Analysis of the Dynamics of Transmission of Microsporidia MB Inside the Population of Anopheles Mosquitoes

Authors : Charlene N. T. Mfangnia, Henri Tonnang, Berge Tsanou, Jeremy Herren

Abstract : The Microsporidia MB found in the populations of anopheles is a recently discovered symbiont responsible for the Plasmodium transmission blocking. From early studies, it was established that the symbiont can be transmitted vertically and horizontally. The present study uses compartmental mathematical modelling approach to investigate the dynamics of Microsporidia transmission in the mosquito population with the mindset of establishing a mechanism for use to control malaria. Data and information obtained from laboratory experiments are used to estimate the model parameters with and without temperature dependency of mosquito traits. We carry out the mathematical analysis focusing on the equilibria states and their stability for the autonomous model. Through the modelling experiments, we are able to assess and confirm the contribution of vertical and horizontal transmission in the proliferation of Microsporidia MB in the mosquito population. In addition, the basic and target reproductions are computed, and some long-term behaviours of the model, such as the local (and global) stability of equilibrium points, are rigorously analysed and illustrated numerically. We establish the conditions responsible for the low prevalence of the symbiont-infected mosquitoes observed in nature. Moreover, we identify the male death rate, the mating rate and the attractiveness of MB-positive mosquitoes as mosquito traits that significantly influence the spread of Microsporidia MB. Furthermore, we highlight the influence of temperature in the establishment and persistence of MB-infected mosquitoes in a given area.

Keywords : microsporidia MB, vertical transmission, horizontal transmission, compartmental modelling approach, temperature-dependent mosquito traits, malaria, plasmodium-transmission blocking
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