**Supplementary file 1:** Experimental design scheme. Goats were randomly allocated with five goats per group and were then vaccinated/immunized (), challenged (), and bleed () at different time points. The study was carried out in compliance with the experimental design of Trials 1 (A) and 2 (B).

**Supplementary file 2:** Mucosal antigen-specific IgA and total IgG and IgE productions. A: Mucosal anti-rHcADRM1 lgA levels in Trial 1. B: Mucosal anti-rHcADRM1 lgA levels in Trial 2. C: Total mucosal IgG productions in Trial 1. D: Total mucosal IgG productions in Trial 2. E: Total mucosal IgE productions in Trial 1. F: Total mucosal IgG productions in Trial 2. Mucosal antibody levels were denoted as minimum to maximum (n = 5 for each group).

**Supplementary file 3:** Variation in serum IgA and IgE levels throughout the study. The kinetics of IgA and IgE levels in the circulation were assessed throughout all time points in Trials 1 (A and C) and 2 (B and D). No differences were observed in serum IgA and IgE levels at each time point among the groups in both trials. Serum antibody levels in each group were shown as mean ± SD (n = 5).

**Supplementary file 4:** The kinetics of other hematological parameters. Red blood cells, basophils, monocytes, lymphocytes, neutrophils, and white blood cells showed no change across the groups throughout all time points in both Trials 1 (A, B, C, D, E, and F) and 2 (G, H, I, J, K, and L). The hematological parameters in each group (n = 5) were presented as mean ± SD.

**Supplementary file 5:** Variation in serum IL-2, IL-10, TNF-α, and TGF-β1 levels throughout the study. All the groups did not differ significantly in serum IL-2 (A and E), IL-10 (B and F), TNF-α (C and G), and TGF-β1 (D and H) levels throughout all time points in Trials 1 or 2. Cytokine levels in each group (group size n = 5) were presented as mean ± SD.