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Search for common antigens to develop universal vaccines to control
avian mites, poultry red mites, tropical fowl mites,
and northern fowl mites
(ワクモ、トリサシダニ、及びミナミトリサシダニを防除する
ユニバーサルワクチン開発に向けた共通抗原の探索)

Infestation with hematophagous avian mites, poultry red mites (PRMs, *Dermanyssus galline*), tropical fowl mites (TFMs, *Ornithonyssus bursa*), and northern fowl mites (NFMs, *Ornithonyssus sylviarum*), negatively impact poultry health and welfare, leading to severe economic losses to the poultry industry. The emergence of drug-resistant mites has diminished the efficacy of acaricides used for controlling avian mites. Vaccine approaches have been developed to control PRMs, and the development of universal vaccines that are effective against other avian mites, including TFMs and NFMs, would greatly enhance their utility. For the development of universal vaccines, molecules that are detrimental to the physiological processes and highly conserved among avian mite species could be ideal vaccine antigens. In the present study, histamine release factor (HRF, in Chapter I), glutathione S-transferase (GST, in Chapter II), cysteine protease (CP, in Chapter III), and ferritin 2 (FER2 in Chapter IV), which have been reported as candidate vaccine antigens against PRMs, were identified from TFMs and NFMs, and the potentials as universal vaccine antigens with broad-spectrum efficacy across avian mites were assessed.

HRF, a multifunctional protein involved in biological activities and allergic responses, and GST, a multifunctional protein involved in acaricide detoxification, identified from TFMs and NFMs were genetically close to those of PRMs. CP is a proteolytic enzyme vital for hemoglobin digestion in blood-sucking arthropods, and FER2 is an iron-binding protein important for iron homeostasis. The peptidase domains (PD) required for the enzyme activities of CP and amino acid residues critical for the oxidation of Fe (II) of TFMs and NFMs were highly conserved to those of PRMs. Immune plasmas

obtained from chickens immunized with recombinant proteins of HRF, GST, CP, and FER2 cross-reacted with each recombinant protein from different avian mites. Moreover, *in vitro* feeding assays showed that immune plasma against recombinant proteins of GST, CP, and FER2 from TFMs and NFMs exhibited acaricidal effects on PRMs, while the effects of immune plasma against recombinant HRFs were limited to nymph PRMs. These results indicate the potential use of HRF, GST, CP and FER2 as vaccine antigens against multiple avian mites.

In conclusion, the present study identified four candidates for universal vaccine antigens with broad protective efficacy against avian mite species. However, the observations obtained in the present study are limited based on *in vitro* findings using PRMs. Therefore, to accurately assess cross-protective efficacy against avian mites, the effects of each antigen on TFMs and NFMs are necessary to be examined *in vitro* and *in vivo*. Moreover, to enhance the protective efficacy, a combination of antigens analyzed in this study as a cocktail vaccine needs to be investigated. Thus, although there are still some limitations, the findings of this study could encourage the future application of universal vaccines against avian mites, thereby improving the economic losses in the poultry industry.