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Effect of Dietary Supplementation with Bee Pollen and Ginseng on Nutrient Utilization, Immunological and Biochemical Blood Parameters and Bacterial Count in Caecum of Growing Rabbits

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Abstract

THIS study aimed to evaluate the effects of bee pollen and ginseng as natural growth promoters on nutrient utilization, blood parameters, and bacterial count in cecum in growing Californian rabbits. Sixty rabbits (5 weeks old, avg. 642.67±15.72 g) were randomly divided into four groups: a control group on a basal diet, a ginseng group (250 mg/kg diet), a bee pollen group (250 mg/kg diet), and a combination group (250 mg ginseng + 250 mg bee pollen/kg diet). The trial terminated from 5 to 13 weeks of age. Rabbits receiving bee pollen showed significantly improved crude protein digestibility, while ginseng improved crude fiber digestion ($P<0.01$). No significant changes were noted in dry matter, ether extract, or total digestible nutrients. Hematological parameters such as hemoglobin, platelet count, lymphocytes, MCV, and MCHC improved significantly ($P<0.05$ or $P<0.01$) with supplementation. Biochemical profiles showed increased total protein, albumin, and AST, alongside reduced ALT, urea-N, and creatinine in all supplemented groups, with values remaining within normal physiological limits. No significant effects were observed on globulin, A/G ratio, MDA, or TAC. However, bacterial counts, including Salmonella and *E. coli* in the cecum, were significantly reduced ($P<0.01$) in supplemented groups. In conclusion, combining 250 mg/kg ginseng and bee pollen enhanced growth, immunity, nutrient utilization, and blood biochemistry in growing rabbits, suggesting a promising natural dietary supplement under hot climate conditions. Further studies are recommended with larger sample sizes and varied dosages.

Keywords: Growth Promoters**,** Ginseng, Pee Pollen, Nutritional Utilization, Blood Biochemical Traits, Immune Response.

Introduction

In Egypt, there is a shortage of red meat per capita compared to the developed countries, which is due to the number of animals relative to the existing population and the lower production as a result of the feed deficiency. Many attempts are devoted to solving this problem, among them maximizing the animals' productivity by using the growth promoters as feed additives [1].The increase in animal protein production can be accomplished through the breeding of short life-cycle animals, such as rabbits, which are commonly raised by smallholders [2].The rabbits have the potential solution to the problem of meat supply due to their brief life cycle and rapid growth, and rabbit meat contains high protein, low cholesterol and a low percentage of fat.Recently, natural feed additives have been used as substitutes for synthetic growth promoters and antibiotics to improve the productivity and immune function of farm animals. Bee pollen and ginseng are widely used as natural growth promoters to the production and reproduction of rabbits [3].

Bee pollen (BP) is used as a natural bio-stimulant. It consists of flower pollen gathered from a variety of plants by bees, which is then incorporated with nectar and secretions produced by the hypopharyngeal glands [4]. BP is a highly nutritious substance, rich in proteins and essential amino acids, and having over 51% of its fatty acids as polyunsaturated, including 39% linolenic acid, 20% palmitic acid, and 13% linoleic acid. Additionally, it acts as a potent nutritional source,

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offering over 12 vitamins, 28 minerals, 11 enzymes or coenzymes, and 11 carbohydrate types, especially glucose, fructose, and sucrose, as well as flavonoids, carotenoids, and phytosterols [5]. Bee pollen also contains antibiotic substances active against *Escherichia coli*, certain species of Proteus, and Salmonella, as well as antioxidant compounds [6]. Bee pollen has the potential to boost cellular immune responses, promote antibody production, and strengthen the overall immune system [7].

Ginseng (*Aralia ceae*), commonly referred to as Asian ginseng, a highly esteemed herbal remedy especially in Asian regions, has been employed for thousands of years to promote homeostasis and enhance vitality [8].

Previous studies have documented the presence of bioactive components in Panax ginseng, including saponins (ginsenosides), antioxidants, peptides, polysaccharides, alkaloids, lignin, and polyacetylenes [9,10,11]. Additionally, several studies have highlighted the therapeutic effects of Panax ginseng on systemic immune function [12]. The presence of ginsenosides in the Panax ginseng complex contributes in the enhancement of various indicators, particularly through its ability to act as an antimicrobial and antioxidant [13,14,15,16].

The purpose of this study was to evaluate the impact of bee pollen and ginseng as organic growth enhancers on nutritional utilization, immune activity, biochemical blood parameters, and bacterial counts in the cecum of growing Californian rabbits.

Material and Methods

Research for this study took place at the Rabbits Research Unit in the Department of Animal and Poultry Production, Faculty of Technology and Development, Zagazig University, located in Zagazig, Egypt. The experiment began in April 2023 and finished in August 2023. The study involved growing Californian rabbits (5 weeks of age). Laboratory analyses were performed at the Research Centre for Water, Soil, and Food, an ISO 17025-accredited facility since 2012, affiliated with the Faculty of Technology & Development, Zagazig University, Zagazig, Egypt.

The study involved a sum of 60 growing Californian (Cal) rabbits, rabbits that are 5 weeks old, with an average initial weight of 642.67 ± 15.72 g. The rabbits were allocated randomly to four trial groups. The primary group consumed a standard diet and served as the control group. The second group was maintained on a basal diet supplemented by 250 mg ginseng/kg diet. Group three was given a basal diet along with an addition of 250 mg bee pollen (BP)/kg diet. Group four received a basal diet supplemented by 250 mg ginseng and 250 mg BP/kg diet. The trial period spanned ages ranging from 5 to 13 weeks. All rabbits were provided with *ad libitum* feeding, and water was continuously available via nipple drinkers in each cage. All rabbits were housed under consistent management, clean and controlled environmental conditions throughout the study.

Samples of the experimental diets were collected for chemical analysis to assess crude protein, crude fiber, ether extract, nitrogen-free extract, and moisture content using internationally recognized testing methods. The diets were designed to fulfill the nutritional needs of growing rabbits as outlined by [17]. The components and chemical composition of the experimental pelleted diets are shown in Table 1.

Digestibility trials:

During the final week of the experimental period, a digestibility trial was conducted with five animals per group. The rabbits were kept individually in metabolism cages (40 x 35 x 30 cm), which ensured complete separation of feces and urine for a 5-day collection period. Feed intake was carefully monitored. Feces collection commenced 24 hours after the daily feed was offered, and the samples were subjected to drying at 60°C for 24 hours. All fecal samples from each animal were pooled, ground, and stored for chemical analysis. Apparent fecal digestibilities in terms of dry matter (DM), crude fiber (CF), crude protein (CP), ether extract (EE), nitrogen-free extract (NFE), and organic matter (OM) were evaluated.

The chemical analysis of the basal diet and feces was determined according to international testing methods. The chemical composition (%) of feed ingredients and experimental diets was performed at the Laboratory for Soil, Foods, and Feedstuffs, a laboratory accredited internationally (ISO 17025/2017). The analyses followed the International Standard Methods (ISO) as described below: moisture content was determined according to [18], crude ash according to [19], crude protein according to [20], and crude fat and crude fiber contents were analyzed following the procedure outlined by the Official Journal [21,22].(Table 1**).**

The available metabolic energy (ME) values were calculated using the equation described by [24]:

ME (Kcal/ kg DM) = (0.588 + 0.164 X) 239.

Where X represents the dry matter digestibility coefficient of the offered diet.

The total digestible nutrients (TDN%) and the digestible crude protein (DCP%) values were determined using the classical formulas outlined by [25].

Blood analysis:

At the completion of the growth trial (13 weeks of age), three rabbits from each group were euthanized, 5 ml blood samples were collected per rabbit. Each sample was split into two tubes: one containing heparin was used as an anticoagulant, and the other without. The heparinized samples were analyzed for various hematological parameters, including red blood cells (RBCs), hemoglobin concentration, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), leukocytes (WBCs), neutrophils, lymphocytes, and platelets. The non-heparinized samples were centrifuged at 3,000 revolutions per minute (rpm) for 15 minutes to separate the serum, which was then stored at -20°C for subsequent biochemical analyses, measuring total protein, albumin, globulin, cholesterol, aspartate aminotransferase (AST), alanine aminotransferase (ALT), urea nitrogen (Urea-N), and creatinine levels. Red blood cell (RBC) and leukocytes (WBC) counts, along with hemoglobin (Hb) concentration, were determined following the methods outlined by [26]. Red blood cell and leukocytes (WBCs) counts were performed using an A.O. Bright-Line hemocytometer under a light microscope at 20× magnification. Prior to counting, blood samples were diluted 1:200 with physiological saline (0.9% NaCl solution) for red blood cell (RBC) counting and 1:20 with a diluting fluid consisting of 1% acetic acid and a few drops of Leishman's stain for white blood cell (WBC) counting. Hb concentration was measured using Sahli's method, which entails mixing blood with 10% hydrochloric acid (HCl), converting hemoglobin into acid hematin (a brown-colored compound), and comparing the color intensity with a standard using a hemoglobinometer.

The serum concentrations of total protein and albumin were determined by employing commercial kits (Diamond Diagnostics), in accordance with the methods described by [27, 28]. The globulin levels were calculated by calculating the difference between total protein levels and albumin levels. The activities of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were quantified using the spectrophotometric method developed by [29]. Urea nitrogen and creatinine levels were assessed using commercial kits (Diamond Diagnostics), in accordance with the methods outlined by [30, 31].

Caecum microbial activity:

At the completion of the study (13 weeks of age), three rabbits from each group were selected for the assessment of intestinal bacterial populations, including *Escherichia coli*, *Salmonella spp*., and total bacterial counts in the cecum. The abdominal region was aseptically opened, and approximately one gram of contents from the ileo-cecal junction was aseptically collected. The sample was placed in a clean test tube containing 9 milliliters of 1% sterile peptone solution (initial dilution of 10^{-1}) and vortexed for one minute to ensure a uniform suspension. Serial tenfold dilutions were then prepared up to 10^{-8}. For every dilution, 0.1 milliliters was transferred onto selective agar plates, media specific to each bacterial group, and incubated under optimal conditions to promote colony growth.

MRS agar (Oxoid, UK) was employed for the enumeration of total aerobic counts and lactic acid bacteria, brilliant green agar (Fisher Scientific, USA) for *Salmonella spp*., and Violet Red Bile Glucose Agar (Sigma-Aldrich, UK) for *Escherichia coli.* The culture media were prepared according to the manufacturer's instructions, poured into Petri dishes that had been sterilized at 180°C for 3 hours, and allowed to solidify at room temperature (28 ± 2°C). Then, 0.1 milliliters of each dilution were plated in duplicate for each microbial group and left to dry. The plates were incubated at 37°C for 24 hours for Salmonella (pink or colorless colonies with a red halo), 72 hours for Escherichia coli (purple-pink colonies), and 48 hours for lactic acid bacteria (LAB) in an anaerobic jar with GAS Pack (Oxoid, UK). The colony-forming units (CFU) were then counted and expressed as CFU per gram of fresh caecal content on a logarithmic scale [32]. The microbial diagnostic examination of cecal contents was performed following the procedures outlined by [33].

Statistical analysis:

Data analysis was carried out using Analysis of Variance (ANOVA) as outlined by [34], employing the General Linear Model procedure of SPSS (version 22). The model used was

$$Yij = \mu + Si + eij$$

Where Yij = the observed value of the dependent variable, μ = Overall adjusted mean, Si = effect of source of natural growth promoters (i = 1, 2 , 3 and 3), and eij = Random error. Duncan's New Multiple Range Test [35] was used to determine significant differences among the least squares means (LSM).

Results and Discussion

Nutrients digestibility and feeding values:

Nutrient digestion coefficients and feeding values of growing Californian rabbits given bee pollen and/or ginseng in the diet are shown in Table 2. Rabbits receiving diets supplemented with 250 mg of bee pollen (BP) exhibited significantly higher digestion coefficients for crude protein (CP) and

digestible crude protein (DCP) (p-value <0.05) as compared to the other supplemented groups and the control one, which received the basal diet without supplementation. However, supplementation had no significant impact on the digestion coefficients of dry matter (DM), organic matter (OM), ether extract (EE), crude fiber (CF), nitrogen-free extract (NFE), or total digestible nutrients (TDN).

These findings align with those of [36, 37], who observed improvements in digestibility coefficients and nutritional values in growing rabbits supplemented with BP at 250 and 500 mg/kg body weight, respectively. Also, [38] indicated that the enhanced nutrient digestibility observed in treated groups might be attributed to the presence of digestive enzymes in bee pollen (BP), which aid in nutrient digestion. Additionally, the increased digestibility may be due to a reduction in feed intake, as suggested by the National Research Council [17], which noted that decreased feed intake can lead to improved digestibility. The enhanced digestibility of nutrients and improved nutritive value of the diet may contribute to better growth performance in rabbits. Specifically, the increase in digestible crude protein (DCP) can be attributed to the improved digestibility of crude protein (CP). Studies indicate that various herbs and plant extracts possess antimicrobial and antioxidant properties, making them effective as natural growth promoters [39]. These plant extracts may enhance growth performance through mechanisms such as modulation of the intestinal microbiota, increased enzyme secretion, improved immune response, maintenance of gastrointestinal tract morphology, and antioxidant activity [40, 41]. Based on these advantages, ginseng extracts could have a beneficial effect on the growth performance of rabbits. **(**Table 2**)**

Blood parameters:

Hematological parameters:

Haematological parameters of growing Californian rabbits fed bee pollen and/or ginseng in the diet are shown in Table 3. The results indicate significant differences in certain haematological parameters. Specifically, rabbits receiving diets supplemented with either 250 mg of ginseng (Gen), 250 mg of bee pollen (BP), or a combination of 250 mg Gen and 250 mg BP per kilogram of diet exhibited significant increases (p-value < 0.05 or p-value < 0.01) in hemoglobin levels (g/dL), lymphocyte percentages (%), and mean corpuscular hemoglobin concentration (MCHC, g/dL). Conversely, these supplemented groups showed decreased levels of platelets ($\times 10^3$/mL), mean corpuscular volume (MCV), and mean eosinophil neutrophil ratio (MEUT) compared to rabbits fed the basal diet without supplementation (control group).

There were no significant differences observed among the groups of growing Californian rabbits fed diets supplemented with bee pollen and/or ginseng and the control group in terms of RBCs counts ($\times 10^6$/µl), WBCs counts ($\times 10^3$/dl), mean corpuscular hemoglobin (MCH), and hematocrit (HC). All hematological values obtained in this study fall within the normal physiological ranges for healthy growing Californian rabbits. Hematological indicators are recognized as reliable indicators of an animal's physiological status, as noted by [42]. Furthermore, [43] highlighted the importance of hematological studies in exploring the link between blood characteristics and a species' ability to adapt to its environment.

Protein fractions and liver and kidney functions:

Protein fractions and liver and kidney functions of blood serum of growing Californian rabbits fed bee pollen and/or ginseng are shown in Table 4. The biochemical values measured in this study fall within the standard range for healthy, growing Californian rabbits. Growing rabbits fed diets supplemented with either 250 mg of ginseng (Gen), 250 mg of bee pollen (BP), or a combination of 250 mg Gen and 250 mg BP per kilogram of diet led to significant increases (p-value < 0.05) for total protein, albumin, and aspartate aminotransferase (AST) levels, as well as significant decreases in alanine aminotransferase (ALT), urea-N, and (P < 0.01) creatinine levels. However, the albumin to globulin (A/G) ratio was not significantly affected by these treatments. These results are consistent with previous studies showing that supplementation with bee pollen and/or mannan-oligosaccharides improves blood biochemical and immunological parameters, along with kidney function, in growing rabbits when compared to control groups [44].

Similar findings have been reported by [36, 45, 46], who observed that supplementing growing rabbits with bee pollen (BP) at 250 or 500 mg/kg body weight improved blood biochemical parameters. [47], also reported that BP treatment resulted in significant increases in plasma total protein, albumin, and glucose concentrations. Enhancement in the protein synthesis and reduction in harmful bacteria due to BP supplementation may contribute to decreased ammonia production and improved metabolic efficiency. These results are consistent with those of [48, 49,36], who found that rabbits fed diets supplemented with BP exhibited reduced urea-N and creatinine concentrations compared to control groups. Conversely, [49] reported that while bee pollen supplementation significantly increased creatinine concentration, it

also significantly decreased plasma urea levels ($P < 0.05$).

Malondialdehyde (MDA) and total antioxidant capacity (TAG):

Malondialdehyde (MDA) and total antioxidant capacity (TAC) of blood serum of growing Californian rabbits fed bee pollen and/or ginseng are shown in Table 5. The results indicate that these treatments did not lead to significant changes in MDA and TAC levels. In contrast, studies by [49, 36] have shown that BP supplementation significantly enhanced TAC when compared to control diets. Also, [5, 50] observed that bee pollen enhanced immune functions in rabbits. The discrepancies between our findings and those of other researchers may be attributed to differences in the number of blood samples analyzed, the concentrations of bee pollen and ginseng used in the diets, and variations in the formulation of the experimental diets.

Caecum microbial activity:

Bacterial counts in the caecum of growing Californian rabbits fed the bee pollen and/or ginseng are shown in Table 6. Growing Californian rabbits fed diets supplemented with either 250 mg of ginseng (Gen), 250 mg of bee pollen (BP), or a combination of 250 mg Gen and 250 mg BP per kilogram of diet exhibited a significant ($P < 0.01$) reduction in the total count of pathogenic bacteria, including Salmonella and *Escherichia coli*, compared to the control group. According to [51], the total bacterial count and lactobacilli populations in the cecal content of rabbits were significantly higher ($P < 0.05$) in those fed diets supplemented with parsley, ginseng, or a combination of both, compared to rabbits on the control diet.There are several benefits to bee pollen (BP) for nutritional and medical purposes [38]. Bee pollen has been utilized as a substitute for antibiotics in rabbit diets, as well as in medical science and bio-cosmetology, due to its diverse biological properties. These properties include antioxidant, antimicrobial, anti-inflammatory, antifungal, antiviral, anticancer, hepatoprotective, immunostimulating, and local analgesic activities. Additionally, bee pollen has been recognized for its potential in apitherapy and wound healing applications [7,52].

The reduction in cecal pH and *Escherichia coli* counts observed in rabbits treated with bee pollen (BP) may be due to enhanced fermentation within the cecum, leading to increased production of volatile fatty acids, which in turn lowers pH. Factors such as diet composition and intake significantly influence cecal pH, fluctuations in pH can reflect changes in the accumulation of organic acids within the digestive contents. These results are consistent with [37], who found that supplementing growing rabbits with BP at 250 and 500 mg/kg body weight enhanced oxidative status and immune response. BP's antimicrobial properties, as noted by [53, 52], contribute to its effectiveness as an antifungal and antibacterial agent. Additionally, [51] found that rabbits receiving diets containing parsley, ginseng, or their combination exhibited significantly higher ($P<0.05$) total bacterial and lactobacilli counts in cecal content compared to those fed a control diet.

Conclusion

The findings of this experiment suggest that supplementing the commercial basal diet for growing rabbits with a combination of 250 mg of ginseng and 250 mg of bee pollen per kilogram of diet is recommended. This supplementation has the potential to enhance growth performance, nutritional utilization, blood biochemical profiles, liver and kidney functions, and immunological parameters, thereby maintaining optimal health and performance during the hot summer conditions in Egypt. Further studies involving larger rabbit populations and higher doses of ginseng and bee pollen are recommended to confirm their effectiveness as growth stimulants.

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This study didn't receive any funding support.

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

All trial practices respected the rules of the Ethical committee of Faculty of Technology and Development, Zagazig University (ZU-IACUC/2/F/151/2024), Egypt.

TABLE 1. Components and chemical composition of the experimental pelleted basal diet.

Ingredients	**%**
Egyptian berseem hay	33.0
Barley grain	16.0
Yellow corn	12.0
Wheat bran	18.0
Soybean meal (44%)	16.5
Common salt	0.5
Molasses	2.0
Di-Calcium Phosphate	0.5
Limestone	1.0
Vitamin & mineral premix*	0.2
DL-Methionine	0.2
Anti-fungi toxins	0.1
Total	**100**
Chemical analysis (%)	
Dry matter (DM)	88.45
Ash	7.87
Organic matter (OM)	80.58
Crude protein (CP)	16.55
Ether extract (EE)	2.81
Crude fiber (CF)	14.51
Nitrogen free extract (NFE)	46.71
Calcium (Ca)	1.34
Phosphorus (P)	0.53
DE (Kcal/kg feed DM)**	2603.1

*The vitamin and mineral premix included in each kilogram of premix contains: Vit. A 2,000,000 Iμ, Vit. D_3 150,000 Iμ, Vit. K 0.33 mg, Vit. B_1 0.33 g, Vit B_2 1.0 g, Vit B_6 0.33 g, Vit. B_{12} 1.7 mg, Pantathonic acid 3.33 g, Biotin 33 mg, Folic acid 0.83 g, Choline chloride 200 mg, Zn 11.7 g, Mn 5.0 g, Fe 12.5 g, Mg 66.7 mg, Se 16.6 mg, Co 1.33 mg, Cu 0.5 g, I 16.6 mg and Antioxidant 10.0 g.

**The Digestible Energy (DE) in kilocalories per kilogram of dry matter (Kcal/kg DM) was calculated according to [23].

TABLE 2. Nutrient digestion coefficients and nutritive values ($\bar{X}$±SE) of growing Californian rabbits at 13 weeks of age, fed diets supplemented with ginseng and bee pollen.

Items	Experimental groups				Sig.
	Control	Ginseng	Bee pollen	Ginseng + Bee pollen	
Digestion coefficient:					
DM(%)	65.95±0.50	67.18±1.30	69.08±0.73	67.61±1.26	NS
OM(%)	66.64±0.67	68.49±1.56	69.98±0.80	68.80±1.20	NS
CP (%)	73.40±0.82^{b}	73.12±1.80^{b}	77.74±0.60^{a}	76.18±1.33^{ab}	*
EE (%)	58.91±1.94	61.06±2.27	62.26±1.61	63.88±1.50	NS
CF (%)	47.86±2.19	52.99±0.50	49.84±1.38	52.39±1.91	NS
NFE (%)	70.07±0.50	71.71±1.81	73.36±0.78	71.14±1.34	NS
Nutritive values:					
DCP (%)	13.97±0.16^{b}	13.92±0.35^{b}	14.83±0.12^{a}	14.50±0.26^{ab}	*
TDN (%)	62.39±0.67	64.14±1.49	65.53±0.76	64.53±1.30	NS
ME(Kcal/Kg)	2725.4±19.30	2773.7±50.59	2848.03±3.36	2790.3±49.00	NS

Means within the same row that are assigned different letters indicate significant differences ($P \leq 0.05$).
NS= Not significant and *= $P \leq 0.05$.

TABLE 3. Haematological blood parameters of growing Californian rabbits fed diet supplemented with ginseng and bee pollen ($\bar{X}$±SE) at 13 weeks of age.

Items	Normal range	Treatment groups				Sig.
		Control	Ginseng	Bee pollen	Ginseng + Bee pollen	
RBCs (x 10^6/µl)	3.7-7.5	5.70 ±0.16	6.00 ±0.18	8.25 ±1.37	6.24 ±0.25	NS
WBCs (x10^3/dl)	5.2-16.5	13.97 ±0.95	13.39±2.50	12.07 ±0.78	13.8±0.21	NS
32111Hb (g/dl)	8.9-15.6	11.43^{b}±0.09	12.48^{ab}±0.53	12.47^{ab}±0.17	12.90^{a}±0.30	*
Plt (×10^3)	112-715	302.33^{a}±46.19	218.11^{ab}±4.01	184.10^{ab}±31.47	126.6^{b} ±8.84	*
Lymph(%)	30-502	43.50^{c} ±0.86	51.17^{bc} ±4.00	55.07^{ab} ±3.20	65.33^{a} ±3.84	**
NEUT (%)	30-502	44.50^{a}±2.06	38.50^{a} ±3.01	37.87^{a} ±3.47	25.89^{b}±3.95	*
MCV (fl)	58-79.6	73.57^{a}±1.67	70.59^{b}±1.489	69.43^{ab}±1.44	64.86^{ab}±0.17	**
MCH (pg)	19.2- 29.5	20.13±0.72	20.81±0.36	22.30±0.91	20.46 ±0.19	NS
MCHC (g/dl)	31.1-37	27.47^{b}±1.59	29.56^{ab} ±1.06	32.53^{a} ±0.68	31.37^{a} ±0.21	*
HC (%)	26.7-47.2	42.03 ±2.11	42.34±0.65	38.46 ±1.33	41.72±0.90	NS

Means within the same row that are assigned different letters indicate significant differences (P ≤ 0.05).
NS= Not significant and *= P ≤ 0.05.

TABLE 4. Blood serum protein fractions, liver and kidney functions of growing Californian rabbits fed diet supplemented with ginseng and bee ($\bar{X}$±SE) at 13 weeks of age.

Items	Normal Range	Treatment groups				Sig.
		Control	Ginseng	Bee pollen	Ginseng + Bee pollen	
Total protein(g/dI)	5.3-7.5	6.38^{b} ±0.13	6.97^{a} ±0.22	6.79^{a} ±0.09	6.80^{a} ±0.21	*
Albumin (g/dI)	2.5-4.5	3.70^{b} ±0.04	4.26^{a}±0.1	3.95^{ab} ±0.17	4.12^{a}±0.07	*
Globulin (g/dI)	1.9-3.5	2.67±0.87	2.71±0.19	2.84±0.18	2.68±0.18	NS
A/G ratio	1.0 - 3.0	1.39±0.03	1.60±0.18	1.41 ±0.152	1.55 ±0.92	NS
AST(U/L)	16-108	58.23^{c}±2.43	97.37^{a} ±1.01	93.47^{ab} ±7.42	83.40^{b} ±1.59	**
ALT(U/L)	17-67	71.20^{a}±8.09	70.47^{a}±2.42	63.20^{ab} ±0.26	50.25^{b}±5.93	*
Urea-N(mg/dl)	10-28	14.33^{a}±0.33	12.00^{b}±0.58	13.00^{ab}±0.010	13.67^{ab}±0.0.88	*
Creatinine(mg/dl)	0.8-2.5	0.96^{a}±0.002	0.82^{bc}±0.009	0.88^{b} ±0.012	0.85^{b} ±0.019	**

Means within the same row that are assigned different letters indicate significant differences (P ≤ 0.05).
NS= not significant, *= P ≤ 0.05 and ** = P ≤ 0.01.

TABLE 5. Malondialdehyde (MDA) and total antioxidant capacity (TAG) enzymes of growing Californian rabbits fed diet supplemented with ginseng and bee pollen ($\bar{X}$±SE) at 13 weeks of age.

Items	**Treatment groups**				**Sig.**
	Control	Ginseng	Bee pollen	Ginseng + Bee pollen	
MDA (mg/dl)	18.99 ±0.01	19.10 ±0.13	20.03±1.96	19.78 ±1.04	NS
TAC(mM/L)	1.55 ±0.009	1.56±0.09	1.61 ±0.01	1.57±0.035	NS

Means within the same row that are assigned different letters indicate significant differences (P ≤ 0.05).
NS = Not significant.

TABLE 6. Bacterial count in the caecum of growing Californian rabbits fed diet supplemented with ginseng and bee pollen ($\bar{X}$±SE) at 13 weeks of age.

Items	Treatment groups				Sig.
	Control	Ginseng	Bee pollen	Ginseng + Bee pollen	
Salmonella	3.87^{a} ±0.006	2.83^{b} ±0.090	2.70^{b} ±0.032	2.75^{b} ±0.087	**
Escherichia coli	5.69^{a} ±0.384	4.47^{c}±0.300	4.66^{b} 0.240	4.40^{c}±0.684	**
Total count	8.72^{a}±0.318	7.57^{b}±0.252	7.55^{b}±0.410	7.62^{b}±0.136	**

Means within the same row that are assigned different letters indicate significant differences (P ≤ 0.05).
** = P ≤ 0.01.

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تأثيرالإضافة الغذائية لحبوب اللقاح والجينسنج على الاستفادة من العناصر الغذائية والمعايير المناعية والكيميائية الحيوية للدم وعدد البكتيريا في الأعور في الأرانب النامية

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الملخص

هدفت هذه الدراسة إلى تقييم تأثير حبوب اللقاح والجينسنج كمحفزات نمو طبيعية على كفاءة استخدام العناصر الغذائية، ومعايير الدم، وعدد البكتيريا في الأعور لدى أرانب كاليفورنيا النامية. تم تقسيم 60 أرنبًا (بعمر 5 أسابيع وبمتوسط وزن 642.67±15.72 جم) عشوائيًا إلى أربع مجموعات: مجموعة ضابطة على غذاء أساسي، مجموعة تتلقى الجينسنج (250 ملجم/كجم علف)، مجموعة تتلقى حبوب اللقاح (250 ملجم/كجم علف)، ومجموعة تتلقى مزيجًا من الجينسنج وحبوب اللقاح (250 ملجم لكل منهما/كجم علف). استمرت التجربة من الأسبوع الخامس وحتى الأسبوع الثالث عشر من العمر. أظهرت الأرانب التي تناولت حبوب اللقاح تحسنًا ملحوظًا في هضم البروتين الخام، بينما أدى الجينسنغ إلى تحسين هضم الألياف الخام ($P<0.01$). لم تُسجّل تغيّرات معنوية في المادة الجافة أو المستخلص الإيثيري أو العناصر الغذائية القابلة للهضم الكلي. تحسّنت مؤشرات الدم مثل تركيز الهيموجلوبين وعدد الصفائح الدموية ونسبة اللمفاويات وحجم الخلية المتوسطة (MCV) وتركيز الهيموجلوبين في الخلية (MCHC) بشكل معنوي ($P<0.05$ أو $P<0.01$) مع الإضافات الغذائية. كما أظهرت التحاليل الكيميائية الحيوية زيادة في البروتين الكلي والألبومين وAST، مع انخفاض في ALT، اليوريا، والكرياتينين، مع بقاء جميع القيم ضمن المعدلات الفسيولوجية الطبيعية. لم تُلاحظ تأثيرات معنوية على الجلوبيولين أو نسبة الألبومين إلى الجلوبيولين أو MDA أو TAC. ومع ذلك، انخفض عدد البكتيريا، بما في ذلك السالمونيلا والإشريشيا القولونية في الأعور، بشكل معنوي ($P<0.01$) في المجموعات المعززة. خلصت الدراسة إلى أن الجمع بين الجينسنج وحبوب اللقاح بجرعة 250 ملجم/كجم لكل منهما يعزز النمو، والمناعة، وكفاءة استخدام العناصر الغذائية، والكيمياء الحيوية للدم لدى الأرانب النامية، ما يشير إلى كفاءتهما كمكملات غذائية طبيعية واعدة في الظروف المناخية الحارة. ويوصى بإجراء دراسات إضافية باستخدام أحجام عينات أكبر وجرعات مختلفة.

الكلمات الدالة: محفزات النمو، الجينسنج ، حبوب اللقاح، الاستفادة الغذائية، الصفات الكيميائية الحيوية للدم، الاستجابة المناعية.