Microplastics and the Digestive System

Plastic that has been broken down into smaller quantities is known as microplastics. Microplastics can be found in food, water, and inside of organisms. The papers by Jin et al. (2019) and Li et al. (2020) explored how the accumulation of microplastics in organisms such as mice could affect intestinal barriers, microbiota, and inflammation in the digestive system. Jin et al. (2019) addressed the issue of microplastic interaction with gut microbiota and how different concentrations might affect outcomes. Li et al. (2020) explored how microplastic accumulation might lead to intestinal inflammation and decrease the intestine's ability to carry out its protective functions against harmful organisms. Although both papers explored the effects of microplastics on these organ systems, they conducted different experiments by measuring different sources, exposure times and doses, and pathways of the digestive system.

Experiments and Methods

Both studies focused their experiments on intestines, digestive organs, and microorganisms. They both used a fluorescent and pristine version of microplastics in their study. Jin et al. (2019) studied polystyrene microplastics whereas Li et al. (2019) studied polyethylene microplastics. Li et al. (2019) chose to study polyethylene microplastics since they were the more common type where the experiment took place.

The first study used water to administer the microplastic doses. Jin et al. (2019) randomized mice into three groups of eight where one group was the control group and received filtered water with no microplastics. The other two treatment groups received doses of 5 μm of microplastics per 100 and 1,000 μg/L water concentrations. Two additional groups of five mice were selected to test accumulation. One of these groups received the filtered water and the other group received 5 μm of fluorescent microplastics. The groups were exposed continuously for 6 weeks and then their organs and blood were stored for sampling. Levels of serum, proteins in the colon and ileum, bacterial primers, and bile acid were measured. Bioanalytics was used to measure microbiota composition. Results were analyzed using an ANOVA statistical test.

On the other hand, the second study used food to administer microplastic doses. Li et al. (2020) used 80 mice for their study which is a larger sample compared to the 34 mice used by the first study. Li et al. (2020) created four groups of 20 mice in each group where one group served as the control group with no exposure to microplastics in their food. There were three treatment groups that received 0.02g, 0.2g, or 2g of microplastics dissolved in 10 kg of feed. The concentration amounts were calculated as 2, 20, or 200 $\mu g\ g^{-1}$ microplastics after accounting for the dilution that occurred. In the results section these concentrations are 6μg, 60μg, and 600μg respectively. The groups were exposed for 5 weeks continuously within their assigned groups and then fecal and tissue samples were collected for analysis. Cytokines in serum, phenotypes, cell abnormalities, inflammation in the colon and duodenum, and cell necrosis were measured. Data was analyzed with a Wilcoxon rank-sum statistical test.

Comparison of Studies

The two studies noted that serum levels increased in treatment groups, but Jin et al. (2019) focused on serum pyruvate whereas Li et al. (2020) focused on serum interleukin-1a levels. Li et al. (2020) found that fatty acid metabolism decreased in groups treated with 60μg and 600μg concentrations to which Jin et al. (2019) agreed that fatty acid synthesis was changed by exposure but did not specify further. Both papers looked at transcription of genes although they focused on different ones. Jin et al. (2019) stated that genes that produced mucous

decreased and Li et al. (2020) found that genes that promoted inflammation such as AP-1 and IRF5 increased in the 600μg concentration group; this is in line with findings that mice in this group experienced intestinal inflammation and had lower defense mechanisms.

The structure of the microbiota was measured at the phylum microorganism level. The studies disagreed in their findings of phyla such as Blautia but agreed on findings around other phylum. Blautia phyla levels in the microbiota decreased in treatment groups (Jin et al., 2019) whereas levels increased in the 60μg and 600μg concentration treatment groups in Li et al.'s (2020) study. Although Deferribacteres was one of the most abundant phlya in the microbiota (Jin et al., 2019), only Li et al. (2020) found differences in levels across the treatment groups. Additionally, actinobacteria phyla were lower in all treatment groups exposed to microplastics (Jin et al., 2019) whereas Li et al. (2020) stated there was only a difference between the 60μg and 600μg concentrations. Jin et al. (2019) and Li et al. (2020) both concluded through their findings that Firmicutes and Parabacteroides decreased in treatment groups.

Conclusions

Some possible explanations for these differences across microbiota phylum are the routes of exposure, dose concentrations, and microplastic type. Since one study experimented with water and another study used food to administer microplastic concentrations, it is possible that the digestive processes used to eat may have played a role in the uptake of microplastics. Dose concentrations and the amount of time that mice were exposed differed across studies which could have also played a role in the results. Since different microplastics were studied, it is possible that effects may vary across microplastic type. In the case of Blautia phyla, levels may have increased to aid in fighting inflammation that was occurring because of the microplastic accumulation. One common trend in both studies was the decrease in microbiota which is alarming considering the role that the microbiota plays in immune functions.

Both studies concluded similar results in their broader discussion of health effects of microplastic accumulation. Jin et al. (2019) concluded that microplastics can accumulate in the gut, lead to gut disfunction, an imbalance of microbiota, and lead to metabolic disorders. Jin et al. (2019) also noted that the damages to the digestive system could lead to additional diseases or infections since inflammation and damage to cells allowed for the transport of harmful toxins. Li et al. (2020) concluded that gut microbiota and flora became imbalanced, inflammation occurred, and bacteria increased as exposure concentrations increased. They also concluded that these disbalances of the microbiota and individual microbes could result in diseases of the digestive system (Li et al., 2020).

The experiments conducted served as species extrapolation experiments and the results were applied to conditions that humans could face if any of the organ systems studied faced similar exposures. Further issues that should be explored include dosage concentrations that humans are exposed to, synergistic effects of plastic and microplastic exposure, and measuring the role of microplastics for individuals with pre-existing health conditions. Both experiments applied their findings to health impacts that are seen in people with these same abnormalities, but the health effects for someone with a pre-existing health condition was not explored. In terms of synergistic and compounding effects, future studies can measure dose-responses when both water and food exposures are occurring since these studies isolated the sources. Another area that could be explored is the developmental timing of the exposures since people may be exposed before birth through the passing of blood from mothers to babies. Lifetime exposure may play a bigger role in health effects depending on when the exposure began and in what dose levels.

References

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