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Enhancement of immune responses by vaccine potential of three antigens, including ROP18, MIC4, and SAG1 against acute toxoplasmosis in mice

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ABSTRACT

Toxoplasma gondii (*T. gondii*) causes considerable financial losses in the livestock industry and can present serious threats to pregnant women, as well as immunocompromised patients. Therefore, it is required to design and produce an efficient vaccine for controlling toxoplasmosis. The present study aimed to evaluate the protective immunity induced by RMS protein (ROP18, MIC4, and SAG1) with Freund adjuvant, calcium phosphate nanoparticles (CaPNs), and chitosan nanoparticles (CNs) in BALB/c mice. The RMS protein was expressed in *Escherichia coli* (*E. coli*) and purified using a HisTrap HP column. Thereafter, cellular and humoral immunity was assessed by injecting RMS protein on days 0, 21, and 35 into four groups [RMS, RMS-chitosan nanoparticles (RMS-CNs), RMS-calcium phosphate nanoparticles (RMS-CaPNs), and RMS-Freund]. Phosphate buffered saline (PBS), CNs, CaPNs, and Freund served as the four control groups. The results displayed that vaccination with RMS protein and adjuvants significantly elicited the levels of specific IgG antibodies and cytokines against toxoplasmosis. There were high levels of total IgG, IgG2a, and IFN-γ in vaccinated mice, compared to those in the control groups, especially in the RMS-Freund, indicating a Th-1 type response. The vaccinated and control mice were challenged intraperitoneally with 1×10^3 tachyzoites of the *T. gondii* RH strain four weeks after the last injection, and in RMS-Freund and RMS-CaPNs groups, the highest increase in survival time was observed (15 days). The RMS can significantly increase Th1 and Th2 responses; moreover, multi-epitope vaccines with adjuvants can be a promising strategy for the production of a vaccine against toxoplasmosis.

1. Introduction

Toxoplasmosis, a widespread zoonotic infection, is caused by a pathogen within the phylum Apicomplexa named *Toxoplasma gondii* (*T. gondii*) in all warm-blooded animals, including about 30% of the human population worldwide (Dubey, 2008). Even cold-blooded animals can serve as a source of infection for humans and other hosts that feed on them (Nayeri et al., 2021). *T. gondii* can cause a serious infectious disease during pregnancy and may lead to abortion or severe congenital defects, such as intellectual disability, blindness, and hydrocephaly, in the affected fetus (Elsheikha, 2008). In addition, this infection in immunocompromised patients may lead to severe and progressive complications, such as encephalitis or pneumonitis, and even may lead to death if left untreated (Wang et al., 2017). Sulfadiazine/-pyrimethamine as available chemical treatments lead to multiple side effects (e.g., fatal bone marrow suppression, hematologic toxicity, and

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