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Ameliorative effect of nano chromium on some hematological values and GLUT-2 in rabbits fed a high- Fat diet

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Abstract

Nano-chromium has an anabolic effect when used in low concentrations and boosts nucleic acid synthesis in the liver; it is also termed a glucose tolerance factor (GTF) because it regulates the ' 'insulin's metabolic action. It is used in the metabolism of carbohydrates, proteins, and fats. This study was carried out on 20 local white male rabbits (aged two months), which were randomly assigned into four groups: the first was a control group fed on a standard diet, the second was a group fed on a high-fatty diet (HFD), the third was a group fed on a standard diet which has was given Chromium at a concentration of 2 mg/L with drinking water, and the fourth was a group of nano chromium fed on a fatty diet who were given chromium 2 mg/ L of drinking water. The fatty diet group had higher levels of erythrocytes, leukocytes, Hb, hematocrit, lymphocytes, neutrophil, glucose, cholesterol, triglyceride, GLUT-2, insulin, and insulin resistance with a decrease in HDL. In comparison, the two groups of chromium nanoparticles showed lower levels of erythrocytes, leukocytes, Hb, hematocrit lymphocytes, neutrophil, glucose, cholesterol, triglyceride GLUT-2, insulin, and insulin resistance but higher levels of HDL. Our objective is to investigate the deleterious effects of the HFD on hematological values, GLUT-2 levels, and insulin levels, as well as the potential for nano-chromium to enhance these qualities.

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Introduction

Over several years, many materials have been used as feed additives in animal diets, including enzymesprobiotics, and organic acid (1,2). However, as a result of the rapid development in the field of animal production in recent years, nanoscale has gotten great attention within the scientific communities in many countries, where many of the companies specializing in the manufacture of new shapes of nanoscale resources that concern animal systems of manufacturing to boost production efficiency (3,4). The word nano is derived from the Latin phrase Nanos, which implies midget the sizes of nanoparticles range from 1-100nm (5,6). As a result of the special properties of nanoparticles represented by their small size, which allows them to pass easily through the walls of the alimentary canal and into the cells of the body faster than usual molecules with greater material sizes, enhancing biocompatibility thus, nanotechnology can be used to feed animals to provide better nutrients improving the immune status of animals and raising the efficiency of animal production (7-9). Nanotechnology also provides a wide field for veterinarians for treatment, diagnosis, tissue engineering, and the production of modern vaccines and disinfectants, as it can already be used in animal care, production, breeding, and reproduction (10). Nanocomposites are manufactured in different forms, including the production of metallic nanoparticles, as their production provides many advantages for the production of animal feed at a lower cost and lower concentrations to be used as potential alternatives to feed additives instead of antibiotics, they can also help in controlling the microbes sitting in the meal and regulating the digestion and absorption process (11). One of these minerals is nano-chromium, using nanocomposites as feed additives instead of large molecules reduces the excretion of minerals (12). Chromium is a compound with a small molecular weight and low toxicity that can increase insulin activity and slow the progression of diabetes (13,14). Cr is a crucial trace mineral required for most vital metabolic processes. It is used in the metabolism of carbohydrates, protein, and fats and has anabolic effects during animal exposure to various types of stress (15,16). Chromium is also an important micronutrient required for glucose metabolism, and its deficiency causes high blood sugar and insulin resistance (17-18). Chromium supplementation has been confirmed to enhance carbohydrate metabolism by potentiating and lowering insulin resistance signifiers, lipid variables, and blood insulin levels (19,20).

Our objective is to investigate the deleterious effects of the HFD on hematological values, GLUT-2 levels, and insulin levels, as well as the potential for nano-chromium to enhance these qualities.

Materials and methods

Ethical approve

The University of Mosul, College of Veterinary Medicine's Animal Care and Use Committee evaluated and approved each step of the experiment's protocols.

Rabbits and diets

In most developing countries, where animal protein supply is insufficient to fulfill the population's protein needs, rabbit offers much potential to assist meet these needs; this is because it has a clear edge over other animals, rabbits are known to reproduce swiftly and have the capacity to eat a variety of foods (21). This treatise was conducted in the experimenter animal house of the College of the Veterinary Medicine / University of Mosul; 20 male rabbits were used at the age of 2 months. The current study lasted for two months, during which the animals were fed standard and provided free feed and water. The nano-Cr powder was provided by 3302Twing Leaflane, Houston, TX77084, USA.

Experimental design

In this reserch, 20 male rabbits were used, which were divided random into four groups (5 rabbits/group) as follows; The control fed a standard diet (control), the group fed a high fatty diet (HFD), a group of nano-chromium fed on a standard ration with nano-Cr two mg/L with drinking water and a group of nano-chromium fed on a high fatty meal with nano-Cr 2 mg/ml with drinking water (HFD+Nano-Cr) (22).

Blood sample collection

Blood specimens were obtained across the marginal ear vein after the animals have fasted overnight, and the samples were split into two groups; the first was situated in heparinized tubes to conduct blood analyses, and the other section has been put in tubes without anticoagulants which were left to clot at room temperature and discarded in a centrifuge with a capacity of 3000 rpm to obtain serum, the samples were kept at -20°C until laboratory analyzes were carried out.

Studied standards

Blood samples containing anticoagulants were used to conduct hematological tests represented in the number of erythrocytes (RBC) and leukocyte(WBC), differential leukocyte count(DLC) hemoglobin (Hb),Hematocrit%, MCV, MCH and MCHC (23), while serum samples were used to measure glucose level using the ready-made analysis kit manufactured by (Randox Company) and the estimation of the level of cholesterol, triglycerides, high-density lipoproteins – cholesterol (HDL-C), using the ready-made kit manufactured by a French company (Biolabs) and calculating the atherogenic index in addition to estimating the level of glucose-2 transporter(GLUT-2) and insulin level in the blood serum using ELISA (24).

Statistical analysis

Statistical analysis of experimental data was carried out using a one-way analysis of variation, and distinctions among groups were determined using Duncan's test for all criteria covered in the study (25).

Results

It is noticed from the data obtained that there was a stastical rise ($P \leq 0.05$) in the No of erythrocytes, leukocytes, hemoglobin, and hematocrit for the group of fat diet compared with the control. The treatment with nano-Cr led to a decline in the blood parameters compared with the control, while the group of nano-Cr with the fatty diet showed a decrease in the above parameters compared with the fatty diet. The treatment with nano-Cr improved the negative effect of the fatty diet by restoring the hematological parameters to their normal level, which is close to the control (Table 1).

Giving the rabbit a fatty diet led to a significant rise in lymphocytes, neutrophils, and basophils, with a reduction in eosinophils and monocyte compared to the control. The chromium nanoscale group showed a decrease in lymphocytes and monocyte accompanied by an enhance decrease in lymphocytes and an enhance decrease in lymphocytes and an enhancement decrease in lymphocytes and monocyte accompanied by an enhancement in eosinophils in comparison to the control group, The addition of chromium nanoform to the fatty diet, led to a decline in lymphocytes and neutrophils with a rise in eosinophils and monocyte in comparison to the fatty diet group. The use of nano-Cr improved the unwanted effect of the fatty diet (Table 2).

The study indicates a significant reduction in MCV and MCH with a rise in MCHC for the fatty diet group compared with the control. Chromium nanoparticles showed a rise in MCV and a decrease in MCHC in comparison to the control. The addition of chromium nanoparticles to the fatty diet led to an increase in MCV and MCH with a decrease in MCHC compared to the fatty diet group (Table 3).

The results indicate a significant elevate in the glucose, cholesterol, and triglycerides of the fatty diet group in comparsion with the control. The addition of chromium nanoscale to the ratio led to a decline in the biochemical parameters compared to the control. The group of nano-Cr with the fatty diet showed a significant reduction in the above parameters compared to the fatty diet. The chromium nanoform improved the negative aspects of the fatty diet by returning the parameters to their normal level, which was close to the control group (Table 4).

The data indicated a significant rise in LDL, VLDL, and atherogenic index, accompanied by a reduction in HDL for the fatty diet group in comparison with the control group. The Chromium nanosized showed a decrease in LDL, VLDL, and atherogenic index with a rise in HDL compared to the control. Compared to the fatty diet group, adding nano-chromium to the fatty diet resulted in a decrease in LDL, VLDL, and the atherogenic index, as well as an increase in HDL, indicating the importance of nano-chromium in improving the negative impact of the fatty diet (Table 5).

Table 1: Effect of nano-Cr on some hematological value in rabbits given a high-fat diet

Treatment	RBC (10^6/mm^3)	WBC (10^3/mm^3)	Hematocrit (%)	Hb (g/dl)
Control	5.86±1.96 b	6.48±2.71 b	30.60±3.40 b	10.95±2.01 b
HFD	6.93±2.81 a	7.46±3.89 a	31.98±4.29 a	12.38±3.51 a
Nano-Cr	4.99±1.66 c	5.01±2.87 c	29.73±3.01 c	9.19±3.22 c
HDF+ Nano-Cr	4.01±1.52 d	4.93±2.75 d	27.41±2.87 d	8.26±3.17 d

The information is presented as an average± SE. Little distinct letters in the column indicate the major difference between collections at P≤0.05.

Table 2: Effect of nano-Cr on DLC in rabbits given a high-fat diet

Treatment	Lymphocyte (%)	Neutrophil (%)	Eosinophil (%)	Basophil (%)	Monocyte (%)
Control	45.15±0.78 b	37.21±0.39 b	1.96±0.10 c	1.91±0.16 a	13.85±1.40 b
HFD	51.62±0.92 a	40.17±0.47 a	2.47±0.18 b	1.09±0.10 a	10.11±1.27c
Nano-Cr	43.88±0.71 c	36.98±0.34 b	3.68±0.20 a	1.89±0.14 a	13.93±1.44 b
HDF+ Nano-Cr	42.94±0.68 c	35.98±0.31 c	3.87±0.25 a	1.88±0.14 a	14.23±1.52 a

The information is presented as an average± SE. Little distinct letters in the column indicate the major difference between collections at P≤0.05.

Table 3: Effect of Nano-Cr on blood indices in rabbits given a high-fat diet

Treatment	MCV (fl)	MCH (pg)	MCHC (g/100ml)
Control	52.25±2.11 c	18.77±2.33 b	35.51±2.12 b
HFD	47.23±2.09 d	17.82±1.32 c	38.58±2.78 a
Nano-Cr	59.62 ±2.29 b	18.89±2.45 b	30.94±1.31 c
HDF+ Nano-Cr	68.39±2.98 a	21.09±2.88 a	30.29±1.18 c

The information is presented as an average± SE. Little distinct letters in the column indicate the major difference between collections at P≤0.05.

Table 4: Effect of nano-Cr in glucose and cholesterol and triglyceride in rabbits given a high-fat diet

Treatment	Glucose (mg/100ml)	Cholesterol (mg/100ml)	Triglyceride (mg/100ml)
Control	116.35±2.98 c	332.61±3.57 b	99.67±1.82 b
HFD	387.61±3.84 a	529.43±4.93 a	120.89±2.76 a
Nano-Cr 2mg/L	114.19±2.75 d	319.75±3.11c	88.54±2.09 d
HDF+ Nano-Cr 2mg/L	121.87±2.48 b	310.82±2.39 d	94.49±1.65 c

The information is presented as an average± SE. Little distinct letters in the column indicate the major difference between collections at P≤0.05.

Table 5: Effect of nano-Cr on lipoprotein value in rabbits given a high-fat diet

Treatment	HDL-C (mg/100ml)	LDL-C (mg/100ml)	VLDL-C (mg/100ml)	Atherogenic index
Control	28.93±1.69 c	263.48±2.70 b	19.35±2.11 b	11.78±1.85 b
HFD	19.76±1.09 d	495.49±3.05 a	26.18±2.79 a	26.66±1.98 a
Nano-Cr	30.64±2.19 b	213.41±2.08 d	18.71±2.04 c	10.48±1.67 c
HDF+ Nano-Cr	33.59±2.97 a	248.53±2.14 c	17.98±1.73 d	9.28±1.18 d

The information is presented as an average± SE. Little distinct letters in the column indicate the major difference between collections at P≤0.05.

Compared to the control, the fatty diet group had a significant rise (P0.05) in Glut-2, insulin, and insulin resistance. Compared to the control, nano chromium treatment reduced Glut-2, insulin, and insulin resistance. The addition of nano-chromium to the fatty diet also reduced the above parameters compared to the fatty diet group, demonstrating the role of nano-chromium in improving the fatty diet's negative effect (Figure 1).

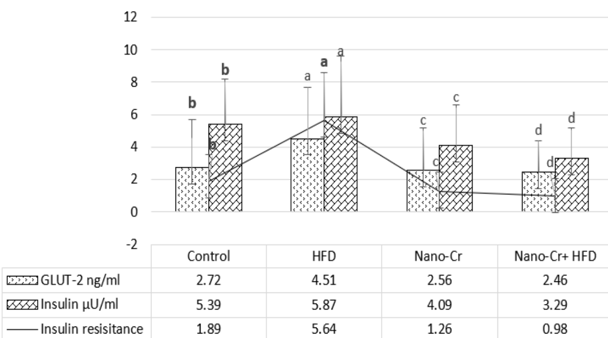

Figure 1: Effect of nano-Cr on GLUT-2 and insulin and insulin resistance in rabbits given a high fat.

Discussion

The current study investigated the hypothesis of using a fatty diet. Its effect on some blood traits, insulin, and GLUT-2 levels, and the possibility of improving them by using nano-chromium as feed additives to the rabbit diet, was put forward, as fatty food can cause wide inflammatory effects resulting in a boost in the rate of white cells and neutrophils (26), and this is consistent with Maysami *et al*. (27) where he stated that an excessive amount of fat in the meal could cause not only an exponential rise in the rate of leukocyte but also to a significant rise in erythrocyte, MCV, hemoglobin and PCV value. The fatty tissue system is linked to a variety of health issues, including the occurrence of insulin resistance; that obesity is characterized by an increased fatty acid backup in the extending fat tissue quantity and is tightly linked to the onset of insulin resistance in peripheral tissues such as adipose and skeletal muscle (28). The use of nano-chromium led to reversing the negative effects of a fatty diet if the results showed a decrease in blood parameters, lipid profile, insulin level, and insulin resistance, and this corresponds to what was stated by Dworzański *et al*. (29), Amer *et al*. (30) if they implied the nano chromium reduction in leukocyte in the case of using a fatty diet. The addendum of Cr to the ratio of rabbits at a concentration of 0.6 mg/kg of food led to a decrease in the value of cholesterol, LDL, TG, and an increase in HDL. Nano- Chromium plays a crucial role in preserving blood glucose (31). The improved effect of Chromium can be attributed to its role as an antioxidant mineral, which increases the level of glutathione, superoxide dismutase, and catalase inside the body (32). Numerous studies have shown that Chromium can act as an immunomodulator (stimulating or suppressing) by influencing immune system elements such as B cells, T cells, and macrophages, as well as cytokine production (33). A lack of this mineral in the body results in weakened humoral immunity (34). Trace elements, like metals, are necessary for the proper operation of biochemical processes, particularly as cofactors for enzymes, and in a wide range of methods implicated in glucose assimilation and hormonal control, particularly insulin, Chromium is a mineral that the body necessitates in trace quantities and is among the most broadly used and overall nutrition (35). Chromium is an insulin cofactor that enhances amino acid absorption, promotes lipogenesis from glucose, and promotes fat storage in the liver and fatty tissues (36,37). This allows Cr to participate in the autoamplificatione of insulin signaling to maintain the active conformation, which improves glucose tolerance by potentiating the action of insulin, which is required for nutrient metabolism (38). Accordingly, to a previously described hypothesized mechanism of action for Chromium in insulin control, Chromium improves insulin governing to target tissue by raising the sensitivity and quantity of insulin receptors, which are found in most cells but vary in concentration depending on cell type. Insulin receptors are made up of two extracellular α subunits that include the insulin-bounding site and two trans membrane β subunits, thus Chromium, like insulin, appears to impact protein phosphorylation-dephosphorylation events, according to structural characteristics (39). Phosphotyrosine phosphatase (PTP-1) disables the insulin receptor, and Cr inhibits it. Both of Chromium's effects would result in enhanced phosphorylation of the insulin receptor, which is linked to greater insulin sensitivity, resulting in much lower glucose levels and, as a result, an improvement in the hyperglycemic state (40). Thus, the improved effect of nano-Cr can be attributed to the characteristic of nanoparticles with a high biological activity due to their significant chemical reactivity and tiny size, allowing them to quickly pass the cell membrane and alter cell components and functions (41).

Conclusion

Nanotechnology can be used in animal feeding to amounting bioavailability, production performance, and immune status. Rabbits feeding, a Cr nanoscale-supplied meal can alter some biochemical parameters related to carbohydrate and lipid assimilation. Furthermore, reduce insulin and insulin resistance in the fat meal.

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Conflict of interest

According to the researcher, no conflicts of interest are associated with this paper's publication.

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التأثير المحسن للكروم النانوي في بعض القيم الدموية وناقل الكلوكوز -٢ في الأرانب المغذاة على غذاء غني بالدهون

هديل محمد حميد

فرع الفسلجة والكيمياء الحياتية والأدوية، كلية الطب البيطري، جامعة الموصل، الموصل، العراق

الخلاصة

يمتلك الكروم النانوي تأثير بناء عند استخدامه بتركيزات منخفضة ويعزز تخليق الحمض النووي في الكبد، ويطلق عليه أيضًا عامل تحمل الكلوكوز لأنه ينظم عمل الأنسولين الأيضي. يمتلك أهمية في عملية التمثيل الغذائي للكربوهيدرات والبروتينات والدهون. أجريت هذه الدراسة على ٢٠ أرنبًا من الذكور البيض المحلية (بعمر شهرين) تم تقسيمهم عشوائيًا إلى أربع مجموعات: الأولى مثلت مجموعة السيطرة المغذاه على عليقة قياسية، والثانية مثلت المجموعة المغذاه على نظام غذائي عالي الدهون، المجموعة الثالثة كانت المجموعة المغذاة على عليقة قياسية تم إعطاؤهم الكروم النانوي بتركيز ٢ ملغم / لتر من مياه الشرب، والرابعة كانت مجموعة الكروم النانوي تم تغذيتها على نظام غذائي دهني وإعطاؤهم الكروم بمعدل ٢ ملغم / لتر من ماء الشرب. أظهرت مجموعة النظام الغذائي الدهني مستويات أعلى من خلايا الدم الحمر، خلايا الدم البيض، الهيموكلوبين، حجم الخلايا المرصوصة، الخلايا اللمفاوية، العدلة، الكلوكوز، الكوليسترول، والدهون الثلاثية، وناقل الكلوكوز -٢، الأنسولين ومقاومة الأنسولين مع انخفاض في البروتينات الدهنية عالية الكثافة- كوليستيرول، بينما سببت مجموعتي الكروم النانوية انخفاض في خلايا الدم الحمر والبيض، الهيموكلوبين، حجم الخلايا المرصوصة، الكلوكوز، الكوليسترول، الدهون الثلاثية ،ناقل الكلوكوز-٢، الأنسولين، ومقاومة الأنسولين، ولكن مستويات أعلى من البروتينات الدهنية عالية الكثافة- كوليسترول. الهدف من هذه الدراسة هو التحقيق في الآثار الضارة للعليقة الدهنية على بعض القيم الدموية، مستويات ناقل الكلوكوز-٢، والأنسولين، بالإضافة إلى إمكانات الكروم النانوي لتحسين هذه الصفات.