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Research Article

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The effects of titanium dioxide nanoparticle on blood proteins in mice

Yoosefi Mahdieh[1], Eslami Mohammad[2], Bahonar Mohammad Sajad[2], Dareshouri Hossein[2], Shariat Sajad[2], Faruqui Sana Sanam[2] and Mehrdad Modaresi[3*]

[1]*Department of Basic Sciences, Faculty of Veterinary Medicine, Ferdowsi University of Mashhad, Iran*
[2]*Research Center of Ostad-Taaher, Department of education and training, Shahreza, Iran*
[3]*Department of Animal Science, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran*

ABSTRACT

Titanium dioxide is a metal oxide which is widely used in everyday life. This material is a white powder with three crystalline phases of anatase, rutile and brookite. The powder is used as white pigment in industry. Two important properties of the material that make it very useful in life are photocatalytic and super hydrophilicity properties. These are used in water and sewage filtration, elimination of air and buildings pollutions, acceleration of photochemical reactions such as hydrogen production, manufacturing anti fog surfaces and layers and self-cleaning glasses. Forty mature mice from Wistar race were selected and divided in four groups. Control group, placebo received only standard food and water whereas experimental groups received 10 and 100 ppm of titanium dioxide in water also. After 14 days, blood samples were taken and blood proteins were measured. Results showed that albumin, alpha 1, alpha 2 and beta and gamma were increased in all groups. Therefore, this nanoparticle can increase blood proteins in the long run and affect overall health by inducing physiological changes.

Keywords: titanium dioxide, nanoparticle, Syrian mice, blood proteins

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INTRODUCTION

Late studies show that many human needs including pharmaceutical, health and agricultural requirements can be met by using various nanoparticles and nanoscience. One nanoparticle which is widely used in human life and is rarely known is titaniumdioxide [1].

This material is a white powder with three crystalline phases of anatase, rutile and brookite. The powder is used as white pigment in industry. Two important properties of the material that make it very useful in life are photocatalytic and superhydrophilicity properties [2]. These properties are described below:

1- photocatalytic property: the material in contact with pollutant molecules of water, soil and air -which are generally organic carbon molecules-breaks them to nonorganic material such as carbon dioxide, water and harmless mineral anions.
2- Super hydrophilic property: this trait which is tightly related to previous property causes self-cleaning phenomenon. Therefore, glass, tiles or dishes surfaces are covered by thin layers of this material to prevent them from getting dirty [3].

Main blood proteins are albumin, globulins such as immunoglobulin, and fibrinogen. Albumin is generally refers to a group of water soluble proteins [4]. This protein is one of the most important plasma proteins of human in terms of function and amount which is not glycosylated. Albumin concentration in human blood is about 303-502 g/dl which can be doubled in case of requirement. The amount of daily synthesis of albumin is almost 140g. It is made in liver with a production rate of 15 g/day. Half-life of albumin in body is 20 days which is demolished and replaced daily by nearly 4% [5].

Albumin in the human body performs the following tasks: fixing the oncotic pressure, transporting thyroid hormones, transporting free fatty acids, transporting non-conjugated bilirubin, Circulation of drugs in the blood, and adjusting the pH of blood [4].

Globulin is a group of cyclic proteins which are heavier and more soluble in water than albumins. Some of globulins are produced in liver and some in immune system in response to antigen presence [5].

Globulins are circulated in blood or act in production place. They are divided in four groups:
1-alpha-1 globulins: alpha (1)-antichymotrypsin, alpha(1)-antitrypsin, trans Cortin
2-alpha-2 globulins: ceruloplasmin, retinol binding protein, and haptoglobin
3-beta –globulins: plasmin, transferrin, β-2 microglobulin, angiostatin, and hemopexin
4-Gamma globulin which are antibodies.

This research was carried out to study the effects of titanium dioxide nanoparticles on blood proteins in mice.

EXPERIMENTAL SECTION

Forty mature male Syrian mice from Wistar race were selected from the age of 4-5 months and weight of 25-30 g. Mice were kept in 25℃ temreture and 25% to 30% humidity, for one week to adapt to environment. After seven days mice were divided in three groups:

Control group, placebo group received only standard food and water whereas experimental groups received 10 and 100 ppm of titanium dioxide in water also.

Blood sample were taken directly from the heart. Blood was poured in test tube impregnated with the anticoagulant heparin and desired parameters were measured. Obtained data were analyzed to determine the effects of titanium dioxide on blood proteins.

Obtained data were analyzed using one way ANOVA at 5% probability level, and using SPSS13 program.

RESULTS AND DISCUSSION

Albumin amount,alpha-1, alpha-2 and beta –globulins were increased significantly by experimental groups ($p<0.05$).

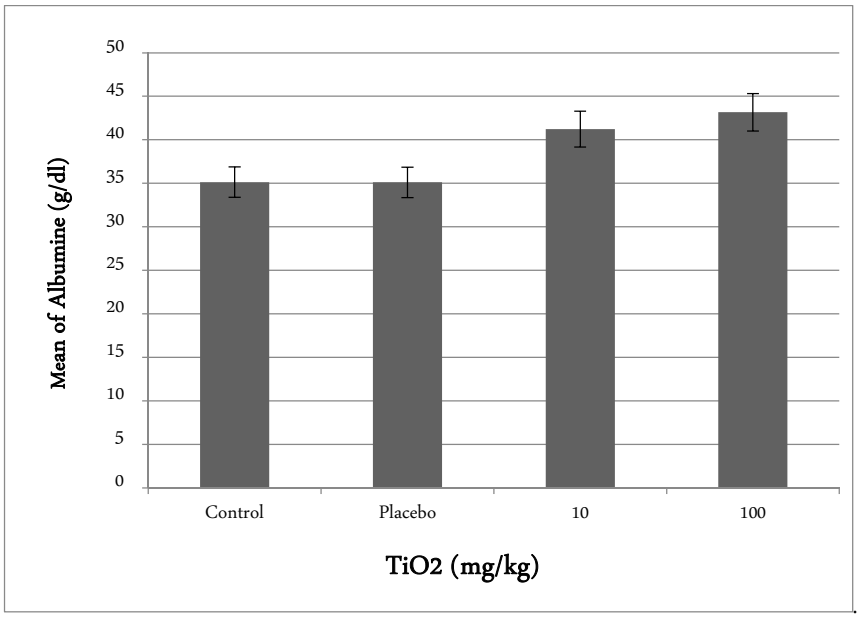

Figure1. Mean comparison of serum albumin in all groups

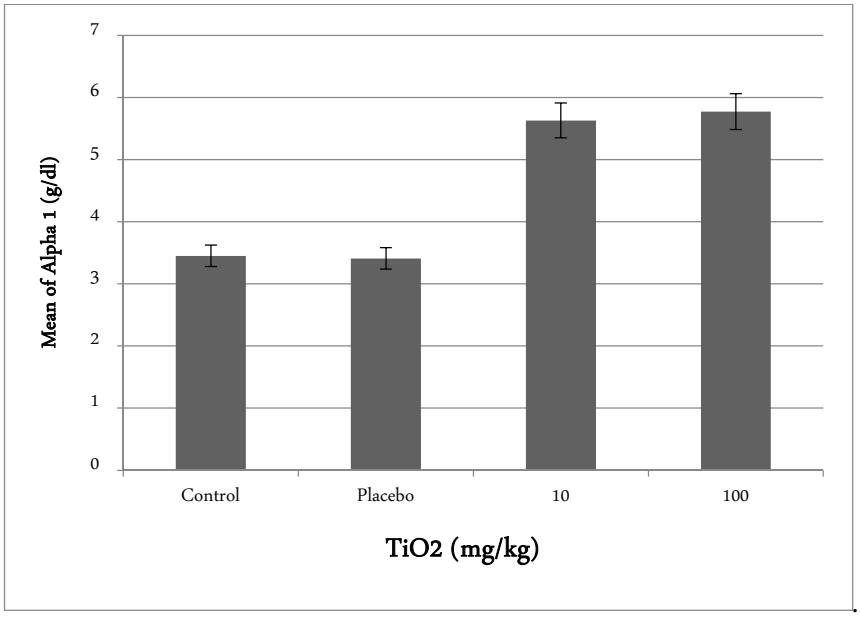

Figure 2. Mean comparison of alpha-1concentration in all groups

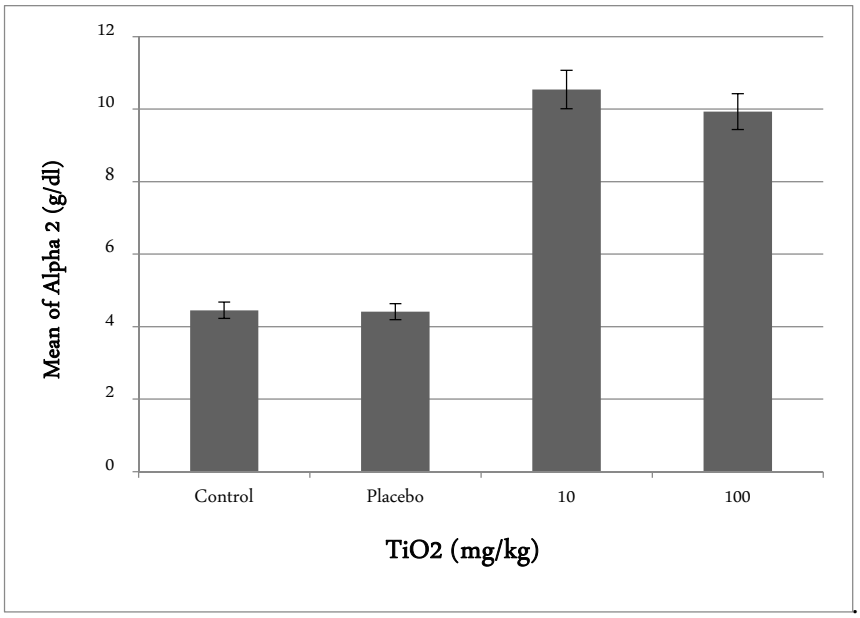

Figure 3. Mean comparison of alpha-2 concentration in all groups

According to results, albumin was increased by treatments. Albumin synthesis is reduced in various diseases especially liver diseases. Considering the positive effect of 10 and 100 doses of titanium dioxide on increasing albumin amount, using this nanoparticle is proposed in lever diseases [4].

Serum level of alpha-1 and alpha-2 in experimental groups were different from control group significantly ($p<0.05$). Main proteinsofalpha-2 globulin band are alpha-2- macroglobulinand haptoglobulin [5].

Haptoglobulin is involved in the absorption of free hemoglobin and inhibits hemoglobin and other iron excretion through the urine.

In nephrotic syndrome, with the loss of other small proteins, alpha-2-macroglobulin is increased tenfold or more. In this disease, proteins with low weigh are filtered and appear in urine and albumin decrease plus increase in alpha-1 globulin and alpha-2-macro globulin are observed[6].

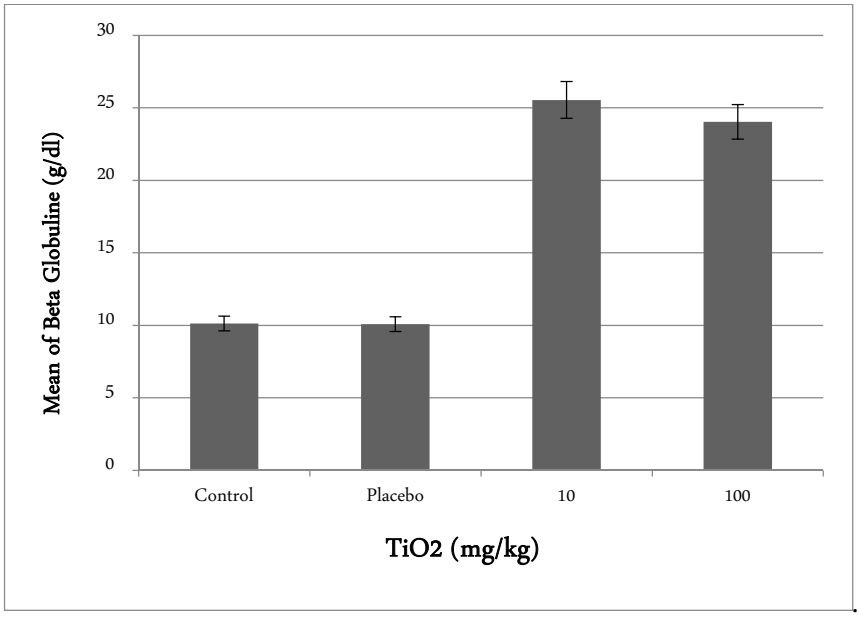

Figure 4. Mean comparison of beta concentration in all groups

Possibly, increasing amounts of titanium dioxide has created a change in glomerular capillary permeability. Also, increase in serum globulin levels in experimental group show increase in immune globulin products [7, 8].

The amount of beta-globulin in titanium dioxide groups were increased significantly in proportion to control group ($P<0.05$). Transferrin and hemopexinare from beta zone cells. Considering that transferrin is the most important component of beta zone, this protein transfers ferric ions from inter cellular reservoirs or mucosal ferritin to bone marrow. mRNA transcription adjustment in liver (where it is produced) is carried out commensurate with the amount of iron in the blood and iron in the hepatocytes side[9].

CONCLUSION

Increase in globulin synthesis shows that titanium dioxide can strengthen immune system without antigenic stimulation. On the other hand, increase in serum globulins in this study indicates increasing effect of this material on activity of immune system of Syrian mice. Also, increase in albumin synthesis could be considered a sign of changes in liver cells.

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