EFFECT OF SILVER NANOPARTICLES ON CHICKEN HEALTH AFTER INFECTION WITH *CAMPYLOBACTER JEJUNI*

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Introduction

Silver nanoparticles (AgNP) have gained much attention in recent years due to their biomedical applications, especially as antimicrobial agents. AgNP may be used in poultry production as an alternative to the use of antibiotic growth promoter. However, little is known about the impact of oral administration of AgNP on the gut microbiota and the immune system. The aim of the present study was to investigate the effects of AgNP on growth, hematological and immunological profile as well as intestinal microbial composition in broilers challenged with *Campylobacter jejuni* (*C. jejuni*).

Materials and Methods

Ninety day-old broiler chickens were randomly assigned to two groups: control and provided with AgNP in the drinking water (50 ppm). At day 11, all birds were orally challenged with an overnight *C. jejuni* culture. Feed consumption, water intake, body and organ weights were registered to evaluate the influence of AgNP on chicken performance. The *in vivo* antibacterial activity of AgNP was assessed by using plate count method by measuring packed cell volume (PCV) percent in chicken blood samples using the micro-hematocrit reader. Humoral immune status was determined by measuring plasma immunoglobulin concentrations. The effect of AgNP on the inflammatory response was measured in liver tissue samples by mRNA expression of TNF-α and NF-kB using qPCR analysis.

Results and Discussion

AgNP did not affect the intestinal microbial profile of birds. These results are consistent with *in vivo* experiments with the microbial profile of young quails receiving hydrocolloids of AgNP administered with 5-25 ppm [1]. The obtained results may suggest that AgNP were gastro-sensitive, the stability and dispersion of AgNP in gastric acid is a critical factor for antibacterial activity.

The body weight gain and the relative weights of bursa and spleen were reduced when supplemented with AgNP. The results are consistent with decreased body and organ weights in chickens treated with 25 ppm of AgNP [2]. The PCV results indicated that the provision of AgNP did not influence the percentage of red blood cells. On the other hand, it was reported that the oral administration of AgNP induced some changes in the red blood compartment, such as increased red blood cell count and coagulation parameters [3].

The plasma concentrations of IgG and IgM were lower in birds receiving AgNP compared to the non-supplemented control group (FIG. 1) AgNP might impair intestinal actively transported sugars, amino acids, trace elements, and vitamins, and deficiencies of these nutrients may decrease antibody formation. Similar observations showed decreased plasma IgG levels in chickens treated with 10 and 20 ppm AgNP but not infected with *C. jejuni* [4].

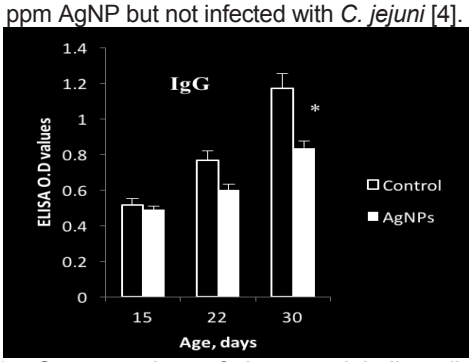

FIG. 1. Concentration of immunoglobulins (IgG) in chickens infected with *C. jejuni* * Indicates significant difference between control and AgNP ($p < 0.05$).

The expression of *TNF-α* and *NF-kB* at mRNA level was significantly higher in birds receiving AgNP. An increase in mRNA expression of inflammatory mediators and low IgG and IgM levels could be due to the nanoparticle uptake triggering cellular effects, leading to inflammatory responses. However, the conflicting results might indicate that AgNP have multiple cellular targets that vary among different cell type. These results are attributed to several confounding factors such as pH [5], continuous oral administration of AgNP, or even the availability of free radicals to induce oxidative stress and damage cells [3,6]. We propose that nanoparticles time of exposure, route of administration, particles size, aggregate formation, and altered bio-distribution in the form of rapid clearance owing to non-specific pathogen clearance from the systemic circulation could serve as aided factors. One possible cause for the AgNP dependent initiation of inflammation could be the fact that they enhance the production of reactive oxygen species. These oxygen-derived free radicals may lead to mitochondrial dysfunction, increased gene expression of inflammatory cytokines (TNF-α) and activation of specific transcription factors (NF-kB).

Conclusions

The application of AgNP via the drinking water in the concentration of 50 ppm reduced chicken growth, impaired immune functions and had no antibacterial effect on different intestinal bacterial groups, which may limit the applicability of AgNP against *C. jejuni* in broiler chickens.

Acknowledgments

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References

[1] E. Sawosz, M. Grodzik *et al*., Arch. Geflügelk. 73 (3) (2009) S208–213.
[2] F. Ahmadi, A.H. Kurdestany, Global Veterinaria 5(6) (2010) 366-370.
[3] Y.S. Kim, JS. Kim *et al.,* Inhal. Toxicol. 20(6) (2008) 575-583.
[4] L. Pineda, A. Chwalibog *et al.,* Arch. Anim. Nutr. 66(5) (2012) 416-429.
[5] P.L. Nadworny, J.F. Wang *et al.,* J. Inflamm. 7(13) (2010) 1-20.
[6] E.J. Park, E. Bae *et al.,* Environ. Toxicol. Pharmacol. 30 (2) (2010) 162-168.