This study investigates the efficiency and sustainability of biodiesel production from poultry waste utilizing organic catalysts, employing comprehensive statistical analyses to assess biodiesel yield, emissions profiles, and economic feasibility. Poultry waste, characterized by high lipid content (25-30%), was pre-treated to reduce free fatty acid (FFA) levels, optimizing the transesterification process. Descriptive statistics, including mean and standard deviation, summarized key variables such as yield percentages and emissions of CO_2 and NO_x. A one-way Analysis of Variance (ANOVA) revealed statistically significant differences ($p < 0.05$) in biodiesel yields across various catalysts, with sulfuric acid achieving 92% yield, potassium hydroxide at 90%, and heterogeneous catalysts yielding 88% and 85% for eggshell-derived CaO and wheat straw biochar, respectively. Pearson's correlation coefficients indicated a strong positive correlation ($r = 0.85$) between catalyst reusability and biodiesel yield, underscoring the importance of sustainable materials in production. A multiple regression model, with an R-squared value of 0.78, effectively predicted biodiesel yield based on variables including CO_2 emissions and sustainability index. The environmental assessment showed that biodiesel from poultry waste results in up to 50% lower CO_2 emissions compared to traditional diesel fuels. This research contributes to the understanding of sustainable biofuels, highlighting poultry waste as a viable feedstock that supports the circular economy by minimizing waste and promoting resource recovery, and advocates for policy frameworks incentivizing the use of organic catalysts in biodiesel production to align with global sustainability goals.