Diet Influences Nutrient Utilization Metrics and Gut Microbiome of Rainbow Trout *Oncorhynchus mykiss* More Than Genetic Line: Differential Responses to Fishmeal-, Plant-, And Insect-derived Feeds

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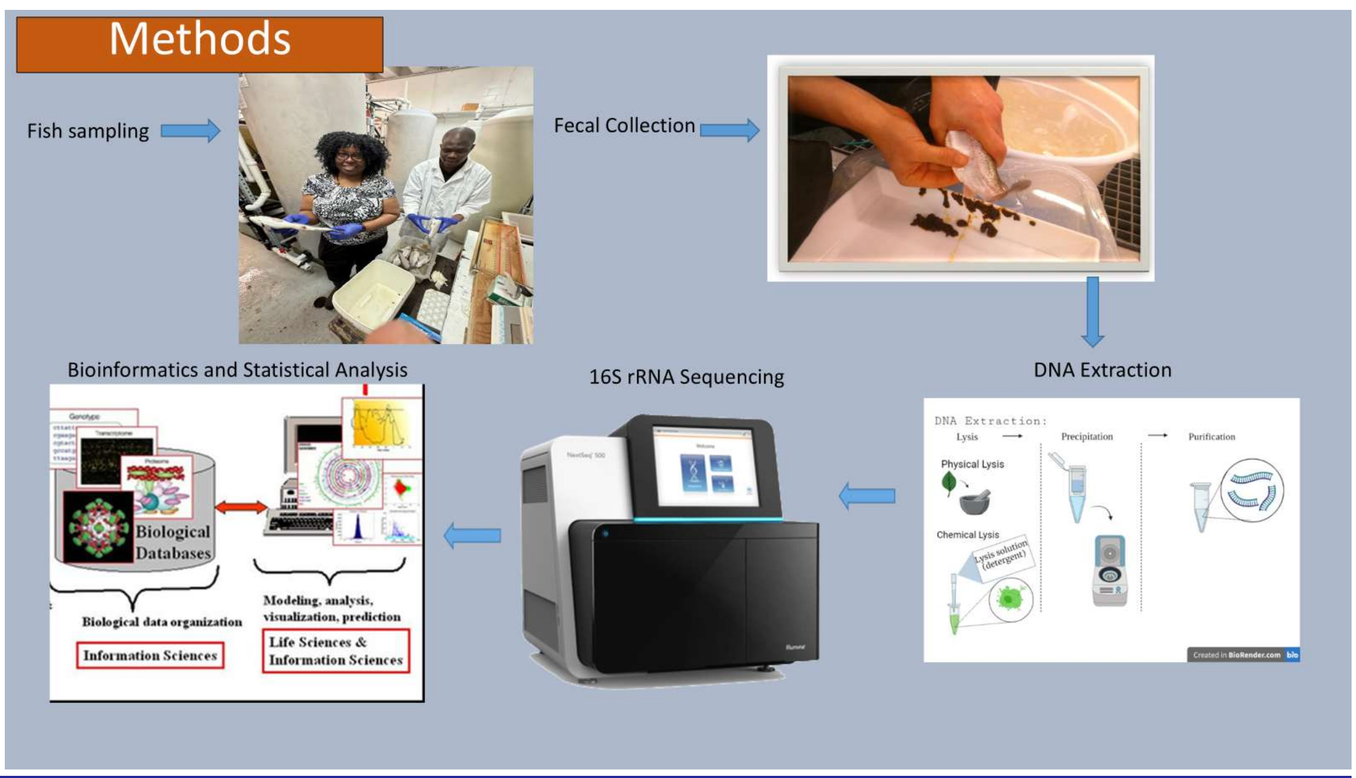
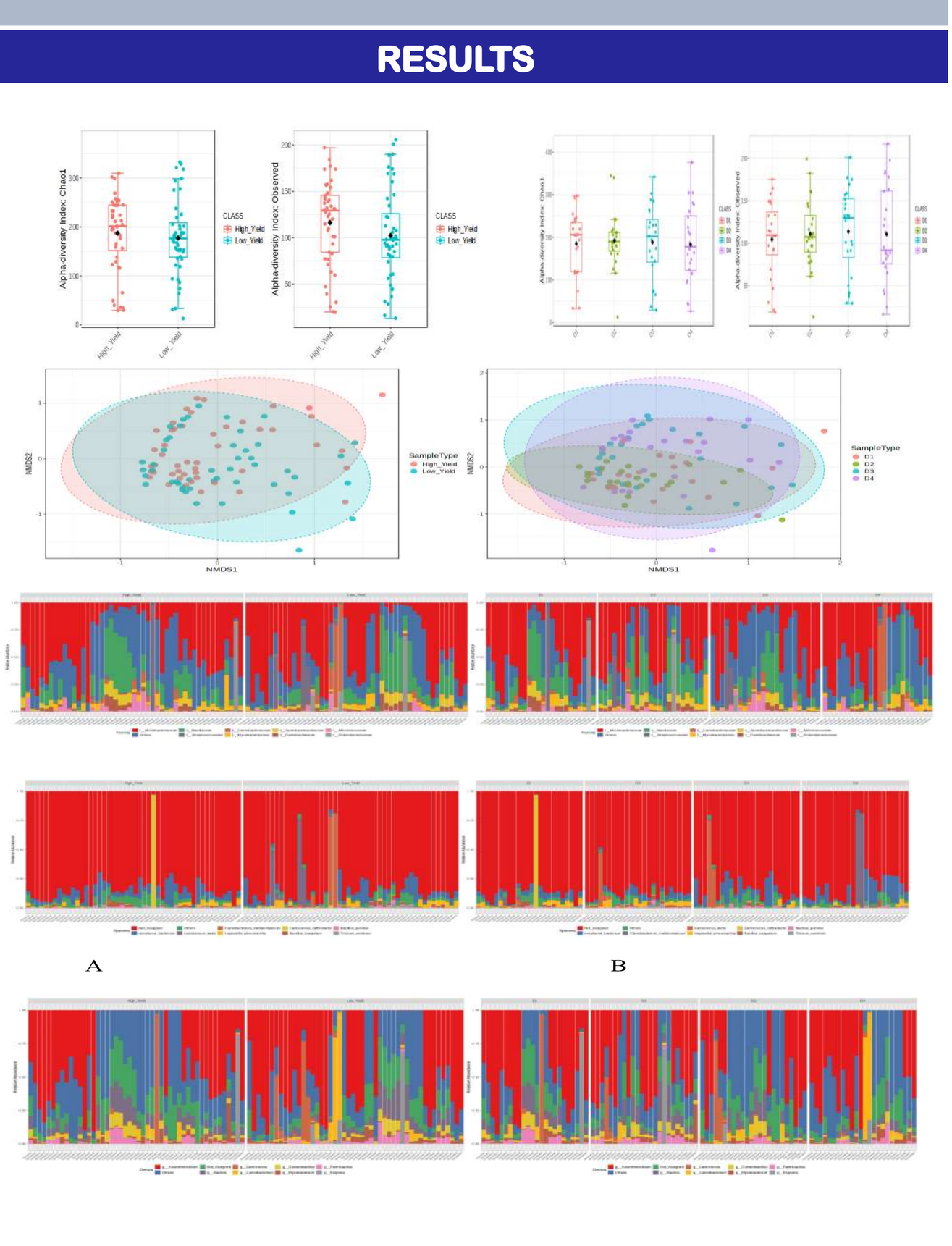
INTRODUCTION

- The sustainability of rainbow trout (*Oncorhynchus mykiss*) aquaculture is challenged by heavy reliance on fishmeal and fish oil.
- Alternative protein sources such as plant- and insect-derived ingredients offer promising solutions but may alter nutrient utilization and gut microbial ecology.
- The gut microbiome plays a critical role in digestion, nutrient absorption, and host health, and its response may vary with both dietary composition and host genetic line.
- This study evaluated whether diet or genotype exerts a stronger influence on whole-body composition, nutrient retention, and gut microbiota in high-yield (HY) and low-yield (LY) muscle rainbow trout. Diet1(D1)-Fishmeal based,Diet2(D2)-Vegetable based, Diet 3(D3)-Insectmeal based, Diet4(D4)-FM +VP +IM ratio 1:1:1

MATERIALS AND METHODS



RESULTS



- Whole-body composition:Genotype affected moisture content only ($P < 0.05$). Diet significantly influenced protein, lipid, ash, and energy ($P < 0.05$). Diets D1 and D4 produced higher protein and ash levels.
- Nutrient retention:No significant genotype effect. Diet was the dominant factor ($P < 0.05$). D1 and D4 showed the highest nutrient utilization efficiencies.
- Gut microbiota composition: Dominated by Actinobacteriota (52%), Firmicutes (31%), Proteobacteria (~10%). Alpha diversity was not affected by diet or genotype. Beta diversity showed a significant diet effect (PERMANOVA, $P = 0.018$), but not genotype.
- Taxonomic shifts: Insect-based diets (D3, D4) increased Bacillus and lactic acid bacteria. Plant-based diet (D2) favored Actinobacteriota. D4 supported the highest microbial richness.Genotype–diet interaction revealed stronger microbiome shifts in HY fish fed insect-containing diets.

DISCUSSION

- Diet exerted a greater influence than genetic line on nutrient utilization and gut microbiota in rainbow trout.
- Insect meal inclusion selectively promoted beneficial bacterial taxa (e.g., *Bacillus*, lactic acid bacteria) associated with improved digestion and probiotic potential, while plant proteins enhanced Actinobacteria linked to polysaccharide degradation.
- Mixed diets (D4) provided the most balanced microbial community and superior nutrient retention, highlighting the value of ingredient blending.
- Genetic line-dependent responses to insect diets suggest opportunities for precision aquaculture, where feed formulations are tailored to genetic background to optimize performance and sustainability.

CONCLUSIONS

🥗 Diet is the dominant driver of gut microbiome structure

🧬 Genetic line has minor influence, but interacts with diet

🐜 Insect-based and mixed diets enhance beneficial microbes

🌱 Blended diets (D4) optimize microbial balance and feed efficiency

References
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ACKNOWLEDGEMENTS

USDA NIFA is acknowledged for financial support