Effects of wheat germ oil and zinc oxide nanoparticle dosage on renal function, liver enzymes and some antioxidant parameters in Awasi lambs.

Ra'ad F. Abdullah 1 , Abdul Khaliq Ahmed Al-Janabi 2
1Department of Animal Production, College of Agriculture ,Tikrit University, Iraq.
2Department of Animal Production, College of Agriculture, Tikrit University, Tikrit, Iraq.
*Corresponding author's email: raad.f.abd001@tu.edu.iq

Abstract
This study was conducted in the animal field of the Department of Animal Production/ Faculty of Agriculture / University of Tikrit , to study the effect of adding wheat germ oil (WGO) individually or in combination with zinc nano-oxide (ZNON) on some indicators of kidney function, liver enzymes and oxidation and their antioxidants in the Awassi lambs, as 20 casual loads were used, ranging in age from 3 to 4 months, with a weight of 20.96 ± 0.23 kg. The animals were randomly distributed to five treatments the first treatment was dosed with distilled water, the second and third treatments were dosed with wheat germinal oil (WGO) (5 and 10 mg/kg live weight) respectively, while the fourth and fifth treatments were dosed with a mixture of wheat germ oil (WGO) and zinc nano-oxide (ZNONON) (5 mg/kg live weight (WGO) + 50 mg/ kg feed (ZON) and 10 mg/ kg live weight (WGO) + 50 mg/kg feed (ZNON) respectively .
Kidney function indicators The results showed a clear and significant improvement (P≥0.05) during a decrease in the Data values of urea and creatine in animals treated with a mixture of wheat germ oil + zinc monoxide (T4 and T5) If compared with the measurement group. The results of the statistical analysis showed an Effective decrease (P□0.05) in the Data values of the enzyme transporting the amine group Alt in the fifth and fourth treatments. The Data values of the AST enzyme also witnessed a prominent decrease (P□0.05) It's Data values in the blood serum of the treated animals compared to the control group after 90 days of treatment. While there was a significant increase (P□0.05) in the Data values of Clutathione in the blood serum of the fourth treatment animals compared to the T1 and T2 treatments after 90 Days of continuous dosing, and in return, the Malone Data values di-Aldehyde recorded a Values have declined dramatically(P□0.05) in the treated animals T3,T4 and T5 compared to the control group and the T2 treatment after 45 and 90 days of treatment.

Keywords: wheat germ oil, zinc oxide nanoparticles, liver and kidney function indicators, antioxidants lambs .

Introduction

Natural materials and compounds currently used in scientific research, medicines and medical additives are safe to use and contain many effective compounds. These materials include natural oils of different types and quantities. One of the high-quality oils is wheat germ oil. When examining the composition of wheat germ oil, it was found that it does not contain starch, contains a large number of minerals in different proportions, and most importantly contains important vitamins such as vitamin E, which can reach 500 parts per million (ppm) (1). It mainly contains phytosterols and tocopherols (2). It also contains unsaturated fatty acids in different data values, of which about 80% are linoleic acid and linolenic acid. The consumption of these fatty acids is important for humans and animals because they provide a source of energy and produce important fats during the milk production process in dairy animals and have anti-inflammatory properties (3). Wheat germ oil is linked to the body's biological activity such as lowering the Data

ISSN 2072-3857

values of cholesterol in the liver, plasma and blood, delaying aging and protecting cellular membranes by preserving unsaturated fatty acids from oxidizing agents such as peroxidase. The mineral elements are found in very small quantities in the tissues of living organisms, and they are obtained from various food sources or through mineral supplements. The most important of these elements are iodine, copper, zinc, selenium, chromium, cobalt, iron and molybdenum. These elements work to maintain public health and enhance immunity, growth, production, reproduction and various biological processes within cells, especially the work of enzymes (4). Zinc is one of the most important and rare essential mineral elements in the body of the organism and necessary for the biological and metabolic activity of more than 300 enzymes effective and important for the function of protein synthesis and the preservation of nucleic acids and the immune system (5). It also affects the mechanism of action of antioxidants in the body, especially antioxidants that affect the cell membrane. Once there is a decrease in zinc, there is an increase in harmful fatty oxidation that causes an increase in oxidizing agents (6). The use of wheat germ oil in previous studies was limited to cosmetics and medical uses, especially complementary medicine. It is also noted that its use in the Data values of research was on laboratory animals such as mice, rats and rabbits. Therefore, this study aimed to find out its impact on the peripatetic lambs individually or with zinc oxide nanoparticles on some indicators of kidney function, liver enzymes and antioxidants..

Materials and methods

In the experiment, 20 howling lambs were used between the ages of 3-4 months with an average weight of 20.96 ± 0.23 kg. The animals were divided into five treatments (4 animals per treatment). The first treatment included: control treatment. Treatment 2 : The animals were dosed with 5 mg/kg live weight of wheat germ oil (wgo) .Treatment 3: The animals were dosed with 10 mg / kg live weight of wheat germ oil. Treatment 4 : The animals were dosed with 5 mg/kg live weight of wheat germ oil and 50 mg / kg feed of nano-zinc oxide (NZNO) Treatment 5 The animals were dosed with 10 mg/kg live weight of wheat germ oil and 50 mg / kg feed of nano-zinc oxide (NZNO.(

The experiment animals were subjected to an introductory period of (14 days) during which the animals were taken care of health before the start of the experiment to protect them from possible pathological infections. The animals were fed a concentrated leech (Erbil Feed Company) as in Table (1) collectively for each transaction separately and at a rate of 3% of the Weight for each sample and served as a morning and evening meal . The amount of fodder is adjusted every two weeks in the light of weight changes with the availability of coarse fodder (hay) freely. Clean water was provided in a barn for each group. Cubes of mineral salts were placed inside each barn for all groups. Blood samples were collected regularly every forty-five days at 7:30 a.m. after the animals had been cut off from the feed for 12 hours, From a vein in the neck area (jugular) using a special(10 ml) syringe into clean, sterile plastic wine tubes .

Table 1. The chemical composition of the experimental leech

Chemical composition of the feed provided	
Percentage of dry matter	5.13
Humidity	11.70
Ether Extract	2.2
Raw Fiber	6.73
Total Protein	17.57
the energy	2770

ISSN 2072-3857

Zinc oxide nanoparticle processing

The US-origin nano-zinc oxide produced by US Research Nanomaterials, Inc. was prepared and purchased. The nano-zinc oxide used in the study is characterized by the following specifications: Nanoparticle (zno) purity: 99% , APS : 50nm Nanoparticle (zno (.

Wheat Germ Oil

Pre-prepared wheat germ oil was used, which was based on the method of preparing wheat germ (cold pressing) by moistening wheat seeds for 5-7 days (the growing period) and adding a little vegetable oil (corn oil or sunflower oil) to moisturize the embryo to facilitate its squeezing. After several days, the added oil is disposed of by filtering to squeeze the soaked wheat germ with special machines that operate under cold hydraulic pressure and collect and fill the oil .

Blood tests

Blood serum biochemical assays involving urea, creatinine and AST transaminases were performed by Automatic Assay (ALT) using a Spin 120 device manufactured by the Spanish spinreact company. As for antioxidants, the Data values of serum clotathione (GSH) were estimated using the modified method of the Ellmans German reagent (7). To estimate the MDA Data values in serum, he used the modified indirect method followed by Guidet and Shah (1989) (8.(

Statistical

Statistical analysis was conducted using the complete randomize design (CRD) one-way, and the significance test of the differences between coefficients was used Duncan's multi-range test, and the electronic statistical analysis program SAS was used. (2012) to analyze data according to the following mathematical model:

$Yij = \mu + Ti + eij$

Results and discussion

Effect of treatment with wheat germ oil and zinc nanoparticles on urea, and Creatinine Data values in the blood of experimental lambs.

The results shown in Table (2) showed that there was no significant difference at the Data values ($P \geq 0.05$) By comparison between animals treated with wheat germ oil, nano-zinc, and the control group in the Kidney function indicators of urea and blood creatinine values 45 days after dosing. The treatment had a significant impact on the Data values of serum urea after 90 days of treatment. The animals of the fourth and fifth With the recorded treatment, the values decreased significantly ($P \geq 0.05$)in the value of this trait compared to the control group, while it did not differ morally from the second and third treatment. As for the creatinine Data values, it witnessed Values declined dramatically ($p \geq 0.05$)in its Data values in the serum of the fourth treatment animals compared to the control group, while it did not differ morally from the rest of the transactions during this period.

This improvement in kidney function may be due to the antioxidant effect of wheat germ oil, which may have affected the oxidation and reduction states of vital organs with high activity in the body due to its content of natural antioxidants such as polyphenols and tocopherols (9). The results of this study were consistent with what Belewu and Adewumi (2021) (10) found, which confirmed a Values have declined dramatically in the Data values of urea in the serum of zinc-treated goats at the Data values of 80 mg/kg feed for 56 days compared to the rest of the transactions. The same result was reached by Yusuf et al. (2023) (11), as he noticed Values have declined dramatically in the Data values of urea in the serum of zinc-treated goats at Data valuess of 300 and 600 mg/kg feed for 84 days, as measured by control .

ISSN 2072-3857

Table 2. Effect of treatment with wheat germ oil and zinc nanoparticles on kidney function in Awasi lambs (mean ± standard error. (

Treatments	Kidney function (mg / dL) Urea	Creatinine
After 45 days of transaction		
T1	54.05 ± 3.77	0.81 ± 0.70
T2	57.23 ± 0.68	0.31 ± 0.04
T3	57.93 ± 1.21	0.23 ± 0.09
T4	50.63 ± 4.54	0.18 ± 0.02
T5	51.75 ± 2.39	0.25 ± 0.06
Moral	N.S	N.S
After 90 days of transaction		
T1	58.90 ±0.53 a	0.58 ± 0.15 a
T2	55.15 ±0.76 ab	0.26 ± 0.13 ab
T3	55.30 ± 2.44 ab	0.29 ± 0.13 ab
T4	41.30 ± 0.84 c	0.11 ± 0.03 b
T5	53.88 ± 1.94 b	0.29 - 0.15
Moral	*	*

• :*Indicates significant differences between averages at a probability Data values ($p \leq 0.05$ (

• NS : indicates no significant differences between averages

T1 : Control treatment T2: Treatment with wheat germ oil at a By an amount of 5 mg/kg live weight T3: Treatment with wheat germ oil at a By an amount of 10 mg/kg live weight T4: Treatment with wheat germ oil at a By an amount of 5 mg / kg live weight and nano-zinc at a By an amount of 5 mg /kg feed T5: Treatment with wheat germ oil at a By an amount of 10 mg/kg live weight and nano-zinc.

Effect of treatment with wheat germ oil and zinc nanoparticles on serum enzymes in peripatetic lambs.

The results of the statistical analysis shown in Table (3) indicated that there was no significant effect of the treatment with wheat germ oil and nano-zinc in the an amount of the enzymatic transporter of the Ameen, AST and ALT group between the different transactions after the passage of 45 days of the treatment. While the Data values of AST enzyme witnessed a Values have declined dramatically($P \square 0.05$) in the blood serum of the fourth and fifth treatment animals compared to the third and first treatment, while it did not differ significantly from the second treatment after 90 days of treatment. In the same context, it is noted that the Data values of Alt enzyme also witnessed a Values have declined dramatically($P \square 0.05$) in its Data values in the blood serum of the fourth treatment animals followed by the second treatment and then the third and fifth treatment compared to the control group.

The moral decline that occurred in the Data values of the enzymatic transporter of the amine, AST and ALT group after 90 days of treatment may be due to the synergistic role of wheat germ oil and nano-zinc, as the oil has an antioxidant effect for its high content of vitamin E, as it is the richest among the natural sources in its content of this vitamin(12) (13) reported. There was an improvement in the oxidation and reduction indicators in male rats that suffer from oxidative damage in the liver tissue, as he noticed an improvement in the internal oxidation index such as GSH, SOD, and cat that led to inhibition of the stages of lipid peroxidation and gene expression of some of

its cofactors. On the other hand, he noticed an improvement in the Data values of liver enzymes AST and ALT . This improvement is consistent with the observed improvement in some indicators of oxidation and reduction. These assumptions are supported by the finding of Mehranjani et al. (2007) (14) of a significant increase in the Data values of vitamin E in the livers of animals treated with wheat germ oil, which gave them antioxidant strength in liver tissues

.

Table 3. Effect of treatment with wheat germ oil and zinc nanoparticles on liver function in Awasi lambs (mean ± standard error. (

Treatments	Liver Enzymes (U /L) Alt enzyme	AST enzyme
After 45 days of transaction		
T1	1.47 ± 27.00	10.5**6** ± 112.50
T2	1.91 ± 24.00	13.52 ± 91.00
T3	1.03 ± 27.25	3.18 ± 115.50
T4	2.66 ± 27.25	6.65 ± 99.50
T5	2.53 ± 27.50	0.95 ± 113.25
Moral	N.S	N.S
After 90 days of transaction		
T1	25.50 ± 2.63 a	2.89 ± 94.00 a
T2	0.87 ± 20.50 ab	7.04 ± 57.00 bc
T3	5.11 ± 24.00 a	2.89 ± 70.00 b
T4	1.68 ± 14.00 b	7.97 ± 43.25 c
T5	0.48 ± 12.75 b	9.94 ± 73.00 b
Moral	*	*

• :*Indicates significant differences between averages at a probability Data values (p≤0.05 (

• NS : indicates no significant differences between averages

T1 : Control treatment T2: Treatment with wheat germ oil at a By an amount of 5 mg/kg live weight T3: Treatment with wheat germ oil at a By an amount of 10 mg / kg live weight T4: Treatment with wheat germ oil at a By an amount of 5 mg / kg live weight and nano-zinc at a By an amount of 5 mg /kg feed T5: Treatment with wheat germ oil at a By an amount of 10 mg/kg live weight and zinc.

Effect of treatment with wheat germ oil and zinc nanoparticles on oxidation and its antioxidants in the blood serum of the hapless lambs

The results of the statistical analysis (Table 4) indicated that there were no significant differences (P≥0.05) in the Data values of Clutathione Glutathione in the serum of the sympathetic lambs treated with wheat germ oil and nano-zinc, although there was an increase in its Data values in the blood of the treated animals compared to the control group, but it did not rise to the Data values of significance. From the same table, it is noted that the Data values of Malondialdehyde recorded Values have declined dramatically in the serum of the third, fourth and fifth treatment animals compared to the control group and the second treatment after 45 days of treatment (Table 4) . To follow up the Data values of glutathione after 90 days of treatment, the results shown in Table(4) showed that there was a moral superiority in its Data values among the fourth treatment animals compared to the first and second transactions, while it did not differ morally from the third and fifth transactions. As for the Data values of Malondialdehyde, its Data values witnessed a moral decline among

ISSN 2072-3857

the lambs, the fourth transaction followed by the fifth transaction and then the third transaction compared to the first and second transactions. When the results of Table (4) are observed, we find that the treatment with wheat germ oil and nano-zinc led to an increase in the Data values of glutathione and a decrease in the Data values of dichloro aldehyde in treated animals. The reason for this improvement may be due to the effectiveness of wheat germ oil as an antioxidant due to its high content of vitamin E, as it is the richest among natural sources in its content of this vitamin (12) (13) pointed to an improvement in the oxidation and reduction indicators of male rats, which suffer from oxidative damage in the liver tissue, as he noticed an improvement in the internal oxidation index such as GSH, SODD and cat, which led to inhibition of the stages of lipid peroxidation and gene expression of some of its contributing factors

Table 4. Effect of treatment with wheat germ oil and zinc nanoparticles on oxidation and its antioxidants in the serum of the Awasi lambs" (mean ± standard error. (

Treatments	Oxidation and its antioxidants Glutathione (GSH) (µmol /ml)	Malone dialdehyde (MDA) (µmol /L)
After 45 days of transaction		
T1	1.34 ± 0.10	2.93 ± 0.37 a
T2	1.75 ± 0.27	2.67 ± 0.50 a
T3	2.31 ± 0.16	1.66 ± 0.20 b
T4	2.24 ± 0.83	0.77 ± 0.29 b
T5	2.65 ± 0.47	1.37 ± 0.10 b
Moral	N.S	*
After 90 days of transaction		
T1	1.57 ± 0.26 b	2.81 ± 0.38 a
T2	± 1.65 0.33 b	2.67 ± 29.0 a
T3	± 2.20 0.62 ab	1.74 ± 0.29 b
T4	± 3.27 0.43 a	± 0.56 0.16 c
T5	± 2.64 0.51 ab	0.93 ± 0.24 bc
Moral	*	*

• :*Indicates significant differences between averages at a probability Data values ($p \leq 0.05$ (

• NS : indicates no significant differences between averages

T1 : Control treatment T2: Treatment with wheat germ oil at a By an amount of 5 mg / kg live weight T3: Treatment with wheat germ oil at a By an amount of 10 mg / kg live weight T4: Treatment with wheat germ oil at a By an amount of 5 mg / kg live weight and nano-zinc at a By an amount of 5 mg /kg feed T5: Treatment with wheat germ oil at a By an amount of 10 mg / kg live weight and nano-zinc.

Another entity noted an improvement in the Data values of liver enzymes AST and ALT . This

improvement may be due to the role of zinc in its contribution to increasing the Data values of total antioxidants by stimulating it to increase the synthesis of the metallothionein protein, which can directly neutralize free radicals and protect cells from oxidative damage (15). Zinc also acts as an adjunct to

ISSN 2072-3857

antioxidants by protecting the sulfhydryl group (thiols) present in some proteins, such as enzymes that control phosphorylation processes and the path of oxidation and reduction signals. It binds to the sulfur donor (thiols) of the amino acid cysteine to form zinc thiols. Oxidizing substances can react with these thiols and release zinc in a free state. Zinc ion signals generate strong effects for many cellular processes as an antioxidant response against reactive oxygen species, and by reducing the formation of OHº of H2O2 through its opposition to the active transition metals for oxidation and reduction of iron and copper (16) (17). Zinc also qualitatively induces the production of antioxidant enzymes as the superoxide dismutase enzyme and acts as a cofactor to activate the enzyme clotathione peroxidase (18). or by stimulating gene expression to produce and activate the antioxidant and toxin-metallothionein protein in the liver and kidneys that is very rich in cysteine binding to transition minerals (19.(

This result was consistent with what Mohamed et al. (2017) (20) indicated that the treatment of ewes with nano-zinc 5 and 10 mg/kg feed in late pregnancy and the postpartum period until weaning the newborns, led to a significant increase in the Data values of clotathione in ewes and newborns compared to the control group. On the other hand, Song and Shen (2020)(21) indicated that there was Values have declined dramaticallyin the Data values of dialdehyde coloring in goats treated with zinc supplements 60 and 90 mg/kg dry matter for 30 days. The same result was reached by Kumar et al. (2013) (22), where there was a Values have declined dramatically in the Data values of fat oxidation in calves treated with zinc supplements 40 and 60 mg/kg feed for 90 days . In the same context, Manimaran et al. (2022) (23) explained that the addition of copper sulfate and zinc oxide to the goat's berry Osmanabadi to a By an amount of 100 mg / goat/day and 40 mg/goat/day, respectively, led to a moral rise in total antioxidants. The study conducted by Soufi et al. (2022)(24) showed a Values have declined dramaticallyin the Data values of di-aldehyde Malone in lambs treated with various sources of zinc and at a By an amount of 20 mg/ kg dry material for fodder for a period of 60 days compared to the control group. Mesgaran et al. (2022) (25) also reported a Values have declined dramatically in the Data values of MDA blood in milk cows treated with zinc supplements under thermal stress conditions during the transitional period compared to the control group. Yusuf et al. (2023) (11) confirmed that the treatment of goats with zinc at the Data values of 300 and 600 mg/kg feed for 84 days led to a Values have decline dramaticallyin the Data values of MDA in the serum of treated animals compared to control .

Conclusions

It was noted from the results of the study data about the effective role of wheat germ oil and zinc oxide nanoparticles on the function of renal cells by reducing free radicals, protecting hepatocytes, increasing the Data values of glutathione and reducing oxidizing agents.

References

[1]Brandolini, A., Hidalgo, A., Wheat germ: not only a by-product. Int. J. Food Sci. Nutr. 2012, 63, 71– 74.

[2]Eisenmenger, M., Dunford, N. T., Bioactive components of commercial and supercritical carbon dioxide processed wheat germ oil. J. Am. Soc. Chem. Soc. 2008, 85, 55– 61.

[3]Ozcan , M. M., A. Rosa, M.A. Dessi, B. Marongiu, A. Piras, F.Y.I. Al-Juhaimi. (2013). Quality of wheat germ oil obtained by cold pressing and supercritical carbon dioxide extraction. Czech J. Food Sci., 31(3), 236-240.

[4]Duffy , R. , b. Matthew Yin , E. Redding. (2023). A review of the impact of dietary zinc on livestock health. Journal of Trace Elements and Minerals 5 :100085.

[5]Naji , HA. (2017). The effect of zinc and copper deficiency on hematological parameters, oxidative stress and antioxidants

Data valuess in the sheep. Bas J Vet Res, 16 (2): 344-355.

[6]Yousef, M. I., El Hendy, H. A., El-Demerdash, F. M., & Elagamy, E. I. (2002). Dietary zinc deficiency induced-changes in the activity of enzymes and the levels of free radicals, lipids and protein electrophoretic behavior in growing rats. Toxicology, 175(1-3), 223-234.

[7]Al-Zamely, O. Y.,Al-Nimer, M. S., &Al-Muslih, R. K. (2001). Detection of the Data values of peroxynitrite and related antioxidant status in the serum of patients with acute myocardial infarction. Nation J. Chem, 4(1), 625-637.

[8]Guidet, B. and shah, S. (1989). The Data values of Malondialdehyde after activation with H2O2 and CuSO4 and inhibition by deferoxamine and Molsidomine in the serum of patients with acute Myocardial infarction. National journal of chemistry; 5:139-148.

[9]Abdou, H. M., Mohamed, N. A., El Mekkawy, D. A., & EL-Hengary, S. B. (2017). Vitamin E and/or wheat germ oil supplementation ameliorate oxidative stress induced by cadmium chloride in pregnant rats and their fetuses. Jordan Journal of Biological Sciences, 10(1), 39-48.

[10]Belewu, A., & Adewumi, D. (2021). Effect of green syntheses nano zinc oxide on performance characteristics and haematobiochemical profile of West African dwarf goats. Animal Research International, 18(1), 3938-3946.

[11]Yusuf, A. O., Adeyi, T. K., Oni, A. O., Owalabi, A. J., & Sowande, S. O. (2023). Nano zinc supplementation in ruminant's livestock, influence on physiological, immune functions and oxidative stability of West African dwarf goat bucks. Comparative Clinical Pathology, 32(4), 629-643.

[12]Ohkatsu Y, Kajiyama T, Arai Y. (2001). Antioxidant activities of tocopherols. Polym Degrad Stabil 72:303–11.

[13]Akool, E. S. (2015). Molecular mechanisms of the protective role of wheat germ oil against cyclosporin A-induced hepatotoxicity in rats. Pharmaceutical biology, 53(9), 1311-1317. https://doi.org/10.3109/13880209.2014.980584.

[14]Mehranjani MS, Abnosi MH, Mahmodi M. (2007). Preventing effects of wheat germ oil on sex hormones, liver enzymes, lipids and proteins in rat serum following treatment with pnonylphenol. J Biol Sci 7: 1408–11.

[15]Marreiro, D. D., Cruz, K. J., Morais, J. B., Beserra, J. B., Severo, J. S., & de Oliveira, A. R. (2017). Zinc and Oxidative Stress: Current Mechanisms. Antioxidants(Basel,Switzerland),6(2),24.https://doi.org/10.3390/antiox6020024.

[16]Lee, S.R. (2018). Critical Role of Zinc as Either an Antioxidant or a Prooxidant in Cellular Systems. Oxid. Med. Cell. Longev; 2018. https://doi.org/10.1155/2018/9156285.

[17]Maret, W. (2019). The Redox Biology of Redox-InertZinc Ions. Free Radic. Biol. Med.; 134, 311-326.

[18]Sacan , O. , I.B. Turkyilmaz, B.B. Bayrak ,O. Mutlu, N. Akev, R. Yanardag. (2021). Protective role of zinc in liver damage in experimental diabetes demonstrated via different biochemical parameters. Journal of Biochemical and Molecular Toxicology; 35(1), e22617.

[19]Thompson, M.W. (2022). Regulation of zinc dependent enzymes by metal carrier proteins. Biometals; 35,187–213. https://doi.org/ 10.1007/s10534-022-00373-w.

[20]Mohamed , A.H, M.Y. Mohamed , K. Ibrahim , F.T.E. Abd El Ghany , A.A.S. Mahgoup . (2017). Impact of Nano-Zinc Oxide Supplementation on Productive Performance and Some Biochemical Parameters of Ewes and offspring. Egyptian Journal of Sheep & Goat Sciences; 12(3): 49-64.

[21]Shen, X., Song, C., & Wu, T. (2021). Effects of nano-copper on antioxidant function in copper-deprived Guizhou black goats. Biological Trace Element Research, 199, 2201-2207.

[22]Kumar, G. S., & Krishna, A. G. (2013). Studies on the neutaceuticals composition of

wheat derived oils, wheat bran oil and wheat germ oil. NCBI, 1–7 J. Food Sci Technol.Feb; 52(2): 1145–1151.

[23]Manimaran, S., Kekan, P. M., Daware, S. B., & Wankar, A. K.(2022). Effect of Copper and Zinc Supplementation on Antioxidants and Biochemical Status of Osmanabadi Goats. Indian Journal of Animal Research, 1, 5.

[24]Soufi, B., Alijoo, Y.A., Khamisabadi, H., Khoobbakht, Z. (2022). The effect of inorganic, organic, and nano-zinc sources on growth performance, blood parameters, and antioxidant activity of Sanjabi lambs. J. of Ruminant Research; 9(4): 19-32 http://ejrr.gau.ac.ir.

[25]Mesgaran , M.D. ,H. Kargar ,R. Janssen ,S. D. Mesgaran .A. Ghesmati ,A. Vatankhah . (2022). Manipulating the Performance and Oxidative Responses of Dairy Cattle UnderLong-term Environmental Heat Stress Upon Zinc-MethionineComplex Dietary Inclusion. Research Square; https://doi.org/10.21203/rs.3.rs-1306298/v1.

ISSN 2072-3857