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Short Communication

Evaluation of silver residues accumulation in tissues of Broilers treated with nanosilver using MNSR (A Clinical Trial)

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ABSTRACT

Nanoparticles of silver were treaeted as clinical trials in some broiler farms for its disinfecting characters in 4 broiler farms during growing period. The nanosilver were used orally and inhalatory in amount of 2 -4 ppm and 40 ppm respectively. Some samples of Breast muscle, Femora muscle, Heart, Gizzard, Liver, Skin, Spleen, Lung, Kidney and Cloacal feces were collected randomly in slaughterhouse. The silver nanoparticles residues accumulation in samples were examined by miniature neutron source reactor (MNSR) with a high specificity and sensitivity in ppb levels. Regarding to the results the silver residues were detectable in all the samples (>131ppb), The average of residues in ppb level in examined samples were as $131_{(a)}$ for Spleens, $132_{(a)}$ for Gizzards, $144_{(a)}$ for Hearts, $147_{(a)}$ for Kidneys, $160_{(a)}$ for Lungs, $168_{(a)}$ (a)for Breast muscles, $172_{(a)}$ for Femora muscles, $185_{(a)}$ for Livers, $194_{(a)}$ for Skins and $557_{(b)}$ for cloacal Feces. Comparison of averages among treatments by ANOVA (Duncan) ($p<0.05$), showed that cloacal feces (557 ppb) has significant different with other treatments (different subscripted letter-b). Regarding to the results, nanosilver usages were limited just for surfaces of the farms by Iranian Veterinary Organization for public health opinions.

Keywords: Nanosilver , Broiler ,Evaluation ,Silver, Residues, ,MNSR

INTRODUCTION

The use of metallic silver as an antimicrobial agent has been recognized for a long time (Lansdown, 2006), several types of silver compounds including silver nitrate, silver zeolite and silver nanoparticles are used for a variety of antimicrobial purposes (Kim et al., 2007; Rai et al., 2009; Sarsar et al., 2014); Silver exhibits low toxicity in the human body, and a minimal risk is expected due to clinical exposure by inhalation, ingestion and dermal application (Rai et al., 2009). The silver ions and silver nanoparticles are used as an antimicrobial in a variety of industrial, healthcare and domestic applications (Maillard and Hartemann, 2013) such as water purifier, medical devices, and home disinfectants (Sarsar et al., 2014); They have a good antimicrobial efficacy against some bacteria, viruses and other eukaryotic microorganisms (Ping et al., 2007). Using nanoparticles in agriculture, animal breeding and biological cycles, cause probable entrance to the environment and foods, (Monteiro-Riviere and Tran, 2007). Regardless of the route of administration

of a particle into the body via ingestion or inhalation, they would transported to other organs of the body, such as the liver, kidneys, spleen, brain and could exert cytotoxic effects on the cells of these organs in vivo, (Hunt and Mehta, 2006). The inhaled nanoparticles are more dangerous, and pulmonary deposition fraction is depended on the aerodynamic diameter of the particle. This inhaled nanoparticles can deposit in airways of the conducting and respiratory zones of the lungs, and causes potential pulmonary toxicity due to free radicals and oxidant injury (Donaldson et al., 2005); The nanosized particles could accumulate in the tissues by sedimentation, inertial impaction and diffusion (or Brownian motion) (Lam et al., 2004). In current study regarding to the recommendation of producers (Nano Nasb company) the nanosilver (Nannocid®) have been used in broilers by oral administration and inhalation (Dastmalchi and Rahmanya, 2009) and the residues of nanosilver (Nannocid®) in different samples of treated broilers were evaluated using Miniature Neutron Source Reactor (MNSR) machine for public health opinions.

MATERIALS AND METHODS

Preparation of silver nanoparticles (nanocid). A water soluble form of colloidal brown silver nanoparticles called Nanocid® with an average nanoparticle size of 18 nm was used. This was a powder product of 4000 mg/L (stock solution) made by Nano Nasb Pars Company, Tehran, Iran for antimicrobial usage.

Broiler treatments(In clinical trial). A population of 86900 broiler chicks in 4 different farms were treated with nanosilver during growing period for 53 to 56 days. Nanosilver was used at 2 -4 ppm orally and 40 ppm as inhalant aerosols in treated birds.

Sample preparation. Sampling of edible and inedible organs in all 4 farms were done after slaughtering , so randomly 10 broilers from each farms were selected and about 0.500 to 0.600 gr of their organs included Spleen, Gizzard, Heart, Kidney, Lung, Breast muscle, Femur muscle, liver and skin were sampled, meanwhile some samples of pooled cloacal feces were collected. All samples were labeled, prepared and sealed in the special small nylons and put in the special capsules for entering the heart of MNSR machine.

Evaluation the nanosilver residues by MNSR. MNSR[1](miniature neutron source reactor) machine is a small and compact reactor which have been used in peaceful researching projects and works based on the irradiation a lots of neutrons to the samples for activating different isotopes of a wanted elements and can detect and evaluate the amounts of each elements regarding to amounts of its isotopes based on its half life in a high specificity and a high sensitivity (PPb). The capsulated samples were put in to the central core of MNSR by a pneumatic pomp and faced to the neutrons bombarding for making isotopes of examined elements.

Statestical test. The average of the nanosilver residues inter different treatments were analyzed statistically by ANOVA ($p<0.05$), (Duncan test). (Same letter shows non significant difference and different letter shows significant difference inter treatments).

RESULTS AND DISCUSSION

Regarding to results, the silver residues in ppb levels were detectable in all samples. Table 1 shows the average of silvers in different samples and ANOVA test results ($p<0.05$). Each cell in rows with same subscripted letter ($_a$), shows non significant difference. The average of silver residues in examined samples increasingly were as $131_{(a)}$ for Spleens, $132_{(a)}$ for Gizzards, $144_{(a)}$ for Hearts, $147_{(a)}$ for Kidneys, $160_{(a)}$ for Lungs, $168_{(a)}$ (a)for Breast muscles, $172_{(a)}$ for Femora muscles, $185_{(a)}$ for Livers, $194_{(a)}$ for Skins and

1- The MNSR is a small and compact research reactor which is tank-in-pool type, with highly enriched fuel (~ 90% U235). The tank is immersed in a large pool, and the core is, in turn, immersed in the tank. The maximum nominal power is ~ 30 kW, located in Iran nuclear power organization (Isfahan Laboratory of Precipitants).

$557_{(b)}$ for cloacal Feces in ppb level . Mean value comparison among treatments by ANOVA (Duncan) ($p<0.05$), showed that cloacal feces (557 ppb)$_{(b)}$ had significant different with other treatments. Regarding to the results, accumulation of silver were happened in all examined organs and feces of the treated birds, the most accumulation of residues were detected in the skins (194 ppb) $_{(a)}$ and the less amount were detected in the spleen(131 ppb)$_{(a)}$ as non significant, but the residues in the cloacal feces showed significant different (557 ppb)$_{(b)}$. The most amounts of nanosilver residues in treated broiler tissues were detected in the skin, which received some nanosilver via direct external contamination and received some nanosilver via blood circulation internally, (Brunekreef and Holgate, 2002; Donaldson et al., 2005; Rai et al., 2009). A high concentration of nanosilver in liver (185 ppb) $_{(a)}$ means that nanosilver like the other toxins could detoxify in the liver and excrete trough bile. Silver residues deposition also detected in the kidneys and may proposed that nano particles of silver could be filtered by the kidneys and excreted via urine. Detection of different amounts of nanosilver in edible organs included the muscles of breast, femur ,heart and gizzard suggest that these poultry organs transport nano particles of silver to consumer which is not permitted by FDA –no any nano particle should be in diet (Monteiro-Riviere and Tran, 2007). The nanoparticles in the gastrointestinal tract can be absorbed and transmitted to the other organs of the body such as the liver, kidneys, spleen and others, and shows some cytotoxic effects in cultured cells, also they could exert toxic effects on the cells of these organs in vivo (Hunt and Mehta, 2006). Mild hepatotoxic effects of nanosilver wound dressing in wistar rate would emphasize the necessity of more studies on toxicity potentials of nanosilver application (Bidgoli et al., 2013). There are two suggestion for toxicity of nanoparticles involve their high surface area and the ability to generate reactive species and cause oxidant injury (Brunekreef and Holgate, 2002; Donaldson et al., 2005). This damage can be manifested in different ways, including genotoxicity (Rahman et al., 2002) and altered rates of cell death, including apoptosis (Rahman et al., 2002; Uchino et al., 2002; Kim et al., 2007). Lam et al. (2004) instilled nanotubes into the tracheas of mice and found resulting pathological changes persisting up to 90 days post exposure. Oberdorster (2004) has demonstrated the effects of buckminsterfullerene in causing oxidative stress in fish. It has been hypothesized (Monteiro-Riviere and Tran, 2007), that the chronic inhalation of particles can set up a low-grade inflammatory process that can damage the lining of the blood vessels, leading to arterial disease. Regarding to this study and probable accumulation of nanosilver residues in the different parts of broiler meat and transmission of nanosilver to human, the Iranian Veterinary Organization has limited the nanosilver (Nanocid®) usage in all poultry and cattle farms except for the disinfecting the surface of the farms in the absent of the animals.

Table 1. The mean value amounts of nanosilver residues accumulation in different samples of treated broilers with Nanocid and ANOVA test results ($p<0.05$).

Treatments	Breast Mus.	Femora Mus.	Heart Mus.	Gizzard Mus.	Liver Tissue	Skin Tissue	Spleen	Kidney Tissue	Lung Tissue	Cloacal Feces
Mean value of Silver residues (ppb)	168a	172a	144a	132a	185a	194a	131a	147a	160a	557b
Statistics Analysis 1%	a	a	a	a	a	a	a	a	a	b

(Each cell in rows with same subscripted letters ,means non significant differenc,($p>0.05$)).

Ethics

I hereby declare all ethical standards have been respected in preparation of the article.

Conflict of Interest

Hereby, I declare "no conflict of interest exists" regarding submitted article.

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References

Bidgoli, S.A., Mahdavi, M., Rezayat, S.M., Korani, M., Amani, A., Ziarati, P., 2013. Toxicity assessment of nanosilver wound dressing in Wistar rat. Acta medica Iranica 51, 203-208.

Brunekreef, B., Holgate, S.T., 2002. Air pollution and health. Lancet 360, 1233-1242.

Dastmalchi, F., Rahmanya, J., 2009. The inhibitory effect of silver nanoparticles on the bacterial fish pathogens, and Streptococcus iniae Lactococcus garvieae Yersinia ruckeri Aeromonas hydrophila. Int J Vet Res 3, 137-142.

Donaldson, K., Tran, L., Jimenez, L.A., Duffin, R., Newby, D.E., Mills, N., MacNee, W., Stone, V., 2005. Combustion-derived nanoparticles: a review of their toxicology following inhalation exposure. Part Fibre Toxicol 2, 10.

Hunt, G., Mehta, M.D., 2006. Nanotechnology: Risk, Ethics and Law, Earthscan.

Kim, J.S., Kuk, E., Yu, K.N., Kim, J.H., Park, S.J., Lee, H.J., et al., 2007. Antimicrobial effects of silver nanoparticles. Nanomedicine : Nnanotech, Biol, Med 3, 95-101.

Lam, C.W., James, J.T., McCluskey, R., Hunter, R.L., 2004. Pulmonary toxicity of single-wall carbon nanotubes in mice 7 and 90 days after intratracheal instillation. Toxicological sciences: J Toxicol 77, 126-134.

Lansdown, A.B., 2006. Silver in health care: antimicrobial effects and safety in use. Curr Probl Dermatol 33, 17-34.

Maillard, J.Y., Hartemann, P., 2013. Silver as an antimicrobial: facts and gaps in knowledge. Crit Rev Microbiol 39, 373-383.

Monteiro-Riviere, N.A., Tran, C.L., 2007. Nanotoxicology: Characterization, Dosing and Health Effects, CRC Press.

Oberdorster, E., 2004. Manufactured nanomaterials (fullerenes, C60) induce oxidative stress in the brain of juvenile largemouth bass. Environ Health Pers 112, 1058-1062.

Ping, G., Huimin, L., Xiaoxiao, H., Kemin, W., Jianbing, H., Weihong, T., Shouchun, Z., Xiaohai, Y., 2007. Preparation and antibacterial activity of Fe_3O_4, Ag nanoparticles. Nanotechnology 18, 285604.

Rahman, Q., Lohani, M., Dopp, E., Pemsel, H., Jonas, L., Weiss, D.G., Schiffmann, D., 2002. Evidence that ultrafine titanium dioxide induces micronuclei and apoptosis in Syrian hamster embryo fibroblasts. Environ Health Pers 110, 797-800.

Rai, M., Yadav, A., Gade, A., 2009. Silver nanoparticles as a new generation of antimicrobials. Biotechnol Adv 27, 76-83.

Sarsar, V.K., K., S., M., K.S., 2014. Nanosilver: Potent antimicrobial agent and its biosynthesis. Afr J Biotech 13, 546-554.

Uchino, T., Tokunaga, H., Ando, M., Utsumi, H., 2002. Quantitative determination of OH radical generation and its cytotoxicity induced by TiO(2)-UVA treatment. Toxicol in vitro 16, 629-635.

Bidgoli, S.A., Mahdavi, M., Rezayat, S.M., Korani, M., Amani, A., Ziarati, P., 2013. Toxicity assessment of nanosilver wound dressing in Wistar rat. Acta Med Iran 51, 203-208.

Brunekreef, B., Holgate, S.T., 2002. Air pollution and health. Lancet 360, 1233-1242.

Dastmalchi, F., Rahmanya, J., 2009. The inhibitory effect of silver nanoparticles on the bacterial fish pathogens, and Streptococcus iniae Lactococcus garvieae Yersinia ruckeri Aeromonas hydrophila. Int J Vet Res 3, 137-142.

Donaldson, K., Tran, L., Jimenez, L.A., Duffin, R., Newby, D.E., Mills, N., MacNee, W., Stone, V., 2005. Combustion-derived nanoparticles: a review of their toxicology following inhalation exposure. Part Fibre Toxicol 2, 10.

Hunt, G., Mehta, M.D., 2006. Nanotechnology: Risk, Ethics and Law, Earthscan.

Kim, J.S., Kuk, E., Yu, K.N., Kim, J.H., Park, S.J., Lee, H.J., Kim, S.H., Park, Y.K., Park, Y.H., Hwang, C.Y., Kim, Y.K., Lee, Y.S., Jeong, D.H., Cho, M.H., 2007. Antimicrobial effects of silver nanoparticles. Nanomedicine 3, 95-101.

Lam, C.W., James, J.T., McCluskey, R., Hunter, R.L., 2004. Pulmonary toxicity of single-wall carbon nanotubes in mice 7 and 90 days after intratracheal instillation. Toxicol Sci 77, 126-134.

Lansdown, A.B., 2006. Silver in health care: antimicrobial effects and safety in use. Curr Probl Dermatol 33, 17-34.

Maillard, J.Y., Hartemann, P., 2013. Silver as an antimicrobial: facts and gaps in knowledge. Crit Rev Microbiol 39, 373-383.

Monteiro-Riviere, N.A., Tran, C.L., 2007. Nanotoxicology: Characterization, Dosing and Health Effects, CRC Press.

Oberdorster, E., 2004. Manufactured nanomaterials (fullerenes, C60) induce oxidative stress in the brain of juvenile largemouth bass. Environ Health Perspect 112, 1058-1062.

Ping, G., Huimin, L., Xiaoxiao, H., Kemin, W., Jianbing, H., Weihong, T., Shouchun, Z., Xiaohai, Y., 2007. Preparation and antibacterial activity of Fe 3 O 4 @Ag nanoparticles. Nanotechnology 18, 285604.

Rahman, Q., Lohani, M., Dopp, E., Pemsel, H., Jonas, L., Weiss, D.G., Schiffmann, D., 2002. Evidence that ultrafine titanium dioxide induces micronuclei and apoptosis in Syrian hamster embryo fibroblasts. Environ Health Perspect 110, 797-800.

Rai, M., Yadav, A., Gade, A., 2009. Silver nanoparticles as a new generation of antimicrobials. Biotechnol Adv 27, 76-83.

Sarsar , V.K., K., S., M., K.S., 2014. Nanosilver: Potent antimicrobial agent and its biosynthesis. Afr J Biotech 13, 546-554.

Uchino, T., Tokunaga, H., Ando, M., Utsumi, H., 2002. Quantitative determination of OH radical generation and its cytotoxicity induced by TiO(2)-UVA treatment. Toxicol In Vitro 16, 629-635.