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(Original Article)

Propolis Effect on Growing Rabbits as Natural Health Product

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Abstract

The study conducted at Faculty of poultry farm, Assiut University. Eighty weaned rabbits (40 of Newzealand and California rabbit breeds. 20 males and females of each) to evaluate the blood performance and energy value of meat of rabbits drenched different doses of propolis. Rabbits were allocated to one of the treatment groups (control group, 0.2, 0.4 or, 0.6 g drenched propolis /kg body weight) from 42 to 84 days of age. The results indicated that, the differences in body weight, daily gain and fed conversion ratio were not significant among all groups. RBCs and Hb were increased significantly of males treated with 0.2 g of propolis group than females and other groups. No significant differences were observed in Hb, WBCSs and total Protein due to sex. Total leucocytes counts were decreased by using propolis 0.2 treatment of females and males, also, 0.2 group treated California rabbits had the lowest values compared with 0.6 g of Newzealand rabbits. Total protein had the highest values in females and males blood samples treated with 0.4g propolis. The treatment with 0.2g increased total protein values in California but the 0.4g level increased it in Newzealand ones. Energy values (kJ.100 g^{-1}) were higher in females (465.38±3.49 vs. 460.04±2.16 kJ.100 g^{-1}), California exceeded New Zealand ones, were not significant. The 0.6g propolis level was the highest one (473.63±2.23) and significant. Correlation between W.H.C and cooking loss was negative and not significant. Both blood performance and energy value formulas are completely panoramic ways to evaluate Rabbits health.

Keywords: *Propolis, Rabbits, Body and blood performance, Energy values.*

Introduction

Many investigators revealed that flavonoids, aromatic acids, diterpenic acids and phenolic compounds appear to be the principal components responsible for the biological activities of propolis samples. It was noted that, propolis had an antioxidant property due to its components galangin and pinocembrin (Martinotti and Ranzato, 2015; El-Guendouz *et al*., 2017; Machado *et al*., 2017). Ethanolic extracts of propolis were more effective against gram-positive bacteria and showed limited effect against gram-negative bacteria (Wagh, 2013; Martinotti and Ranzato, 2015; Harfouch *et al*., 2016). It was investigated that, propolis

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inhibit the aflatoxigenic fungi, and also decreases conidial growth in Aspergillus Flavus. Propolis showed activity against different fungi (Aghel *et al*., 2014; Alvareda *et al*., 2015; Franchin *et al*., 2016).

Waly *et al*. (2021) reported that weaned rabbits at six weeks of age, were fed diet supplemented with propolis significantly ($P<0.01$) increased final live body weight and body weight gains and subsequently significantly ($P<0.05$) improved feed conversion ratio and improved total edible parts percentages, while total feed intake decreased insignificantly compared with control rabbits.

The use of haematological and blood biochemistry parameters has proven to be effective and repeatable ways to monitor rabbit health. Testing these parameters is becoming more common in animal science studies. Further, it is widely accepted that fish and chicken with better health status are more likely to grow faster as less energy should be consumed for maintenance energy. Here, a new formula (Blood Performance) is introduced, which contains five common haematological and blood biochemistry parameters: red blood cells, white blood cells, haemoglobin, haematocrit, and total protein. The idea behind this formula is that any single component of this formula cannot be reliable enough as a biomarker of rabbit health and growth. However, interestingly, blood performance can be much more reliable and accurate for monitoring rabbit health and growth by using the formula recommended by Esmaeili (2021).

Pavelková *et al*. (2017) for protein percent and fat percent of fresh meat produce different energy levels by using different feeding additive materials. They concluded that average energy value was in group A fed by feed wheat and group B was fed by granulated fodder Králik gold forte. 461.89 kJ.100 g^{-1} and 440.27 kJ.100 g^{-1}, respectively.

From the previously published researches, there is no data or studies evaluating the blood performance and meat energy value of rabbits breeds drenched propolis.

For this reason, the present study aimed to evaluate the effects of drenching propolis with different doses on Newzealand and California rabbits' performance and health.

Materials and Methods

Animals and experimental design

Eighty weaned rabbits (40 of Newzealand and California rabbit breeds. 20 males and females of each) were drenched commercial propolis" Beekeeping Bee product propolis powder" weekly for along 45 days. Rabbits after 28 days of adaptation period had initial body weight 839.41±49.50 g. All rabbits were examined clinically and were vaccinated against any internal parasites and bloating. All rabbits were weighed then classified in descending order according to their initial body weight. Rabbits were allocated to one of the treatment groups (control group, 0.2, 0.4 or, 0.6 g drenched propolis /kg body weight). Rabbits were housed in metal boxes individually and kept under the same Faculty poultry

Assiut university farm managerial conditions. Ambient temperature and relative humidity were similar in all of the boxes during all experimental periods. Rabbits were fed concentrate mixture to cover 100% of their daily requirements (Table,1).

Table 1. Diet ingredients and chemical composition of experimental grower rations

Ingredients	Grower diet
Alfalfa hay	28.00
Wheat bran	28.00
Barley	20.00
Soybean meals 44%	12.00
Yellow Corn	7.00
Molasses	3.00
Limestone	1.1
Sodium chloride salt	0.3
Vitamin and mineral Premix[1]	0.6
Total	**100**
Chemical composition of diet	
Dry matter	89.20
Ash	8.80
Crude protein %	16.18
Crude fiber %	13.30
Crude fat%	2.4
Nitrogen free extract	57.33
Digestible energy (Kcal/kg)	2620

Vitamin and mineral premix1 at 0.3% of diet supply the following per kg of diet: Vit. A 1200 IU; 500.000 IU.T3; 0.67 mg Vit.K3;0.67 mg Vit B1; 2.0 mg Vit.B2; 0.67 mg Vit.B6; 0.0004 mg Vit.B12; 16.7 mg Pantothenic acid; 0.07 mg Biotin; 1.67 mg Folic acid; 400 mg Choline chloride; 22.3 mg Zn; 10 mg Mn; 25 mg Fe; 1.67 mg Cu; 0.25 mg I; 0.033 mg Se and 133.4 mg Mg.

Daily feed intake was recorded every 24 hrs. for each group at 8:00 a.m. during the experimental period and subtracted by the residuals. Rabbits were weighed at the beginning of the experiment and then weighed every fortnightly during the experimental period.

Blood sampling

Complete blood count (CBC), and Biochemical Parameters Blood samples were collected monthly at 7:00 a.m. after 12 hours of fasting from ear vein. The complete blood count (CBC) was evaluated in the hematological lab in the Faculty of Veterinary, Assiut University. While the 8 ml was collected into another tube which was centrifuged at 3000 rpm for 15 minutes then serum was collected and stored at -20 °C until subsequent analysis. Serum concentrations of total protein were measured using colorimetric assay kits (GPL Diagnostics, Spain).

Blood performance (BP) was calculated according to Esmaeili (2021):

(BP) = Ln (Hb (g/dL) + Ln Ht (%) + Ln RBC (∗105/mm3) + Ln WBC (∗103/mm3) + Ln TP (g/L).

After 30 days of the end of experiment to eliminate the residual of propolis, rabbits were slaughter and the longismuss dorsi muscle at lumber region was dissected for physical and chemical analysis. Water-holding capacity was based on the method of Wierbicki and Deathrage (1958,) Penny *et al*. (1963), Baker *et al*. (1972) and Boccard *et al*. (1981) and calculated as expressible fluid after pressing it by one Kg for ten minutes. Cooking loss was expressed as the percentage of loss related to the initial sample weight (Boccard *et al*., 1981). Protein and fat percentages of meat were chemically analyzed.

The energy value was calculated according to Pavelková *et al*. (2017) equation:

EV (kJ.100g^{-1}) = (16.75 × P) + (30.68 × F), where P = protein percent, F = fat percent.

Statistical analysis

Data were analyzed using the Statistical Analyses System (SAS, 2005). The traits were analyzed using an analysis of variance, with treatment as fixed effect. The comparisons between different treatments were done using Duncan multiple range test (Duncan, 1955).

Results and Discussion

Body weight and daily gain

Body weight at tenth week of 0.2 g propolis as shown in Tables (2 and 3) increased by 10.86 % more than eighth week of the same supplemented dose. While the other doses of propolis increased by 9.99, 7.60 and 3.99 at the same ages of control, 0.4 and 0.6g propolis. As well as the 0.2g propolis had higher daily gain and feed conversion ratio than other treatments at the same ages besides the total daily gain at twelfths week (44.19±2.53g) and total gain (9.42.67 ± 111.74g).

Bonomi *et al*. (2002) said that propolis can be used as an additive to improve growing rabbits body weight at the doses of 20 and 40 ppm (from 30 to 90 d of age), propolis has improved the weight gain 11 and 18% and improved the feed utilization 11 and 17%, respectively. Yousef *et al*. (2010) mentioned that propolis had beneficial effects in improving body weight and had beneficial effects in improving feed intake according to its role against reproductive toxicity of Triphenyltin in male rabbits. Waly *et al*. (2021) found that unsexed weaned 180 rabbits at six weeks of age, were fed diet supplemented with 0, 100, 150 and 200 mg/kg crude propolis for eight weeks. Also, they observed that supplemented propolis to growing rabbit diets significantly (P<0.01) increased final live body weight and body weight gains and subsequently significantly (P<0.05) improved feed conversion ratio, while total feed intake decreased insignificantly compared with control group, but significantly (P<0.01) improved total edible parts percentages.

Kupczyński *et al*. (2016) Said that propolis supplementation improved final body weight, while the ethanolic extract of propolis has also shown to explicit hepatoprotective effects in rabbits with chronic diarrhea.

Table 2. Means and standard error (Mean ± S. E.) of Body weight, daily gain and feed conversion ratio of growing rabbits drenched propolis between sex and breeds

Weight(g)	Age (day)	Sex		Breed	
		F	M	C	N
Initial B.W.	42	849.41±64.07	825±81.12	882.82±61.26	777.67±82.16
Body weight (g),	56	1312.93±64.37	1276.91±58.96	1350.75±58.39	1212.8±60.13
	70	1405.6±62.39	1397.45±65.77	1462.13±57.41	1306.2±62.63
	84	1674±67.06	1615.36±72.32	1731.88±60.66 [a]	1516.9±64.46 [b]
Daily gain (g)	42:56	64.08±5.34	66.54±9.36	69.52±4.48	58.37±9.96
	56:70	18.67±2.63	20.6±3.21	18.51±2.07	21.76±4.66
	70:84	45.81±1.94 [a]	34.93±3.91 [b]	41.56±2.97	40.18±3.7
	Total 84	43.55±1.48	42±4.03	42.56±1.8	43.68±4.47
	Total 45	914.54±31.14	882±84.63	893.73±37.78	917.29±93.87
Feed conversion (g feed/g gain)	42:56	4.00±0.09	4.21±0.13	4.01±0.1	4.22±0.13
	56:70	4.93±1.32	3.13±0.42	3.78±0.57	4.91±2.14
	70:84	5.01±0.09 [b]	5.93±0.37 [a]	5.42±0.26	5.40±0.26
	Total 84	4.50±0.05	4.52±0.12	4.45±0.07	4.65±0.12

F=Female, M=Male, C=California, N=Newzealand.

Table 3. Means and standard error (Mean ± S. E.) of Body weight, daily gain and feed conversion ratio of growing rabbits drenched propolis different treatments.

Weight(g)	Age (days)	Treatment			
		G1	G2	G3	G4
Initial B.W.	42	830.57±100.38	830.75±111.25	835.43±105.91	861.71±97.27
Body Weight (g)	56	1352.8±133.64	1304.86±78.68	1326.29±97.83	1222.57±65.61
	70	1488±102.93	1446.57±79.41	1427.14±102.55	1271.43±69.11
	84	1790.8±124.36	1653.57±92.21	1659.29±92.71	1533.57±87.2
Daily gain (g)	42:5	64±7.54	63.59±14.02	70.12±8.27	61.76±6.75
	56:70	19.31±6.75	23.95±2.17	16.86±3.02	17.71±4.23
	70:84	43.26±5.49	37±6.27	39.6±4.07	44.83±2.1
	Total 84	42.19±2.53	44.89±5.32	42.96±3.49	41.22±2.67
	Total g 45	886±53.08	942.67±111.74	902.17±73.21	865.6±56.12
Feed conversion (g feed/g gain)	42:56	4.17±0.16	3.92±0.23	4.07±0.1	4.20±0.13
	56:70	5.04±1.5	4.63±0.27	5.57±2.4	4.24±0.62
	70:84	5.27±0.39	5.93±0.6	5.40±0.24	5.03±0.09
	Total 84	4.54±0.09	4.63±0.17	5.14±0.11	4.48±0.08

G1=Control group, G2=0.2 g drenched propolis, G3=0.4 drenched propolis, G4=0.6 drenched propolis

Blood parameters (Table, 4) show that RBCs were increased significantly of males treated with 0.2 g of propolis group than females (5.92±0.17a vs. 5.02±0.18b) then 0.6 g group (5.06±0.19 vs. 5.27±0.31), the 0.4 g group (5.21±0.17 vs 5.27±0.34), and finally control group was (4.94±0.13 vs. 4.95±0.13).

Also, Hb values had the same trend where the 0.2 g treated males were higher than females (12.92±0.23 vs. 11.74±0.51) and the least values were contributed to the control group (11.67±0.52 vs. 11.5± 0.24). It depends on the differences between different breeds and sex. The possible reason can be the variability of energy demand and metabolism in different fish species and vertebrates (Brett, 1972, Kramer, 1987); it seems that this decrease has been a global response to stress given that regardless of kind of stress and species, the Hb was decreased. (Esmaeili, 2021). No significant differences were observed in Hb, WBCSs and total Protein due to sex.

Table 4. Complete blood count (Mean ± S.E.) of sex and each different treatments of growing rabbits

Variable	Sex							
	Female				Male			
	G1	G2	G3	G4	G1	G2	G3	G4
RBCS, 10^6/cmm	4.94± 0.13	5.02±0.18[b]	5.21±0.17	5.06±0.19	4.95±0.13	5.92±0.17[a]	5.27±0.34	5.27±0.31
Hb, g/dl	11.5± 0.24	11.74±0.51	11.58±0.26	11.38±0.4	11.67±0.52	12.92±0.23	11.93±0.84	12.13±0.49
Hematocrit, %	35.07±0.6	36.6±1.75[b]	36.99±1.04	35.9±1.01	35.67±1.28	42.00±1.17	37.4±3.07[a]	37.05±1.76
Platelets count, 10^3/cmm	271.33±31.05[a]	392.4±75.5[a]	419.5±56.71	295.63±66.04	268±13.71[b]	243.67±72.37[b]	273.33±102.52	357.17±136.85
WBCs, 10^3/cmm	8.56±1.33	6.14±0.88	10.73±1.55	7.28±0.59	8.09±1.09	7.85±1.24	11.3±1.44	8.14±0.43
TP, (g/dl)	8.29±0.94	10.94±0.54	12.93±3.03	10.1±1.08	17.4±8.54	13.69±0.84	18.66±5.74	11±0.55
Blood Performance	11.7±0.23	11.75±0.23 [b]	12.52±0.28	11.79±0.21	12.56±0.81	12.68±0.16 [a]	12.99±0.31	12.23±0.18

WBCs, White blood cells; TP, total protein, G1=Control group, G2=0.2 g drenched propolis, G3=0.4 drenched propolis, G4=0.6 drenched propolis. a, b, are significantly different at ($p>0.05$) between the same treatment of each sex.

The treatments 0.4 and 0.6 propolis were significantly higher ($P<0.5$) for platelets count of females and males but between breeds the 0.4g and 0.2g were higher for California and Newzealand rabbits, respectively. as compared to the groups and control.

Total leucocytes counts were decreased by using propolis 0.2 treatment of females and males, also, 0.2g treated California rabbits had the lowest values compared with 0.6 g of Newzealand rabbits. It is debatable whether the higher number of WBCs was caused by the supplements or if it was simply a result of optimal health and growth regardless of additives. Many, if not all, stress-related neuroendocrine elements influence immune response directly or indirectly. Depending on their concentration, target cell, and the specific immune function studied, these elements have either an enhancing or suppressive effect on the immune system (Khansari *et al*., 1990).

Total protein had the highest values in females and males blood samples treated with 0.4g propolis. The treatment with 0.2g increased total protein values in California rabbits but the 0.4g level increased it in Newzealand ones.

Blood performance had the same trend for both sex and breed except at 0.2g treated females were less than males significantly.

Kupczyński *et al*. (2016) WBCs, RBCst were highly significant increase in rabbits with chronic diarrhea. Also, Hashem *et al*. (2018) showed that using of propolis in combination with killed vaccine of Pasteurella multocida improved the immune response by increasing RBCs, Hb, MCHC%, Platelets and WBCs, Neutrophils, lymphocytes, Monocytes, phagocytic% were highly significant increase of Newzealand rabbits.

Fouad *et al*. (2021) showed that supplementation of propolis at levels of 200, 400 and 600 mg of propolis/kg feed significantly (P<0.01) increased blood components; Hb, RBC, PCV, WBCs, lymphocyte in Japanese quail.

Mona *et al*. (2021) reported that Propolis supplemented groups revealed that Propolis improved the Newcastle disease vaccine antibody production in both supplemented groups, and significantly improved the phagocytic activity in both supplemented groups. Total leukocytic count was significantly increased in propolis supplemented group with significant increase in lymphocytes and concurrent decrease in heterophils in one day old chicks.

The correlation between Hb with Hematocrit and Blood Performance (Tables 5 and 6) was positive and highly significant (p<0.01) 0.88129 and 0.39388, respectively. The correlation between Hb with Platelets count, TP and WBCs was positive and not affected. Also, correlation coefficients between Ln Hb and Cooking loss, TP and WBCs were positive and no significant. But between Energy Value and W.H.C % were negative and no significant.

Table 5. Complete blood count (Mean ± S.E.) of breed and each different treatments of growing rabbits

Variable	BREED							
	CALIFORNIA				NEWZELAND			
	G1	G2	G3	G4	G1	G2	G3	G4
RBCS, 10^6/cmm	4.94±0.09	5.48±0.18	5.4±0.21	5.32±0.22	5.18±0.08	5.6±0.57	4.93±0.09	4.98±0.25
Hb, g/dl	11.57±0.24	12.31±0.28	12.13±0.28 ^{a}	12.01±0.28	11.8±0.15	12.57±0.99	10.88±0.3 ^{b}	11.39±0.56
Hematocrit, %	35.31±0.6	39.54±1.51	38.87±1 ^{a}	37.69±1.25	36.91±0.5	39.57±2.99	34±1.11^{b}	35.1±1.25
Platelets count, 10^3/cmm	230.00±23.25	218.63±32.61^{b}	415.86±71.86	386.43±128.63	305.06±25.85	558.33±57.91^{a}	316.25±63	257.57±39.66
WBCs, 10^3/cmm	8.36±1.76	6.41±0.92	8.93±0.74 ^{b}	7.93±0.57	10.11±1.75	8.83±1.21	14.3±2.06^{a}	7.37±0.55
TP, (g/dl)	11.94±3.48	13.01±0.83	10.75±1.16	11±0.99	12.25±1.23	11.62±1.29	20.5±5.65	10.1±0.83
Blood Performance	12.04±0.35	12.22±0.23	12.43±0.23	12.17±0.09	12.21±0.13	12.51±0.4	13.01±0.4	11.85±0.26

WBCs, White blood cells; TP, total protein, G1=Control group, G2=0.2 g drenched propolis, G3=0.4 drenched propolis, G4=0.6 drenched propolis. a, b, are significantly different at (p>0.05) between the same treatment within each breed.

As well as, RBCs correlated with Hb, Hematocrit and blood Performance was positive and highly significant (p<0.01) 0.52445, 0.67331, 0.44803, respectively. The correlation between RBCs and RDW and Platelets count was significant (p<0.05) and positive 0.37791, 0.34002, respectively and the correlation between RBCs and TP, WBCs was positive and not affected, respectively.

Table (6). Correlation coefficients between blood components of different genders, breeds and treatments

	RBC's	Hb	Hematocrit	Platelets count	WBCs	TP	Blood Performance
RBC's, 10^6/cmm	1						
Hb, g/dl	0.52445** <.0001	1					
Hematocrit, %	0.67331** <.0001	0.88129** <.0001	1				
Platelets count, 10^3/cmm	0.34002* 0.0146	0.11248 0.4319	0.3187* 0.0226	1			
WBCs, 10^3/cmm	0.02457 0.8641	0.1454 0.3087	0.10593 0.4594	-0.06319 0.6596	1		
TP, (g/dl)	0.12529 0.3961	0.19906 0.175	0.17852 0.2248	-0.12534 0.396	0.84384** <.0001	1	
Blood Performance	0.44803** 0.001	0.45005** 0.0013	0.44967** 0.0013	0.06243 0.6734	0.77851** <.0001	0.86574** <.0001	1

WBCs, White blood cells; TP, total protein.

The Natural logarithm (Table 7) of RBCs with Hb, Hematocrit was correlated positively and highly significant, where it was no significant with WBCs. Also, TP was positive and significant. But, Energy Value, W.H.C. and cooking loss were negative and no significant.

These highly significant correlation coefficients are normally because those Red Blood Cells (RBCs) are the most common type of blood cells in vertebrates and are in charge of delivering oxygen (O2). Also, it had been noticed that the most active ones (usually those at higher trophic levels) have a higher number of RBCs than the sluggish ones (Tandon, and Joshi, 1976). However, higher RBCs can indicate potentially better oxygen delivery to tissues. (Esmaeili, 2021).

Table 7. Correlation coefficients between blood components natural logarithm of different genders, breeds and treatments

	Blood Performance	Ln RBCs	Ln Hb	Ln Hematocrit	Ln WBCs	Ln TP	Energy Value	W.H.C	Cooking loss
Blood Performance	1								
Ln RBCs	0.46032** 0.001	1							
Ln Hb	0.44805** 0.0014	0.52443** <.0001	1						
Ln hematocrit	0.45609** 0.0011	0.67297** <.0001	0.88616** <.0001	1					
Ln WBCs	0.8313** <.0001	0.15706 0.271	0.11575 0.4186	0.09127 0.5242	1				
Ln TP	0.85018** <.0001	0.29188* 0.0441	0.26777 0.0658	0.27815* 0.0556	0.52391** 0.0001	1			
Energy Value, kJ.100g^{-1}	-0.17554 0.2851	-0.16984 0.2884	-0.00287 0.9858	-0.05763 0.7204	-0.1633 0.3077	-0.14304 0.385	1		
WHC, %	0.02158 0.8881	-0.10544 0.4757	-0.16118 0.2738	-0.09 0.543	0.11339 0.4429	-0.03834 0.8026	0.09422 0.5579	1	
Cooking loss, %	0.0475 0.7567	-0.07845 0.5961	0.04891 0.7413	0.05488 0.711	0.08083 0.585	-0.03648 0.812	-0.22789 0.1519	-0.07384 0.6179	1

Table 8. Chemical and physical analysis of different genders, breeds and treatments.

Item	Gender		Breed		Treatment			
	F	M	C	N	G1	G2	G3	G4
Fat, %	4.31±0.12	4.12±0.06	4.22±0.09	4.15±0.08	4.57±0.15 [a]	4.18±0.08[b]	4.05±0.05[b]	3.99±0.07[b]
Moisture, %	71.05±0.17	71.14±0.09	70.98±0.14	71.23±0.09	70.87±0.23	71.08±0.14	71.28±0.13	71.18±0.15
Ash, %	1.31±0.02	1.27±0.02	1.3±0.02	1.28±0.02	1.37±0.03 [a]	1.28±0.01[b]	1.25±0.02[b]	1.25±0.01[b]
Protein, %	19.89±0.23[b]	19.91±0.16 [a]	19.86±0.19[b]	19.95±0.18[a]	18.74±0 [d]	19.48±0 [c]	20.23±0 [b]	20.98±0[a]
Energy Value, $kJ.100g^{-1}$	465.38±3.49	460.04±2.16	462.07±2.79	461.41±2.54	454.22±4.71[c]	454.75±2.47[c]	463.09±1.67[b]	473.63±2.23[a]
Cooking loss, %	35.94±0.72	37.88±1.5	37.23±1.04	36.04±1.19	39.86±0.8[a]	38.41±1.78[ab]	34.41±1.6 [b]	34.89±1.24[b]
WHC%	31.82±1.5[a]	25.37±1.24[b]	27.47±1.08[b]	31.64±2.34[a]	24.64±1.44[b]	28.59±2.17[ab]	32.01±2.36[a]	29.54±2.11[ab]

F=Female, M=Male, C=California, N=Newzealand, G1=Control group, G2=0.2 g drenched propolis, G3=0.4 drenched propolis, G4=0.6 drenched propolis, WHC%= Water holding capacity.

Thus, Hemoglobin From a systematic standpoint to a deep physiological concept, Hb is one of the most studied proteins among biologists. These findings indicate that Hb cannot be used as a biomarker on its own (Brett, 1972, Kramer, 1987 and Esmaeili., 2021). The structure and diversity of this protein are beyond the scope of this paper and have been well described elsewhere (De Souza *et al*., 2007).

While hematocrit had the highest value at 0.4 g treated females and at 0.2 g of males (36.99±1.04 and 42.00±1.17, respectively). But between breeds the 0.2g treated both breeds were of the higher values than different treatments. The correlation between Hematocrit and Blood Performance was positive and highly significant ($p<0.01$) 0.44967. Similarly, Correlations between Ln Hematocrit and WBCs and Cooking Loss were positive and not significant. But, with TP it was positive and significant. While it correlated with Energy Value and W.H.C were negative and not significant.

Since, Hematocrit percent (HT %) shows the volume of RBCs to the plasma. It is widely accepted that higher Ht, showing higher viscosity, is beneficial for health (Moreno *et al*., 2000) in animals, from a long time ago, higher Ht is well connected to higher production (Reynolds, 1953). Increasing Ht within a normal range can represent a good sign of optimized oxygen transport and health but not any unlimited increase. As a result, the relationship between oxygen transport and Ht is a parabolic shape (Kuo, and Pittman, 1988). Thus, Ht can be used as an indicator, but caution is required when drawing conclusions. However, an abnormally high level of Ht can indicate a variety of health issues, including dehydration and kidney disease (Ma *et al*., 1999).

Blood Performance was negatively correlated with MCV, MCH and MCHC, but positively and highly significant correlated with WBCs. WBCs and TP were positively and highly significant correlated with each other.

Total serum protein is one of the most common and useful blood parameters to measure. Serum proteins perform a wide range of functions, including maintaining osmotic pressure, pH, transporting various metabolites and interacting closely with the immune system. This parameter can show the nutritional status of the body indirectly (Zheng *et al*., 2017).

The correlation between TP and Blood performance was positive and highly significant ($p<0.01$) 0.86574. TP not affected significantly by propolis supplementation. Total protein value was the highest at 0.4 g propolis (18.66±5.74) and the blood performance had the same trend (12.99±0.31).

Correspondingly, Correlations between Ln WBCs and LnTP were positive and highly significant. But, with Energy Value was negative and non-significant (Tables 7 and 8). While it correlated with W.H.C. and Cooking loss positive and non-significant. Similarly, correlation between W.H.C and cooking loss was negative and not significant. Whereby increasing cooking loss percentages, the W. H. C. which measured as expressible fluid, was decreased as a result of meat holding water. Correlations between Energy Value and W.H.C were positive, but with cooking loss was negative and non-significantly correlated for both.

Correlations between the blood performance and natural logarithm of RBCs, Hb, Haematocrit, WBCs and TP were positive and highly significant. But between blood performance and Energy value it was negative and no significant. Correlations between blood performance and (W.H.C, Cooking loss) it was positive and no significant. These results are in accordance with the reviewed ones by Esmaeili, (2021).

Energy values (kJ.100 g^{-1}) were higher in females than males (465.38±3.49 vs. 460.04±2.16 kJ.100 g^{-1}), California also exceeded New Zealand ones (462.07±2.79 vs. 461.41±2.54 kJ.100 g^{-1}) and were not significant. The significant and highest value was with the dose 0.6 propolis and followed by 0.4 dose (473.63±2.23 and 463.09±1.67 kJ.100 g^{-1}). The control and 0.2 groups were nearly equal. This may be attributes for either the fat or protein percentages.

Pavelková *et al*. (2017) reported that average energy value was in group A 461.89 kJ.100 g^{-1} and in group B 440.27 kJ.100 g^{-1}. Havlín (1983), shows approximately the same energy value (468.5 kJ.100 g^{-1}) as it was in our Group A. Dalle Zotte (2002) shows energy value in the range 427 – 849 kJ.100 g^{-1}. Hernàndez and Dalle Zotte (2010) and Dalle Zotte and Szendro (2011) specify of energy value of meat rabbits onto 789 kJ and Dalle Zotte (2002) point out of energy value in the range 427 – 849 kJ. Pogány Simonová *et al*. (2010) also, indicated of energy value in rabbit in the range of 416.65 – 491.03 kJ and in control group 415.11 kJ.

Blood Performance and Growth After absorbing energy from feed, this energy contributes to four major physiological components: growth, respiration, energy losses through feaces and nitrogenous excretory products (Jobling, 1995). A wide range of studies including supplementing diets with probiotics, herbal medicine, minerals, fatty acids, yeast, hormones, algae, polysaccharides and lecithin were covered to make a more solid conclusion about the relationship between growth and BP (Esmaeili, 2021). Also, there is a need to use propolis rather than antibiotics.

Conclusion

Goal of work was compared influence of different propolis treatments on chosen parameters (body and blood performance, blood parameters formula, cooking and expressible fluids and energy value) of rabbit's health in commercial rearing.

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تأثير البروبوليس على الأرانب النامية كمنتج صحي طبيعي

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الملخص

أجريت هذه الدراسة بمزرعة الدواجن بكلية الزراعه بجامعة أسيوط. لتقييم أداء الدم وقيم الطاقة على صحة الأرانب المجرعة بجرعات مختلفة من البروبوليس، قسمت الأرانب (80 أرنب 40 نيوزيلندى و40 كاليفورنيا و20 ذكور و20 إناث من كل نوع) لمجموعات (المجموعة الضابطة، 0.2، 0.4 أو 0.6 جم بروبوليس / كجم من وزن الجسم) من 42 إلى 84 يومًا من العمر. أشارت النتائج إلى أن الفروق في وزن الجسم والزيادة اليومية ونسبة التحويل الغذائي لم تكن معنوية بين جميع المجموعات. تم زيادة عدد كرات الدم الحمراء والهيموجلوبين بشكل معنوي في الذكور الذين تم تجريعهم بـ 0.2 جم من مجموعة البروبوليس مقارنة بالإناث والمجموعات الأخرى. لم يلاحظ وجود فروق معنوية في الهيموجلوبين وخلايا الدم البيضاء والبروتين الكلي بسبب الجنس. إنخفضت خلايا الدم البيضاء بإستخدام جرعة 0.2 للإناث والذكور، وأيضًا، كانت المجموعة التي جرعت 0.2 من نوع كاليفورنيا أقل القيم مقارنة بالتي جرعت 0.6 جم من النيوزيلندي. كان للبروتين الكلي أعلى قيم في دم الإناث والذكور المجرعة 0.4 جم بروبوليس. أدت معاملة 0.2 جم إلى زيادة قيم البروتين الكلية في الكاليفورنيا ولكن جرعة 0.4 جم أدت لزيادة قيم البروتين الكلي في النيوزيلندي. كانت قيم الطاقة ($kJ.100\ g^{-1}$) أعلى في الإناث من الذكور (465.38 ± 3.49 مقابل 460.04 ± 2.16 $kJ.100\ g^{-1}$)، كما تجاوزت أرانب كاليفورنيا قيم مثيلتها من النيوزيلندي ولم تكن كبيرة. أيضا، كانت جرعة 0.6 جم الأعلى معنوياً (473.63 ± 2.23). كان الإرتباط بين السائل المرتشح والفقد بالطهي سلبيًا وليس معنويًا. ربما يكون أداء الدم وقيمة الطاقة أفضل الطرق التي تعطي رؤية شاملة لتقييم صحة الأرانب.