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Immune response and protective effect against spring viremia of carp virus induced by intramuscular vaccination with a SWCNTs-DNA vaccine encoding matrix protein

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11 **Abstract** To elicit the immune protective of vaccine against the highly contagious and pathogenic
 12 disease caused by spring viremia of carp virus (SVCV), a novel functionalized single-walled carbon
 13 nanotubes (SWCNTs) were applied as a delivery vehicle for DNA vaccine. In this study, we report a
 14 SWCNTs-DNA vaccine encoding matrix protein of SVCV which, when injected in the muscle at a dose
 15 of 10 µg SWCNTs-pcDNA-*M* vaccine, confers up to 51.3% protection against intraperitoneal challenge
 16 with SVCV. In addition, SWCNTs as a promising vehicle can enhance about 17.5% of the immune
 17 protective effect in SWCNTs-pcDNA-*M* vaccinated common carp compared with fish injected with
 18 naked pcDNA-*M* DNA vaccine. In addition, serum antibody production, none specific immunity
 19 parameters (complement activity, superoxide dismutase activity (SOD), acid phosphatase activity (ACP)
 20 and alkaline phosphatase activity (AKP)) and immune-related genes were used to verify the
 21 enhancement immune response induced in SWCNTs-pcDNA-*M* vaccinated fish, herein all these
 22 mentioned immune activities were significantly enhanced after immunization. Thereby, it is revealed
 23 that the *M* gene of SVCV could be used as an antigen for DNA vaccine constructs, and SWCNTs could

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