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Comparative Growth Response of New Zealand White Rabbits to Various Dietary Sources of Selenium

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Abstract

THIS study evaluated how dietary inclusion of organic selenium and selenium nanoparticles, both at a concentration of 0.3 mg/kg diet, affects the growth, carcass characteristics, and blood parameters in New Zealand White rabbits during the growing period. A total of 45 rabbits, each six weeks old and averaging 746.1±4.41g in body weight, were randomly assigned into three dietary treatment groups (15 rabbits per group with 3 replicates each). The groups were fed pelleted diets consisting of: a selenium-free control diet (T_1), the control diet plus organic selenium (T_2) at level 0.3 mg/kg diet, and the control diet supplemented with nano-selenium (T_3) at level 0.3 mg/kg diet. The feeding trial extended for 8 weeks. Results demonstrated that both final body weight and weight gain were significantly higher in rabbits receiving organic or nano-selenium compared to the control group. Dressing percentage and weight of edible giblets also improved with selenium supplementation. Feed conversion ratios were notably better with selenium supplementation. While nano selenium was relatively better than organic selenium. While serum levels of albumin, albumin/globulin ratio, ALT, cholesterol, and creatinine showed no significant differences among the groups, total protein, globulin, and AST levels were significantly affected by selenium source. Economically, nano-selenium supplementation achieved the best returns, followed by organic selenium, relative to the control. Conclusively, it could be recommended to supplementation nano or organic selenium of the rabbit diets improve growth, carcass characteristics, and blood parameters in New Zealand White rabbits and improve economic efficiency.

Keywords: Organic Selenium, Nano Selenium, New Zealand White Rabbits, Growth Performance.

Introduction

Animal nutrition and environmental conditions are key elements in maintaining health and maximizing productivity. Improving these aspects enhances the efficiency of rabbit production. Recently, nanotechnology has emerged as a promising tool in agriculture, especially in animal nutrition and health improve animal production systems [1]. Its unique properties—including tiny particle size (1–100 nm), high surface area, and chemical stability—allow for innovative approaches in mineral delivery and health management. Nanoparticles can be used as a source of trace minerals in diets. As there are various properties and source of selenium [2].

Selenium (Se), a vital trace element, plays a critical role in physiological functions such as metabolism, Immunity, growth, reproductive performance, [3] hormone activity, and antioxidant defence mechanisms [4]. chemical reactivity. Now products of nanotechnology have become largely available and usable in the field of nutritional supplements. Nano-selenium, in particular, has gained attention due to its enhanced bioavailability, strong absorption, and lower toxicity compared to other forms. This research aims to assess how different selenium sources in the diet influence growth performance, carcass yield, and selected blood parameters in growing New Zealand White Rabbits.

Material and Methods

This experiment was conducted at the rabbit production unit of the Faculty of Agriculture, Cairo University, located in Giza, Egypt.

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Synthesis of Selenium Nanoparticles

Selenium nanoparticles (SeNPs) were synthesized through a reduction process involving sodium sulfite (Na_2SO_3) in diluted aqueous solution. The sodium seleno sulfate precursor was obtained by refluxing a combination of elemental selenium and Na_2SO_3 in double-distilled water at a temperature of 70–80°C for 7 to 8 hours, following the method described in [5]. To stabilize the nanoparticles, a 1% (w/v) aqueous solution of polyvinyl alcohol (PVA) was prepared and added during synthesis. The formation of selenium nanoparticles was visually confirmed by the appearance of an orange-red color within a minute of mixing PVA with the selenosulfate solution. The use of stabilizers like PVA is essential in nanoparticle preparation to prevent aggregation, as emphasized in [6].

Experimental Animals and Feeding Management

A total of 45 weaned New Zealand White rabbits, six weeks of age, with an average initial weight between 741.66 g and 749.33 g, were used. The animals were randomly divided into three experimental groups (15 rabbits each) following a completely randomized design. All rabbits were adapted to a basal control diet for one week prior to the start of the trial. Feed and clean water were provided freely (ad libitum) throughout the study period. Three dietary treatments were applied:

T1: Basal diet without selenium (control)

T2: Basal diet supplemented with 0.3 mg/kg of organic selenium

T3: Basal diet supplemented with 0.3 mg/kg of selenium nanoparticles

Diets were formulated to be nearly equal in protein and energy (iso nitrogenous and iso-caloric), meeting the nutritional requirements for growing rabbits as per [7]. Digestible energy (DE) was calculated using the formula proposed by [8]:

DE (kcal/g) = 4.36 – 0.0491 × NDF, With NDF (%) calculated from crude fibre using the equation: NDF = 28.924 + 0.657 × CF (%).

Growth Performance Assessment

Body weight was measured weekly from the age of 6 to 14 weeks. Average daily weight gain was calculated, and weekly feed intake was recorded per rabbit. The feed conversion ratio (FCR) was determined as grams of feed consumed per gram of weight gain.

Carcass Evaluation

After the 8-week feeding period, four rabbits from each group were fasted overnight and then slaughtered to evaluate carcass characteristics. Measurements dressing percentage, and relative weights of internal organs (liver, heart, kidneys) as a proportion of pre slaughter live weight and total giblets following procedures adapted from [9].

Blood Biochemical Analysis

Blood samples (2 mL) were collected from the marginal ear vein of each rabbit. The samples were allowed to clot and then centrifuged at 3000 rpm for 15 minutes to separate serum, which was stored at -20°C until analysis. The serum was analyzed for total protein (TP), albumin (Alb), and globulin (Glb)—with globulin calculated as Glb = TP– Alb. The albumin-to-globulin ratio (A/G) was also determined. Additionally, the following biochemical indicators were measured using colorimetric methods: Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Creatinine Total Cholesterol Commercial Kits (purchased from Bio-diagnostic, Cairo, Egypt, www.Biodiagnostic.com according to manufacturer′s instructions.

Economic Efficiency

Economic efficiency (EEF) was evaluated using the following formula: EEF = Net Revenue / Total Costs, where total costs were calculated in Egyptian Pounds (L.E.) based on prevailing market prices during the experimental period.

Statistical Analysis

The collected data were statistically analyzed using the General Linear Model (GLM) procedure described in [10], through a one-way analysis of variance (ANOVA). The statistical model employed was: Yij = μ + Ti + eij, Where: Yij = individual observation, μ = overall mean, Ti = effect of treatment and eij = random error Significant differences among means were determined using Duncan's Multiple Range Test [11].

Results

As shown in Table 2, rabbits receiving the organic selenium (T_2) or nano selenium (T_3) diets exhibited a significantly higher final body weight and weight gain compared to the control group. Furthermore, feed intake was significantly increased in the nano supplemented group (T3). Feed conversion ratio (FCR) improved markedly in both T_2 and T_3 groups relative to the control while T3 was better.

Carcass Characteristics

Data in Table 3 indicate that rabbits in T_2 and T_3 groups had significantly higher dressing percentages and edible organ weights compared to those in the control group. However, other carcass such as liver, kidneys, heart, and total giblets, were not significantly affected by selenium supplementation.

Blood Biochemical Parameters

Blood plasma parameters are summarized in Table 4. All measured values remained within normal physiological limits. Serum albumin, albumin/globulin ratio (A/G), ALT, total cholesterol, and creatinine levels did not show statistically significant differences among the groups. However, total protein, serum globulin, and AST levels showed notable differences between treatments.

Discussion

Growth Performance

The superior results in values of final body weight, body weight gain and feed conversion ratio in the nano-selenium group may be attributed to the distinctive properties of selenium nanoparticles, which include a larger surface area, high reactivity, abundant active sites, enhanced catalytic potential, and reduced toxicity [12]. Similarly, [13] observed that body weights higher of rabbits supplemented with Nano-Se than rabbits receiving sodium selenite or no selenium, may be nano selnium enhanced bioavailability, strong absorption, and lower toxicity compared to other forms.. Moreover, [14] demonstrated that there was significantly improved growth performance of heat-stressed growing rabbits fed diets supplemented 25 mg/kg organic selenium. In agreement, [15] reported that supplementing rabbit diets with Nano-Se (0.02– 0.05 mg/kg) or organic Se (0.1 mg/kg) significantly increased average live body weight and improved FCR compared to rabbits fed sodium selenite (0.1 mg/kg) or no selenium. Additionally [16], final body weight and average body weight gain were not affected (P>0.05) by adding Se-algae at 0.2 mg in rabbit diets under high ambient temperature summer season. While, feed conversion ratio was significantly (P<0.011) improved.

Carcass Characteristics

In the current study was consistent with [17] who reported rabbits receiving 0.3 mL oral doses of either organic or nano-selenium were slight increase in carcass percentage., compared to inorganic selenium or the control. Additionally, [14] found that increase in carcass and dressing weight occurred with feeding rabbit diets add 25 mg/kg organic selenium in heat-stress. improvement in carcass yield may be correlated with the enhanced final body weight in rabbits fed diets supplemented organic and nano-selenium.

Blood Biochemical Parameters

In the present experiment, the results of blood constituents with supporting these findings, [18]. This reported an increase in AST levels among rabbits fed 0.8 or 1.2 mg/kg of selenomethionine, compared to those receiving either 0.4 mg/kg or no supplementation. Meanwhile, ALT levels were unaffected by selenium form or dosage. The same study observed reduced serum creatinine and cholesterol levels in rabbits supplemented with 0.8 or 1.2 mg/kg organic selenium, compared to the control group. Likewise, [14] found that feeding heat-stressed rabbits with 25 mg/kg organic selenium improved total protein and globulin concentrations, while reducing serum cholesterol levels. serum total protein, and globulin concentration significant increase while reduce albumin concentration with supplemented 0.1 mg Se-algae in rabbit diets and also significantly (P<0.0001) reduced total cholesterol under high ambient temperature summer season.

Economic Efficiency

Economic efficiency results illustrated in Table (5) showed that the lowest total feed cost was noticed with T_3 and T_2. Economic efficiency was the highest for T_3 (1.0419) followed by that T_2 and relative economic efficiency was improved with supplemented T_3 and T_2 (124.73and 120.19).[19] indicated that 0.3 g selenium yeast/ kg diet in broiler chicken diets achieved the. best economic efficiency and higher relative economic efficiency.

Conclusion

In summary, supplementing the diets of growing New Zealand White rabbits with selenomethionine or nano-selenium at 0.3 mg/kg significantly improved growth performance, weight gain, feed This study didn't receive any funding support feed conversion ratios, carcass traits, several blood parameters, and economic efficiency.

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

This study follows the ethics guidelines of the authors thank the members of animal research institute for their help with practical advice.

TABLE 1. Ingredients and chemical composition of experimental diets

Items	T_1	T_2	T_3
Clover hay	30.00	30.00	30.00
Barley	10.56	10.56	10.56
Wheat bran	20.54	20.54	20.54
Yellow corn	15.32	15.32	15.32
Soybean meal (44% CP)	15.64	15.64	15.64
Vit,,&Min.*	0.30	0.30	0.30
$NaHCO_3$ (sodium bicarbonate)	1.10	1.10	1.10
Sodium Chloride (NaCl)	0.32	0.32	0.32
Di-calcium phosphate	1.84	1.84	1.84
Limestone	1.10	1.10	1.10
DL-Methionine	0.28	0.28	0.28
Molasses	3.00	3.00	3.00
Total	**100**	**100**	**100**
Organic-selenium	_	0.3	_
Nano-selenium	_	_	0.3
OM%	94.44	94.44	94.44
CP%	16.51	16.51	16.51
CF%	13.49	13.49	13.49
EE%	3.43	3.43	3.43
NFE%	60.01	60.01	60.01
Ash%	6.56	6.56	6.56
DE(kcal/kg)	2508.9	2508.9	2508.9
NDF	36.87	36.87	36.87
ADF	20.75	20.75	20.75
ADL	4.32	4.32	4.32

Each kg of premix contained 100 mg vitamin E, 10 mg vitamin B1, 20 mg vitamin B2, 400,000 IU vitamin A, 100,000 IU vitamin D, 30 g Calcium, 12 g phosphorus, 40 g Na, 1000 mg Cu, 60 mg I, 60 mg Co, 11 g mg, 2000 mg Manganese, 2000 mg Zn, 3000 mg Fe. T_2: 0.3 mg/kg organic selenium, T_3: 0.3 mg/kg nano-selenium. NDF: Neutral Detergent Fiber, ADF :Acid Detergent Fiber, ADL :Acid Detergent Lignin .

TABLE 2. Growth performance of growing rabbits fed experimental diets

Items	T_1	T_2	T_3	Polled SE	P. value
Final body weight(g)	2143.33 ^{b}	2256.67 ^{a}	2263.33 ^{a}	17.32	0.014
Daily body weight gain(g)	24.92^{b}	27.05^{a}	27.03^{a}	0.42	0.0268
Daily feed intake (g)	109.66^{b}	111.33^{ab}	112.0^{a}	0.63	0.096
Feed conversion ratio (g feed/body g gain)	4.40^{a}	4.12^{b}	4.14^{b}	0.05	0.028

a and b mean within some rows with differing superscript are significantly differ (P<0.05). T1: control, T2: 0.3 mg/kg selenomithionine, T3: 0.3 mg/kg nano-selenium.

TABLE 3. Carcass traits of growing rabbits fed experimental diets.

Items	T_1	T_2	T_3	Polled SE	P. value
Dressing (%)	56.91 ^{b}	59.52 ^{a}	60.72 ^{a}	0.381	0.0011
Heart, %	0.97^{a}	0.90^{a}	0.90^{a}	0.01856	O.5477
Liver, %	3.31^{a}	3.17 ^{a}	3.35^{a}	0.0358	0.2019
Kidneys ,%	0.273^{a}	0.265^{a}	0.273^{a}	0.0026	0.1459
Edible giblets,%	4.55^{a}	4.33^{b}	4.52^{a}	0.0489	0.449

a and b mean within some rows with differing superscript are significantly differ (P<0.05). T1: control, T2: 0.3 mg/kg selenomithionine, T3: 0.3 mg/kg nano-selenium.

TABLE 4. Blood constituents of growing rabbits fed experimental diets.

Items	T_1	T_2	T_3	Polled SE	P. value
Total protein (g/dL)	6.07 [b]	6.23 [a]	6.33 [a]	0.05	0.0194
Albumin (g/dl)	3.30	3.37	3.33	0.05	0.7023
Globulin (g/dl)	2.77 [b]	2.86 [ab]	3.00 [a]	0.04	0.024
A/G ratio	1.19	1.18	1.11	3.20	0.2519
AST (mg/dl)	40.33 [b]	40.42 [b]	40.72 [a]	0.04	0.0008
ALT (mg/dl)	14.19	13.97	14.13	0.11	0.3685
Total cholesterol (mg/l)	72.00	71.67	72.00	0.69	0.1068

a and b mean within some rows with differing superscript are significantly differ ($P<0.05$). T1: control, T2: 0.3 mg/kg selenomithionine, T3: 0.3 mg/kg nano-selenium

TABLE 5. Economic Efficiency of growing rabbits fed experimental diets.

Items	T_1	T_2	T_3
Total average weight gain (g)	1.396	1.515	1.514
Selling price/rabbit (LE) (A)	139.60	151.50	151.40
Total feed intake	5.536	5.510	5.398
Price/kg feed(LE)	13.74	13.74	13.74
Total feed cost/rabbit (LE) (B)	76.06	75.70	74.16
Net revenue(LE)[1]	63.54	75.80	77.24
Economicefficiency[2]	0.8353	1.0039	1.0419
Relative Econ. Eff.[3]	100	120.19	124.73

Price of 1 kg live body weight =100 LE (1) Net revenue = A – B. (2) Economic efficiency = (A-B/B). (3) Relative Economic Efficiency.

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مقارنة أداء النمو للأرانب النيوزيلاندى الأبيض المغذاة على علائق مضاف لها أنواع مختلفة من السيلينيوم

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الملخص

هدفت هذه الدراسة إلى تقييم تأثير إضافة السيلنيوم العضوى والنانو سيلنيوم بمعدل 0.3 مجم/كجم عليقة على النمو خصائص الذبيحة وبعض خصائص الدم فى الارانب النيوزيلاندى الأبيض. تم إستخدام 45 أرنب عمر 6 أسابيع، ويبلغ متوسط وزنها 746.1±4.41g ووزعت عشوائيا الى ثلاث مجاميع 15 أرنب لكل مجموعة مع ٣ مكرارات لكل مجموعة تم تغذية المجموعات كما يلى: العليقة الأولى مجموعة كنترول بدون إضافة السيلنيوم (T_1)، مجموعة تغذت على العليقة الكنترول مع إضافة السيلنيوم العضوى(T_2) معدل 0.3مجم/كجم ، مجموعة تغذت على العليقة الكنترول مع إضافة النانو السيلنيوم(T_3) بمعدل 0.3مجم/كجم إستمرت التجربة لمدة 8 أسابيع. أظهرت النتائج أن الوزن النهائي والزيادة الوزنية اليومية كانتا أعلى بشكل ملحوظ فى الأرانب التى تلقت السيلنيوم العضوى والنانو سيلنيوم مقارنة بمجموعة الكنترول كما تحسنت نسبة التصافى ووزن الأجزاء المأكولة مع إضافة السيلينيوم كذلك كانت كفاءة التحويل الغذائي أفضل مع إضافة السيلنيوم .ولكن إضافة النانو كان أفضل نسبيا أما بالنسبة لمستويات الالبيومين ونسبة الألبيومين الى الجليبولين ALT والكوليسترول الكلى والكراتنين فلم تظهر فروق معنوية فى حين تأثرت بشكل ملحوظ مستويات البروتين الكلى الجلبيولين و AST بمصادر السيلنيوم وقد لوحظ أعلى كفاءة أقتصادية بإضافة النانو سيلنيوم يليه السيلنيوم العضوى مقارنة بالكنترول. أشارت النتائج إلى أن إضافة السيلنيوم النانو أوالعضوى فى علائق الأرانب حسن من الأداء الأنتاجى وصفات الذبيحة وخصائص الدم للأرانب النيوزلاندى الأبيض بالإضافة الى تحسين الكفاءة الأقتصادية

الكلمات الدالة: السيلنيوم العضوى ,النانو سيلنيوم الارانب النيوزيلاندى الأبيض الأداء الأنتاجى.