



Research Article

Effect of zinc and copper nanoparticles on the level of hepcidin, erythropoietin and ferritin in the shami goats kids

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Abstract

The experiment for this study was carried out in the fields of the Agricultural research office - Ruminant Research Department (Aqar Quf) of the Iraqi Ministry of Agriculture from February 14, 2021, to February 14, 2022, with the goal of studying the effect of zinc and copper nanoparticles on the physiological performance of the female kids of Shami goats by analyzing a number of physiological performance indicators, including hepatocyte hormone (Hepcidin), Kidney hormone (Erythropoietin) and Ferritin.

Keywords: Zinc nanoparticles, Copper nanoparticles, Hepcidin and Erythropoietin

Introduction

With the progress and development of various sciences at all levels and fields, the modern era can be considered the era of nanotechnology in order to employ nanoparticles in various forms in many fields such as medicine, engineering and environmental technology (Bayda et al., 2019), and nanomaterials have been used in the fields of Molecular Biology, Biology, Mineral nutrition, Reproductive Physiology, and Pharmacology (Swain et al., 2016 ; Giljohann et al. 2020 and Stueber et al. 2021) indicated that nanomaterials can play an important role in improving the chemical and physical composition of compounds as well as their biological activity when converted into nanoparticles, and it was indicated that each method has its advantages and disadvantages. Taking into consideration all the most useful chemical methods by which nano-sized homogeneous particles can be produced (Swain et al., 2016). ZnONps and CuONps nanoparticles are one of several compounds currently registered and recognized as safe by the World Health Organization when used according to the instructions and recommended doses (Abdelbaky et al., 2022).

Materials and Methods

Animals and experiment transactions

The fields at the General Authority for Agricultural Research furnished the 20 Shami goat youngsters utilized in this experiment, ranging in age from 3 months to 4 months and in weight from 17 kg to 25 kg, with an average of 22.49 kg. All of the animals were split up into four groups: 1st control and the 2nd were dosed with 70 mg of zinc nano/week, 3rd was dosed with 70 mg nanocopper/week while 4th was dosed with a mixture of zinc and nanocopper 70 mg zinc and 70 mg copper/week.

US Research Nanomaterials, Inc.'s zinc and copper nanoparticles were purchased from Al-Bashir Scientific Office in Baghdad's Bab Al-Moadham., of American origin and supplied by Us Research Nanomaterials, Inc. According to the following specifications:

- Zinc oxide ZnO: CAS number 1314-13-2, 53 nm, MW=81.83 and Assay 99.5%.

Table 1: Effect of zinc and copper nanoparticles on Hepcidin, erythropoietin and ferritin

Traits	Physiological period	T1 Control	T2 ZnO	T3 CuO	T4 ZnO+CuO
Hepcidin ng/ml	Pre-puberty	33.20±3.44 a	18.40±1.28 ab	20.00±3.24 ab	14.20±2.31 b
	Pre-pregnancy	23.37±1.49 a	17.07±1.20 b	18.82±0.78 b	17.64±0.93 b
	Early-pregnancy	26.84±1.23 a	22.26±2.01 b	20.01±1.26 bc	16.01±0.66 c
	Late-pregnancy	27.44±1.93 a	23.68±1.27 ab	21.51±1.14 b	17.00±1.26 c
	Post-partum	21.48±1.25 a	18.58±0.95 ab	16.82±1.25 bc	14.16±0.98 c
Erythropoietin mU/ml	Pre-puberty	13.82±0.55 c	15.04±0.85 bc	16.32±0.21 b	20.10±0.71 a
	Pre-pregnancy	14.42±0.69 c	16.02±1.01 bc	17.22±0.56 ab	18.75±0.73 a
	Early-pregnancy	14.25±0.53 b	14.88±0.83 b	15.98±0.35 b	18.83±0.32 a
	Late-pregnancy	13.49±0.32 b	14.30±0.49 b	16.69±0.30 a	17.89±0.47 a
	Post-partum	13.86±0.71 b	13.34±0.75 b	16.81±0.44 a	18.00±0.60 a
Ferritin ng/ml	Pre-puberty	26.29±1.05 a	25.36±1.04 a	24.81±0.83 a	27.24±0.98 a
	Pre-pregnancy	23.80±0.37 a	24.20±0.66 a	24.20±0.66 a	25.40±0.60 a
	Early-pregnancy	24.40±0.74 a	24.60±0.87 a	24.40±0.50 a	23.20±0.96 a
	Late-pregnancy	24.70±0.70 a	24.20±0.58 a	23.20±0.86 a	22.00±0.70 a
	Post-partum	24.80±0.86 a	24.20±0.58 ab	23.40±0.92 ab	22.70±0.70 b

• Values are mean ± standard error.

• Copper oxide CuO: CAS number 1317-38-0, 50 nm, MW=79.55 and Assay 99.5%.

The dosing solution is prepared by dissolving 1gm of Xanthan gum in 100 ml of distilled water for the purpose of making a suspension that has the ability to carry substances as a colloidal solution. The following suspension solutions were prepared:

1. Suspension of nano-zinc 10 mg nano-zinc / ml, this was done by mixing 100 mg of nano-zinc in 1000 ml of the suspension solution (the animals of the second treatment were dosed 7 ml / week for the duration of the experiment)

2. Suspension of Nano copper 10 mg Nano copper / ml, this was done by mixing 100 mg of Nano copper in 1000 ml of suspension solution (the animals of the third treatment were dosed 7 ml / week for the duration of the experiment)

3. Suspension of the mixture (10 mg nano-zinc and 10 mg nano-copper)/ml, this was done by mixing 100 mg nano-zinc and 100 mg nano-copper in 1000 ml of the suspension solution (the fourth treatment animals were dosed 7 ml/week for a period of time). Experience)

The period research experiment for this study ran from February 14, 2021, to February 14, 2022, The experimental time period was divided to five physiological periods:

1. two months prior to the onset of puberty, beginning on February 14, 2021 (February 14 - April 14, 2021).

2. Prior to becoming pregnant, went through a period that lasted roughly 2.5 months (from April 15 to June 30, 2021).

3. Third trimester of pregnancy: Began 14 days after the release of the males (males released on July 1, 2021) and lasted for another 2.5 months (from July 15 to September 30, 2021).

4. During the fourth trimester, goats who became pregnant after October 1, 2022, but before they gave birth were considered to be in the "late pregnancy" category (November 28, 2021, the date of the birth of the first goat).

5. Postpartum: From the time goats had completed giving birth until February 14th, 2022, this period lasted (the end of the field experiment).

Blood collection

Blood samples were collected from the jugular vein after 12 hours of animal feeding, and by means of a 10 ml disposable syringe, and placed in clean, sterile, vacuumed glass tubes that contain Clot activator. Then the tubes were left for an hour under laboratory temperature and then stored at 4°C (refrigerator). The tubes were arranged in the refrigerator at an angle of 45° for 24 hours, after which they were placed in a centrifuge (3000 rpm) for 20 minutes to separate the blood serum. Below -20°C (frozen) until biochemical tests are performed.

Results and discussion

The results in [Table \(1\)](#) on the effect of nano-zinc and nano-copper treatment on the level of Hcpidin hormone in the blood serum of Shami goats indicated a significant decrease (P0.05) in the fourth treatment animals compared to the control group, while it did not differ from the second and third treatments during the stage before puberty, and it is also noted in the same [Table \(1\)](#) that there was a significant decrease (P0.05) for this trait in the second, third, and fourth treatments during the stage before puberty. In terms of the late pregnancy stage, the results showed a significant decrease (P 0.05) in the level of Hcpidin hormone in the second, third, and fourth treatments when compared to the control group, while the third treatment did not differ significantly from the control group during the late pregnancy stage and after birth. It is possible that the treatment with zinc and copper nanoparticles improved the condition of the hepatocytes ([Ognik et al. 2019](#) ; [Boey and Ho 2020](#)), resulting in a decrease in stress levels ([Wang et. al 2016](#)). Also, the use of zinc NPs and copper NPs had an effect on the hormone Erythropoietin, according to statistical analysis of the means ([Table 1](#)). For the pre-puberty stage, the fourth group was significantly (P 0.05) superior to the treatments, and the third group was significantly (P 0.05) superior to the control group. The results also showed that there was a significant (P 0.05) superiority for this trait in the blood of animals for the fourth treatment compared to the control treatment and the second treatment for the stage before pregnancy, and the third treatment was significantly superior (P 0.05) compared to the control group for the stage after pregnancy. When compared to the other treatments, it was significantly (P 0.05) superior to the fourth treatment during the early pregnancy stage. During the late pregnancy and postpartum stages, the third and fourth treatments were significantly (P 0.05) superior to the control group and the second treatment. This

could be due to the addition of zinc or copper, which are important in the production of hemoglobin in the blood ([Takahashi, 2022](#) ; [Sobierajska et. al 2022](#)), as well as the integrity of the tissues ([Kou, et. al 2021](#)), the decrease in the level of the hormone Hcpidin, and the maintenance of the level of serum enzymes that transport the amino group ([Hirota, 2021](#) ; [Zou et. al 2021](#)).

The statistical analysis of the effect of zinc and copper nanoparticles on ferritin protein levels revealed that there was no significant effect for the physiological stages prior to puberty, before pregnancy, early pregnancy, and late pregnancy ([Table 1](#)), while the fourth group decreased significantly (P0.05) compared to the control group during the postpartum period.

Conflict of Interest

The author hereby declares no conflict of interest.

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Ethical Considerations

The study was approved by the institutional ethical committee

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