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ANALYSIS OF A FRACTIONAL ORDER THREE SPECIES FOOD WEB MODEL

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Abstract. In this study, we examine a fractional-order three-species food web model incorporating intraguild predation. We investigate the existence and uniqueness of solutions for the proposed fractional-order system. Furthermore, we derive the necessary and sufficient conditions for the presence of positive equilibrium points and analyze the system stability around these points. Our findings indicate that fractional-order models exhibit more feasible dynamics compared to their integer-order counterparts. Finally, numerical simulations are provided to validate and illustrate the analytical results.

Keywords. Fractional order food web model, Stability analysis, Dynamical behavior.

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1 Introduction

In recent years, three-species food chain models have attracted considerable attention in ecological research. In particular, three species food chain model have been identified and exhibit chaotic dynamics without intraspecific interactions [1]. Many researchers have extensively examined three-species food-web model and express complex dynamical behavior [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12].

Fractional calculus is an advancement of ordinary differentiation and integration to an arbitrary order and has emerged as a powerful tool for modeling dynamic systems. The increasing number of applications of fractional-order systems underscores their effectiveness in providing more accurate and feasible representations compared to integer-order models. For example, the fractional Lotka-Volterra model, which incorporates memory and mutualism in species sustainability with harvesting, was studied in [13]. Similarly, the stability and dynamics of a fractional-order Leslie-Gower prey-predator model