

#### Section IV: Discussion

The objectives of this project were accomplished, which is shown by difference in slopes testing. The original objectives of this project were to identify whether prebiotics or probiotics (inulin or bifidobacterium) are more effective at treating depression and to identify whether prebiotics and probiotics are more effective at treating depression together or separately. In order to do this, first, the effectiveness of the levodopa must be established, which is shown through the p-value of  $0.000287169^{***}$ . After this is established, it can be concluded that the flies have been significantly depressed for the purpose of this study. Thereafter, to ensure that this study aligns with published and proven scientific literature, both individual treatment groups are compared against the two controls and are shown to be effective. This is due to the low p-values:  $0.00489^{**}$  for levodopa and bifidobacterium,  $0.00453^{**}$  for levodopa and inulin,  $0.00000823^{***}$  for control and inulin, and  $0.00000247^{***}$  for control and bifidobacterium.

After establishing the study's preliminary results align with that of proven and published scientific literature, proving the hypotheses of the study were the next step. The first hypothesis was that inulin and bifidobacterium will be equally effective at treating depression. This is shown to be true by comparing the slopes of the linear regressions of the two graphs using a difference in slopes test. The p-value produced from this test is 0.823, which is far above any significance level and therefore proves that there is no statistical difference between the two slopes. The second hypothesis of this study was that using prebiotics and probiotics together would have a greater than expected effect on depression levels. However, this was shown to be false as after doing linear regressions on all three graphs, the slope on the graph of the inulin and bifidobacterium together was slightly lower than that of inulin and bifidobacterium individually. In order to confirm this, a difference of slopes test was performed between the combination treatment and bifidobacterium, since it was slightly lower than inulin (not significantly), and it showed a p-value of 0.8236, which is far above any significance level. This meant that when used

in combination, bifidobacterium and inulin did not have a synergetic effect. A potential cause for this could be due to the molecular mechanisms of both treatments, as they affect depression levels through two different body systems. Bifidobacterium primarily improves gut condition, which indirectly decreases depression levels, while inulin affects parts of the nervous system, causing depression levels to decrease.

This work shows that there is no evident benefit to providing both probiotics and prebiotics as treatments simultaneously for a depressed individual. Although they do employ different mechanisms, based on this research they seem to be unable to complement each other and do not produce a synergetic effect.

A potential limitation to this study is the use of one prebiotic and one probiotic only. This is a major limitation as it is not representative of the plethora of different choices of each substance which are available. Another limitation to this study is the use of only two assays as there are many other assays which could be employed for measuring depression levels. This is also one of the major challenges I faced during this study, as materials did not arrive as quickly as expected, leaving less time for more assays and certain other parts of the project which were pushed into future steps.

### **Future Research**

The first major future research which this study must lead to is the association of gut health of individuals to these different treatment groups. This is an unproven area in the field of the gut-brain axis and is necessary to be researched to enable personalized/precision medicine for depressed individuals. To do this, the DNA-sequencing of the feces of the flies would be necessary, as it measures bacteria populations. Another future step, which would allow for the removal of a potential limitation, is the use of a larger variety of probiotics and prebiotics rather than just the use of inulin and bifidobacterium. This will ensure that there are several probiotics and prebiotics which are more accurately representative of

the many different varieties of both categories of substances. A third future step which is also important to increase the relevance of this study is to test each of these treatment groups against a group which uses a standard antidepressant. This would allow for further comparisons among the available depression treatments.

### **Section V: Conclusion**

The two objectives of this study were to determine whether prebiotics or probiotics are more effective at treating depression, and if there is a synergetic effect when they are used in combination. To do this drosophila were induced with depression using 10 $\mu$ M and 10mM of levodopa. The flies were then used transferred to bottles which contained treatment groups as well as two control groups. The flies used in these environments were then put through negative geotaxis assays as well as forced swim tests. Then using the data gathered from each of these experiments, each assay on each group was linear regressed. Thereafter, the slopes of each of these graphs were gathered, and based on the objectives of this study as well as for the purpose of ensuring alignment with previous scientific literature, a difference in slopes test was performed on the relevant groups. The findings from this analysis indicated that inulin, bifidobacterium, and their combination treatment were equally effective at treating depression. This is important as it highlights that it is excessive for a patient to take inulin and bifidobacterium, together, to lower depression levels. All in all, inulin and bifidobacterium alone can revolutionize depression treatments across the globe as they do not need to be used in combination, which allows for an increase in accessibility.