876871 | 0.501744 | 0.263401 |
| Std. Deviation | 0.5912784 | 0.5675569 | - | 0.1586567 | .2143035 | 0.4787715 | 0.3350654 | 0.2426981 |
| College of Health Science | Mean | 0.805751 | 1.513678 | 1.986772 | 0.422788 | 0.000000 | 0.000000 | 0.301030 | 0.000000 |
| Std. Deviation | 0.7497115 | 0.8389642 | - | 0.5107010 | 0.0000000 | - | - | - |
| College of Humanities and Social Sciences | Mean | 0.953764 | 1.551947 | 1.499764 | 0.081189 | 0.100343 | - | 0.515080 | 0.234939 |
| Std. Deviation | 0.5443306 | 0.5655323 | 0.8474717 | 0.1885275 | 0.1737997 | - | 0.4075908 | 0.2037869 |
| Total | Mean | 0.884064 | 1.537553 | 1.471632 | 0.189750 | 1.040323 | 1.713665 | 0.506051 | 0.234706 |
| Std. Deviation | 0.6167692 | 0.6856328 | 0.8645205 | 0.3395634 | 0.9565707 | 0.7076561 | 0.3817076 | 0.2123679 |

#### 4.4.2 ANOVA

The ANOVA table summarizes the analysis of variance for the relative abundance of various fungi across different colleges. For Log A. niger, the F-value of 0.357 and significance level of 0.839 indicate no significant differences between colleges. Similarly, for Log A. fugamitus, the F-value of 0.038 and significance level of 0.997 suggest no significant differences. Log A. flavus shows an F-value of 1.711 and a significance level of 0.196, indicating no significant differences either. However, for Log Penicillin sp., the F-value of 3.572 and significance level of 0.012 reveal significant differences between colleges, with further analysis showing a significant deviation from linearity (F = 4.355, Sig. = 0.008). Log Curvularia sp. presents a highly significant difference with an F-value of 11.382 and significance level of 0.000, with both linearity (F = 37.184, Sig. = 0.000) and deviation from linearity (F = 2.781, Sig. = 0.051) contributing to this result. Log Rhodototula sp. also shows significant differences (F = 14.031, Sig. = 0.000), with a notable deviation from linearity (F = 25.478, Sig. = 0.000). In contrast, Log Yeast (F = 0.145, Sig. = 0.965) and Log A. terreus (F = 0.669, Sig. = 0.616) exhibit no significant differences.

The implications of these results indicate that while most fungi show no significant variance in their relative abundance across different colleges, certain fungi like Penicillin sp., Curvularia sp., and Rhodototula sp. do exhibit significant differences. This suggests that environmental or other college-specific factors might influence the distribution and abundance of these specific fungi, highlighting the need for further investigation into what drives these differences. For example, the significant deviation from linearity in Penicillin sp. and Rhodototula sp. indicates that non-linear factors are at play, which might include localized conditions or interactions with other species that vary between colleges.

Table 4: ANOVA

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ANOVA Table** | | | | | | | |
|  | | | Sum of Squares | df | Mean Square | F | Sig. |
| Log A. niger College | Between Groups | (Combined) | 0.554 | 4 | 0.139 | 0.357 | 0.839 |
| Linearity | 0.051 | 1 | 0.051 | 0.133 | 0.716 |
| Deviation from Linearity | 0.503 | 3 | 0.168 | 0.431 | 0.731 |
| Within Groups | | 46.616 | 120 | 0.388 |  |  |
| Total | | 47.170 | 124 |  |  |  |
| Log A. fugamitus College | Between Groups | (Combined) | 0.072 | 4 | 0.018 | 0.038 | 0.997 |
| Linearity | 0.005 | 1 | 0.005 | 0.011 | 0.916 |
| Deviation from Linearity | 0.067 | 3 | 0.022 | 0.046 | 0.987 |
| Within Groups | | 77.963 | 162 | 0.481 |  |  |
| Total | | 78.035 | 166 |  |  |  |
| Log A. flavus College | Between Groups | (Combined) | 2.458 | 2 | 1.229 | 1.711 | 0.196 |
| Linearity | 1.241 | 1 | 1.241 | 1.728 | 0.198 |
| Deviation from Linearity | 1.217 | 1 | 1.217 | 1.694 | 0.202 |
| Within Groups | | 23.701 | 33 | 0.718 |  |  |
| Total | | 26.159 | 35 |  |  |  |
| Log Penicillin sp. College | Between Groups | (Combined) | 1.406 | 4 | 0.352 | 3.572 | 0.012 |
| Linearity | 0.121 | 1 | 0.121 | 1.225 | 0.273 |
| Deviation from Linearity | 1.286 | 3 | 0.429 | 4.355 | 0.008 |
| Within Groups | | 5.512 | 56 | 0.098 |  |  |
| Total | | 6.918 | 60 |  |  |  |
| Log Curvularia sp. College | Between Groups | (Combined) | 23.162 | 4 | 5.790 | 11.382 | 0.000 |
| Linearity | 18.917 | 1 | 18.917 | 37.184 | 0.000 |
| Deviation from Linearity | 4.245 | 3 | 1.415 | 2.781 | 0.051 |
| Within Groups | | 24.420 | 48 | 0.509 |  |  |
| Total | | 47.581 | 52 |  |  |  |
| Log Rhodototula sp. College | Between Groups | (Combined) | 6.433 | 2 | 3.216 | 14.031 | 0.000 |
| Linearity | 0.592 | 1 | 0.592 | 2.585 | 0.124 |
| Deviation from Linearity | 5.840 | 1 | 5.840 | 25.478 | 0.000 |
| Within Groups | | 4.584 | 20 | 0.229 |  |  |
| Total | | 11.017 | 22 |  |  |  |
| Log Yeast College | Between Groups | (Combined) | 0.089 | 4 | 0.022 | 0.145 | 0.965 |
| Linearity | 0.002 | 1 | 0.002 | 0.010 | 0.920 |
| Deviation from Linearity | 0.087 | 3 | 0.029 | 0.190 | 0.903 |
| Within Groups | | 10.547 | 69 | 0.153 |  |  |
| Total | | 10.636 | 73 |  |  |  |
| Log A terreus College | Between Groups | (Combined) | 0.123 | 4 | 0.031 | 0.669 | 0.616 |
| Linearity | 0.001 | 1 | 0.001 | 0.012 | 0.915 |
| Deviation from Linearity | 0.123 | 3 | 0.041 | 0.888 | 0.453 |
| Within Groups | | 2.628 | 57 | 0.046 |  |  |
| Total | | 2.751 | 61 |  |  |  |