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Probiotics Effect on Healthspan in the Model Organism Caenorhabditis elegans

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Abstract

In America, there are high rates of obesity and obesity-related diseases partially due to a high glucose diet. Possessing a propensity towards reversing a glucose-rich diet, probiotics, live microorganisms such as yogurt, were used to combat this. To experiment with humans let alone mice would be tedious, so, the microscopic nematode, Caenorhabditis elegans was used as a model. Because C. elegans possesses homology with humans, they can be used to study probiotics with application in human health. Sponsored by the Creative Inquiry program, this project analyzed the relationship between different probiotics and their effect on lifespan.

With Escherichia coli OP50 as the control and varying Lactobacillus strains as the experimental groups, lifespan assays were conducted. Our results show that certain probiotics increase the lifespan and reverse the detrimental effects of a high glucose diet. Conversely, certain probiotic species, such as Lactobacillus plantarum, can decrease and promote negative health consequences in C. elegans. From these results, the understanding of the human microbiome and better treatments for obesity and obesity-related diseases can be made.

Methods

1. Determine the effects certain probiotic strains have on C. elegans lifespan.
2. Determine if the same probiotic strains can reverse the health consequences of a high glucose diet in C. elegans.
3. Consistent with previous research, the probiotic strains tested extended nematodes’ lifespan.
4. Conclusion and Significance
5. Aims

Introduction

The Western diet consists of foods rich in glucose. In turn, high glucose consumption leads to gut microbiota alterations, which causes increased levels in Firmicutes and decreased Bacteroidetes. Additionally, there exists an increased paracellular permeability. These changes are linked with the obesity phenotype. One way to possibly improve one’s diet is consuming products containing probiotics. Probiotics are microorganisms that promote good health and are ubiquitously present in our daily lives. The probiotics used in this experiment were the Lactobacillus fermentum, Lactobacillus plantarum, Lactobacillus delbrueckii, Bacillus subtilis, and Bacillus coagulans. These probiotics plantarum are found in the gastrointestinal tract, dairy products, and spoiled milk respectively.

C. elegans were used because of their short lifespans and simple maintenance. The lifespan of C. elegans maintained on E. coli OP50 was approximately 7-19 days.2 These probiotics can be supplemented into a diet and may be a cost-effective way to decrease the effects of obesity. We hypothesized that certain Lactobacillus and Bacillus strains will reverse the negative effects of a high glucose diet using C. elegans as a model.

Aims

1. Determine the effects certain probiotic strains have on C. elegans lifespan.
2. Determine if the same probiotic strains can reverse the health consequences of a high glucose diet in C. elegans.

Results

Table 1. Lifespan of nematodes on high glucose diet and probiotics at 25°C

<table>
<thead>
<tr>
<th>Diet</th>
<th>Mean±SE (Days)</th>
<th>N</th>
<th>P-value</th>
<th>% Decrease of Lifespan</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli OP50</td>
<td>13.42±4.225</td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. 2% glucose</td>
<td>11.33±3.927</td>
<td>69</td>
<td>&lt;0.05</td>
<td>15.70%</td>
</tr>
<tr>
<td>B. subtilis</td>
<td>13.77±4.282</td>
<td>86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. fermentum</td>
<td>12.75±3.138</td>
<td>87</td>
<td>&lt;0.05</td>
<td>5.30%</td>
</tr>
<tr>
<td>L. coagulans</td>
<td>17.26±1.221</td>
<td>92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. subtilis with 2% glucose</td>
<td>15.01±1.412</td>
<td>73</td>
<td>&lt;0.05</td>
<td>11.39%</td>
</tr>
<tr>
<td>L. fermentum with 2% glucose</td>
<td>14.63±3.262</td>
<td>92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. plantarum</td>
<td>13.99±0.248</td>
<td>73</td>
<td>&lt;0.05</td>
<td>16.18%</td>
</tr>
<tr>
<td>L. coagulans with 2% glucose</td>
<td>15.08±0.256</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. delbrueckii</td>
<td>14.13±0.310</td>
<td>74</td>
<td>&lt;0.05</td>
<td>8.70%</td>
</tr>
</tbody>
</table>

Figure 1. Diagram of C. elegans lifespan assay experiment using various probiotics.

Figure 2. Diagram of C. elegans lifespan assay experiment using various probiotics.

Figure 3. Preliminary body bend assay data. L4 nematodes were placed on different diets: OP50, OP50 with 2% glucose, L. plantarum, L. plantarum with 2% glucose, B. subtilis, and B. subtilis with 2% glucose. After three minute intervals for 10 nematodes, sinusoidal motion movements were recorded for each of the diets.

Figure 4. Lifespan curves of nematodes fed on each probiotic with or without 2% glucose supplemented into diet at 25°C.

Figure 5. Lifespan curves of nematodes fed on each probiotic with or without 2% glucose supplemented into diet at 25°C.

Figure 6. Lifespan curves of nematodes fed on each probiotic with or without 2% glucose supplemented into diet at 25°C.

Figure 7. Lifespan curves of nematodes fed on each probiotic with or without 2% glucose supplemented into diet at 25°C.

Figure 8. Lifespan curves of nematodes fed on each probiotic with or without 2% glucose supplemented into diet at 25°C.

Figure 9. Lifespan curves of nematodes fed on each probiotic with or without 2% glucose supplemented into diet at 25°C.

Figure 10. Lifespan curves of nematodes fed on each probiotic with or without 2% glucose supplemented into diet at 25°C.

Future Directions & Significance

Future directions include determination of long-term effects of probiotic supplementation, investigation of probiotic targeted pathways, experimentation with higher level organisms, and more body burdens and broad size assays with the same probiotics.

Acknowledgments

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References


