ABSTRACT

This thesis reports studies related to the development and application of silver nanoparticles (AgNPs) for treatment of water used in poultry farming. The study is divided into three parts. The first part deals with the synthesis and characterization of AgNPs and their fate and risk in the water environment. In this part of the study, AgNPs dispersion in terms of aggregation and sedimentation, and antibacterial activity were analyzed in poultry farm water and compared with the similar mechanisms in de-ionized (DI) water. The analysis of farm water samples revealed that the concentrations of some inorganic and total organic matter were higher than the permissible limits, mainly because the water was from shallow well (<60 ft) and untreated. The aggregation and sedimentation of the AgNPs in the farm water was observed for different concentrations of water pollutants, as compared to DI water. The average aggregation of AgNPs in the farm water and DI water was observed 275±10 and 49 nm, respectively. The mass sedimentation of AgNPs in the farm water and DI water was observed 90±2 and 19%, respectively. The optimum dose of 50 ppm AgNPs was determined through minimum inhibitory concentration (MIC) test and checked for the disinfection test against total coliform bacteria in the farm water. The average size of the laboratory synthesized AgNPs was 8-20 nm and the synthesis route was cost effective for commercial development.

In the second part, a study was conducted in two poultry farms of West Medinipur district, West Bengal, India with a target to reduce the prevalence of pathogenic bacteria, *Escherichia coli* (*E. coli*) commonly found in the poultry drinking water by the application of a formulation of AgNPs. Two poultry farms A and B were selected as case and control groups, respectively, for sampling. The study was designed with 3 replications. In the case group, the supplied water generally used for the poultry was dosed with synthesized AgNPs throughout the study period, while in the control group the untreated water was supplied for drinking by the poultry. The study also included the impact of AgNPs dose on factors of standard poultry growth performance like mortality count, feed intake (FI), body weight (BW), and food conversion ratio (FCR). The observations revealed that, compared to the control, in the case group the percentage mortality was reduced significantly ($p<0.05$), and FI and BW increased significantly ($p<0.05$) but no significant effect however, was observed on FCR ($p>0.05$). The results of average 4.92% mortality of case poultry, compared to the average 14.13% mortality in control

would potentially provide substantial economic benefit to the farmers. Moreover, the consumption risk assessment surmised that a 1.2 µg/g of silver retained by the poultry. The hazard quotient (Ag) was 0.34 (<1) which is considered non-toxic for the poultry, and the poultry is fit for human consumption. A cost-benefit analysis weighs in favour of AgNPs use by the farmers, to particularly deal with the effects of *E. coli*.

In the third part, the supplementation of 50 ppm dosed AgNPs as a disinfectant in broilers drinking water was investigated to examine their blood serum biochemistry and organ histology in the case group, compared to the control. At the end of 42 days, the blood and major organs of the 1 case broiler out of 75 and 1 control broiler out of 75 were collected. The procedure was repeated 3 sets one after another, each consisting 42 day intervening period. The liver enzyme, lipid profile, glucose level, organ histology, and concentration of AgNPs in liver, spleen, heart and small intestine were determined. Importantly, in all the 3 sets the changes in lipid profile, liver enzyme, and glucose level of the case broilers were not statistically significant compared to the control ($p>0.05$). The histology of liver, kidney, heart, spleen, and small intestine of broilers has not shown any particular damages to the cells as compared to the control samples. The present study concludes that the administering 50 ppm AgNPs of average 15 nm size in the poultry drinking water was found safe for consumption as well as growth enhancement. The overall analysis points to safe and economic application of AgNPs in the untreated poultry farm water having microbial load.

Keywords: AgNPs; Farm water; Disinfection; Growth performance; Risk Assessment; Economic Analysis; Organ histopathology.