# EFFECT OF PROPOLIS SUPPLEMENTATION ON GROWTH PERFORMANCE, NUTRIENTS DIGESTIBILITY, CARCASS CHARACTERISTICS AND MEAT QUALITY OF GROWING NEW ZEALAND RABBITS

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## SUMMARY

This study aim to evaluate the effect of crude Egyptian propolis supplementation to growing New Zeland white rabbits diets on growth performance, nutrients digestibility, carcass characteristics and meat quality. A total of 180 unsexed weaned rabbits at six weeks of age were randomly distributed into four groups. The groups were fed diet supplemented with 0, 100, 150 and 200 mg/kg crude propolis. The experimental period extended for eight weeks. The results showed that supplemented propolis to growing rabbit diets significantly (P<0.01) increased final live body weight and body weight gains, and significantly (P<0.05) improved feed conversion ratio, while total feed intake decreased insignificantly compared with control group. There were no significant differences in DM, CF, EE and NFE digestibility coefficients. While, the digestibility coefficients of OM and CP, and the nutritive values DCP and TDN were significantly increased. Supplementing rabbit diets with propolis also significantly (P<0.01) improved carcass, dressing and total edible parts percentages, whereas heart, kidney, liver and giblets were not affected. Propolis supplementation significantly (P<0.01) decreased abdominal fat percentages and insignificantly decreased shoulder fat percentages. The inclusion of propolis in diet significantly increased the spleen percentages (p<0.01) and impiety small intestine percentages (p<0.05). There were no significant differences for total protein and pHu in meat between all treatment groups. Increasing propolis level in the diet significantly decreased total cholesterol, triglycerides and malondialdehyde. The addition of propolis in the rabbit diet positively influenced the physical properties of rabbit meat by significantly decreasing (P<0.01) its drip and cook loss percentages. It can be concluded that propolis addition in growing New Zeland rabbit diets improved productive performance, some nutrient digestibility, some carcass characteristics and meat quality.

***Keywords:*** *Propolis, growing rabbit, growth performance, nutrients digestibility, carcass characteristics, meat quality.*

## INTRODUCTION

Meat of rabbit is considered a healthy food (Ouhayoun, 1992; Dalle Zotte, 2002; Combes, 2004; Bianchi, *et al*., 2006) because it is lean, rich in proteins, low in cholesterol and high in polyunsaturated fatty acids (Bazan *et al*., 2011 and Wall *et al*., 2010). Propolis is a natural product from the honey bee used in the folk medicine for a long time (Attia *et al*., 2017). The term propolis comes from two Greek words, pro (which means for or in defense of) and polis (which means the city); thus propolis means in defense of the city or beehive (Ghisalberti, 1979). Propolis contains about 300 compounds with three main groups: flavonoids, phenolic acids and esters (Simoes, *et al*., 2004).

Abd El-Hady and Hegazy (1994) reported that Egyptian propolis contains phenolic acids esters (72.7%), phenolic acids (1.1%), aliphatic acids (2.4%), dihydrochalcones (6.5%), chalcones (1.7%), flavanones (1.9%), flavones (4.6%) and tetrahydrofuran derivatives (0.7%). Many scientific papers have been published on the chemical composition of propolis, it contains organic compounds such as polyphenolics (58%) and flavonoids (28%) (Kurek-Górecka *et al*., 2014), active components like polyphenols, terpenoids, steroids, sugars, amino acids (Benzie and Strain, 1999).

Propolis has an antioxidant activity (Fokt *et al*., 2010; Piccinelli, *et al*., 2013 and Bittencourt *et al*., 2015). That may be related to the high content of polyphenolic compounds, such as flavonoids (Mello and Hubinger 2012 and Piccinelli *et al*., 2013). Propolis plays an important role in bee hives, it

considered as a chemical weapon against pathogenic microorganisms (Fokt *et al*., 2010; Bankova 2005). Propolis shows antibacterial (Silici and Kutluca 2005), antifungal (Kartal *et al*., 2003), antiviral (Amoros *et al*., 1992), anti-inflammatory (Fokt *et al*., 2010), immunostimulating (Oršolić *et al*., 2004) and hepatoprotective (Won Seo *et al*. 2003) activities.

Garcia *et al*. (2004) found that supplemented rabbit diet with 0.1% propolis improved weight gain and feed conversion. Also, in broiler supplemented 0.03% propolis reduced the feed intake and improved the body weight and feed conversion ratio (Attia *et al*., 2014). The mixture of bee pollen and propolis decrease the level of triglycerides, cholesterol, creatinine and blood urea nitrogen in rats (Hu *et al*., 2003). The propolis supplemented to the rat diet improved the growth rate and the digestive utilization of iron and the regeneration of the haemoglobin (Haro *et al*., 2000). The propolis improved the reproductive traits and blood profile of rabbit does (Attia *et al*., 2015). Also, propolis has antibiotic properties and may improve growth performance, feed efficiency and feed intake of animals (Sarker and Yang, 2010). These may be due to that it contains antioxidants, vitamins, minerals, phenolic constituents and enzymes (El-Hanoun *et al*., 2007)

The aim of this study was to evaluate the effects of propolis supplementation on the growth performance, nutrient digestibility, carcass characteristics and meat quality of growing New Zealand white rabbit.

## MATERIAL AND METHODS

This study was designed to evaluate the effect of different levels of propolis (0, 100, 150 and 200 mg/kgm diet) as a feed supplement to growing New Zeland white rabbits diets on growth performance, digestibility, carcass characteristics and meat quality. At 6 weeks of age 180 unsexed New Zealand white weaned rabbits were allocated to four dietary groups with three replicates (15 each). Rabbits were individually housed in wire cage for 8 weeks. Drinking water and feeders were presented to rabbit *ad-libitum*. Basal diet was formulated according to NRC (1977). The chemical composition of the experimental diets was reported in Table (1).

**Table (1):** Ingredients and chemical composition of the experimental diets

| Ingredients | % | Chemical composition: | On DM bases, % |
|---|---|---|---|
| Corn, ground | 31.95 | Dry matter | 87.80 |
| Soybean meal 44% | 11.50 | Crude protein | 16.00 |
| Wheat bran | 11.50 | Crude fibre | 13.04 |
| Berseem hay | 39.00 | Ether extract | 7.80 |
| Molasses | 5.00 | Nitrogen free-extract | 54.57 |
| NaCl | 0.50 | Calcium | 0.59 |
| Methionine | 0.25 | Total phosphorus | 0.35 |
| Premix | 0.30 | DE (Kcal/kg diet) | 2669 |

*DE- Digestible energy (Kcal/kg diet) provided by calculation*
*premix: Each 3 kg contain: vitamin A, 12.000.000 IU; vitamin D, 2.500.000 IU; vitamin E, 10.000 mg; vitamin K3, 1000 mg; vitamin B1, 1000 mg; vitamin B2, 5000 mg; vitamin B6, 1500 mg; niacin, 30.000 mg; biotin, 50 mg; folic acid, 1000 mg; pantothenic acid, 10.000 mg; Mn, 60.000 mg; Zn, 50.000 mg; Fe, 30.000 mg; Cu, 5.000 mg; Se, 100 mg; Co, 100 mg; Mn, 250.000 mg; CaCo3, up to 3kg.*

At the beginning of the experiment, rabbits (6 weeks old) were weighted and separated into three groups with similar live weight. The individual live body weight and feed consumption of rabbits were weekly recorded. The body weight gain and feed conversion ratio were calculated.

At the end of the experiment digestibility of nutrients was measured by Cheeke (1987). Three male in each rabbit groups (14 weeks of age) were individually housed in metabolic cages and samples of feed and feces were daily collecting. Also, the digestible crude proteins (DCP) and total digestible nutrients (TDN) were calculated according to Cheeke *et al*. (1982). The feces samples were oven- dried at 60°C for 24 h and then grounded. Samples of diet and feces were chemically analyses according to the classical (AOAC, 1996).

For the evaluation of carcass, 3 male rabbits in each group at the end of the experiment were fasted for 12h and slaughtered. The hot carcass, liver, kidneys, heart, spleen and impiety small intestine were weighted and the percentages were calculated, also the dressing, giblets and total edible parts percentages were calculated. The L. lumborum muscles (between the 1st and 7th lumbar vertebra) of each carcass were used to determine the chemical composition. After slaughter the pH values were measured by using a pH meter according to Blasco *et al*. (1993).

Mixture of meat were stored on -20°C for 4 days before chemical measurements, total protein, total cholesterol, triglycerides and malondialdehyde (MDA) contents were determined by colorimetric methods using analytical kits produced by Biodiagnostic Company, Egypt. Drip loss percentages were calculated by divided the difference between weights before and after chilling for 24h. By the first weight (Lundström and Malmfors, 1985). The cooking loss was determined according to Omojola and Adesehinwa (2006). The obtained data were subjected to analysis of variance using the general linear model (GLM) procedure of SAS User's guide (SAS, 2001). And Duncan's Multiple Range test (Duncan's, 1955) was used to separate means. Statistical significance used the following model at probability level of ($P<0.05$):

$$Yij = \mu+Ti+eij.$$

Where: $\mu$= Overall mean of Yij, Ti = Effect of treatment, I=(1,2,3) eij =Random error.

## RESULTS AND DISCUSSIONS

### *Growth performance*

The effects of supplementing growing rabbit diets with propolis on growth performance are presented in Table (2). Data clearly showed that as the level of propolis was increased final live body weight and total weight gain and feed conversion ratio were gradually improved. Rabbits fed basal diet supplemented with 200mg/kg propolis recorded higher final live weight by 12.34% and higher total weight gain by 17.33%, respectively compared with the control group. There were no differences in feed intake between treatment groups. These results are in agreement with Hashem *et al*. (2017) who found that feed conversion was improved and live body weights and weight gain of rabbits were higher in the groups received diets contained 150 and 300mg/kgm propolis compared to the control. Also, Attia *et al*. (2015) reported that all natural growth promoters including propolis improving productive and reproductive performance, significant lowering of feed intake and improved feed conversion of rabbit does. Supplementing broiler duck with 0.02 or 0.04 g propolis/kg diet increased BWG by10.50 and13.50%, respectively during day-old to 60 days of age (Bonomi *et al*., 2002). On the other hand, Coloni (2007) and Piza *et al*. (2021) reported that inclusion of crude propolis in growing rabbit diets did not increase the weight gain. The current results may be related to that propolis could promote intestinal health by increase the levels of beneficial bacteria and decrease the pathogenic types (Kacaniova *et al*., 2012). Additionally, propolis is an alternative source to antibiotics in diet (Itavo, *et al*., 2011) which may improve growth performance and feed efficiency of animals (Sarker and Yang, 2010). Also, propolis has antimicrobial, anti-inflammatory, and immunomodulatory properties (Daneshmand *et al*., 2015) which allowing for better utilization of nutrients. Moreover, propolis stimulates the activities of saccharase, amylase and phosphatase by progress nutrient digestibility and absorption (Marieke *et al*., 2005).

**Table (2):** Effect of supplementing diet with propolis on growth performance.

| Items | Experimental groups | | | | Pooled SE | Sig |
|---|---|---|---|---|---|---|
| | Control | 100mg/kg Propolis | 150mg/kg Propolis | 200mg/kg Propolis | | |
| Initial live weight (g) | 631.67 | 628.67 | 623.33 | 629 | 25 | Ns |
| Final live weight (g) | 2249.67$^{c}$ | 2396$^{b}$ | 2484.67$^{ab}$ | 2527.33$^{a}$ | 38.41 | ** |
| Total weight gain (g) | 1618$^{c}$ | 1767.33$^{b}$ | 1861.33$^{ab}$ | 1898.33$^{a}$ | 28.85 | ** |
| Total feed intake (g) | 4610 | 4293.3 | 4190.2 | 4092.8 | 73.61 | Ns |
| FCR | 2.86$^{a}$ | 2.43$^{b}$ | 2.25$^{b}$ | 2.16$^{b}$ | 0.02 | * |

*a, b…. Means within each row have no similar letters are significantly different (P ≤ 0.01)*

***Nutrient digestibility coefficients***

The influences of dietary supplementation with propolis on nutrient digestibility coefficients and nutritive values of growing rabbits are shown in table (3). There were no difference between different groups in DM, CF, EE and NFE digestibility coefficients. Coefficients of OM were significantly ($p<0.05$) improved with supplementing growing rabbit diets with propolis compared to control group and the best result was recorded to the group fed diet contained 200mg/kg diet propolis. The digestibility coefficients of CP were significantly increased ($P<0.05$) in the groups contained 100, 150 and 200mg/kg propolis by 2.57, 3.7 and 6.71%, respectively, compared to the control group. The nutritive values as DCP were significantly ($P<0.05$) elevated with propolis supplemented in rabbit diets by 2.45, 3.64, and 6.62%, respectively, compared to the control group. There were no significant differences in TDN between the control and the group contained 100mg/kgm propolis. Whereas, TDN were significantly improved in groups contained 150 and 200mg/kgm propolis compared to control.

Zanato (2008) found that use of prebiotics in the growing rabbits diets improved the digestibility of DM and CP. The improvement in the digestibility coefficient of OM and CP may be due to that Propolis has the ability to improve nutrient digestibility and absorption which stimulate the activities of saccharase, amylase and phosphatase (Marieke *et al*., 2005). Also, propolis contains benzoic and 4-hidoxibenzoic acid, which may improve the digestibility of such nutrients as protein and ash (Seven, 2008 and Seven *et al*., 2012). On the other hand, Piza *et al*. (2021) showed no difference in nutrient digestibility, whereas Prado (2011) mention that propolis had a bad effect on digestibility due to that propolis contain wax which is indigestible.

**Table (3):** Effect of supplementing diet with propolis on Nutrient digestibility coefficients and nutritive values

| Items | Experimental groups | | | | Sig | Pooled SE |
|---|---|---|---|---|---|---|
| | Control | 100mg/kg Propolis | 150mg/kg Propolis | 200mg/kg Propolis | | |
| DM | 64.21 | 65.12 | 65.7 | 67.71 | 0.55 | Ns |
| OM | $65^{b}$ | $65.8^{b}$ | $66.2^{ab}$ | $68.59^{a}$ | 0.52 | * |
| CP | $73.8^{c}$ | $75.67^{bc}$ | $76.55^{ab}$ | $78.75^{a}$ | 0.65 | ** |
| CF | 34.33 | 35.72 | 36.1 | 40.1 | 1.5 | Ns |
| EE | 67.2 | 70.2 | 69.55 | 71.1 | 1.2 | Ns |
| NFE | 68.59 | 69.22 | 71.16 | 68.7 | 0.6 | Ns |
| Nutritive value (%DM) | | | | | | |
| DCP | $13.44^{c}$ | $13.77^{bc}$ | $13.93^{ab}$ | $14.33^{a}$ | 0.22 | ** |
| TDN | $61.75^{b}$ | $62.6^{b}$ | $65^{a}$ | $63^{ab}$ | 0.47 | * |

*a, b and c: Means in the same row having different superscripts differ significantly.*

***Carcass characteristics***

The effects of supplementing diet with propolis on carcass characteristics are presented in Table (4). Dressing percentages were significantly ($P<0.01$) increased by 9.08, 17.54 and 21.85% for the groups contained 100, 150 and 200mg propolis, respectively compared with the control. Also, carcass and total edible parte percentages were significantly increased. Whereas, there were no significant effects on heart, kidney, liver and giblets percentages. Abdominal fat was significantly ($P<0.05$) lower in the groups fed diets contained propolis and shoulder fat was insignificantly lower than the control. The relative weight of spleen was significantly ($P<0.01$) increased by supplementing propolis to growing rabbit diets. The small intestine percentage was significantly ($P<0.05$) increased due to the propolis supplementation.

These results are in harmony with finding of Attia *et al*., (2013) who mentioned that used propolis resulted in significant improved carcass percentage for rabbit. The same results concerning to carcass were obtained in poultry by Attia *et al*. (2014) and Hascik *et al*. (2014). In the connection of spleen, Shreif and El-Saadany (2017) reported that spleen relative weight was significantly improved with adding propolis to chicken ration. The increased in spleen weight in growing rabbits were confirmed by Dias *et al*. (2013) that promote the proliferation and differentiation of immune system cells. The same authors reported that the intestine weight was higher in rabbits supplemented with propolis. The increased in impiety small intestine may be related to that propolis increased the levels of beneficial bacteria and decrease the pathogenic types which improve intestinal health (Kacaniova *et al*., 2012).

**Table (4):** Effect of supplementing diet with propolis on carcass characteristics.

| Items | Experimental groups | | | | Pooled SE | Sig |
|---|---|---|---|---|---|---|
| | Control | 100mg/kg Propolis | 150mg/kg Propolis | 200mg/kg Propolis | | |
| Dressing (%) | 57.47$^{c}$ | 62.69$^{bc}$ | 67.55$^{ab}$ | 70.03$^{a}$ | 12.97 | ** |
| Carcass (%) | 46.37$^{b}$ | 53.15$^{ab}$ | 58.15$^{a}$ | 59.65$^{a}$ | 13.74 | ** |
| Heart (%) | 0.33 | 0.34 | 0.33 | 0.35 | 0.001 | Ns |
| Kidney (%) | 0.61 | 0.71 | 0.71 | 0.7 | 0.003 | Ns |
| Liver (%) | 3.12 | 3.07 | 3.17 | 3.3 | 0.04 | Ns |
| Giblets (%) | 4.07 | 4.13 | 4.21 | 4.35 | 0.03 | Ns |
| Total edible parts (%) | 50.45$^{b}$ | 57.28$^{ab}$ | 62.36$^{a}$ | 64$^{a}$ | 13.59 | ** |
| Abdominal fat (%) | 0.99$^{a}$ | 0.75$^{ab}$ | 0.7$^{b}$ | 0.62$^{b}$ | 0.02 | * |
| Shoulder fat (%) | 0.17 | 0.15 | 0.12 | 0.08 | 0.01 | Ns |
| Spleen (%) | 0.11$^{c}$ | 0.13$^{bc}$ | 0.16$^{ab}$ | 0.18$^{a}$ | 0.001 | ** |
| Impiety Small intestine (%) | 3.88$^{b}$ | 4.75$^{a}$ | 4.24$^{ab}$ | 4.8$^{a}$ | 0.14 | * |

*a, b…. Means within each row have no similar letters are significantly different (P ≤ 0.01)*

***Meat quality***

The effects of 8-weeks supplementation of growing rabbit diets with propolis on meat quality are shown in Table (5). There were no significant differences in total protein percentages in meat between treatment groups. All the treatment groups were significantly lower in total cholesterol percentages (P<0.01) and triglycerides percentages (P<0.05) in meat compared with the control group. Malondialdehyde (MDA) content in meat were significantly (P<0.01) lower in treatment groups compared with the control group. There were no differences in pHu of meat between experimental groups. There was a significant (P<0.01) decrease of drip and cooking losses % compared with the control. The decrease in triglycerides and cholesterol may be related to that propolis contains essential fatty acids which inhibit the activity of hepatic3-hydroxy-3-methylglutaryl coenzyme A reductase which regulate enzyme in cholesterol synthesis, also propolis plays a main role as antioxidant material to increase glutathione enzyme activity (Matsui *et al*., 2004 and Babińska *et al*., 2013). The same trend was observed in broiler chickens, Haščik *et al*. (2014) found that MDA values in breast and thigh muscles were significantly (P<0.05) higher in the control group than the group fed diet contain 800 mg/kg propolis extract. The improvement in oxidative state could be due to that propolis contains a high content of flavonoids (Piccinelli *et al*., 2013), phenolic acid (Simoes *et al*., 2004) and terpenoid (Benzie and Strain, 1999) which play an important role as an antioxidant (Fokt *et al*., 2010) which reduce the oxidative stress. The improvement in rabbit meat by propolis supplementation may be due to that propolis is a growth promoter and has antibiotic properties (Sarker and Yang, 2010).

**Table (5):** Effect of supplementing diet with propolis on meat quality.

| Items | Experimental groups | | | | Pooled SE | Sig |
|---|---|---|---|---|---|---|
| | Control | 100mg/kg Propolis | 150mg/kg Propolis | 200mg/kg Propolis | | |
| Total protein (mg/100g) | 6.23 | 6.4 | 6.47 | 6.53 | 0.06 | Ns |
| Total cholesterol (mg/100g) | 187$^{a}$ | 174$^{b}$ | 168$^{bc}$ | 162$^{c}$ | 21 | ** |
| Triglycerides (mg/dl) | 138.5$^{a}$ | 132.07$^{ab}$ | 127.23$^{bc}$ | 120.7$^{c}$ | 30.44 | * |
| Malondialdehyde (nmol/mg) | 4.82$^{a}$ | 4.37$^{b}$ | 4.16$^{b}$ | 4.07$^{b}$ | 0.05 | ** |
| pHu of meat | 6.51 | 6.32 | 6.3 | 6.26 | 0.13 | Ns |
| Drip loss % | 24.63$^{a}$ | 19.82$^{b}$ | 18.45$^{b}$ | 18.22$^{b}$ | 0.66 | ** |
| Cook loss % | 35.75$^{a}$ | 33.22$^{b}$ | 33.16$^{b}$ | 32.33$^{b}$ | 0.47 | ** |

*a, b and c: Means in the same row having different superscripts differ significantly.*

## CONCLUSION

It can be concluded that supplementing growing New Zeland white rabbits diets with crude Egyptian propolis at 200mg/kg improved their live body weight, weight gains and feed conversion ratio with no

effect on feed intake. Also, propolis improved some nutrient digestibility coefficiency and some carcass characteristics. In addition, propolis reduced the total cholesterol and triglycerides, improved the oxidative state and improved some physical properties of rabbit meat.

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# تأثيرإضافة البروبليس علي الأداءالإنتاجي ومعاملات الهضم وصفات الذبيحه وجودة اللحم في الارانب النيوزلاندي النامية

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يهدف هذا البحث إلي دراسة تأثير إضافة البروبليس المصري الخام لعلائق الأرانب النيوزلندي النامية علي الأداء الإنتاجي ومعاملات الهضم وصفات الذبيحة وجودة اللحم. تم التوزيع العشوائي لـ 180 أرنب غير مجنس مفطوم إلي أربعة مجاميع. تم تغذية هذه المجموعات علي علائق مضاف اليها البروبليس بمعدلات صفر، 100، 150، 200ملجم/كجم عليقة من البروبليس واستمرت التجربة لمدة 8 أسابيع.

أظهرت النتائج أن إضافة البروبليس لعلائق الأرانب النامية أدي إلي زيادة الوزن النهائي والوزن المكتسب للجسم وتحسن معامل التحويل الغذائي ونقص غير معنوي في الغذاء المأكول مقارنة بالمجموعة المقارنة. لم تكن هناك فروق معنوية في معامل هضم المادة الجافة والألياف الخام ومستخلص الدهن ومستخلص الازوت الخالي من النيتروجين، بينما معامل هضم المادة العضوية والبروتين الخام والقيمة الغذائية لمعامل هضم البروتين ومجموع المركبات الغذائية المهضومة زاد زيادة معنوية. كما أدت إضافة البروبليس لعلائق الأرانب إلي زيادة نسبة الذبيحة والتصافي ومجموع الأجزاء المأكولة بينما القلب والكلي والكبد لم تتأثر. انخفضت دهون البطن بصورة معنوية ودهون الكتف بصورة غير معنوية بإضافة البروبليس. أدت إضافة البروبليس للعلائق إلي زيادة نسبة الطحال ووزن الأمعاء الدقيقة فارغة. لا توجد فروق معنوية بين المعاملات في نسبة البروتين ودرجة الحموضة في اللحم. بينما بزيادة نسبة البروبليس يقل الكوليسترول الكلي والجليسريدات الثلاثية والمالون الدهيد بصورة معنوية. أثرت إضافة البروبليس لعلائق الأرانب بصورة أبجابية علي بعض الخواص الفيزيئية للحم عن طريق نقص معدل فقد الماء ومعدل الفقد في الطبخ بصورة معنوية. يمكن أن نستنتج أن إضافة البروبليس لعلائق الأرانب النيزلاندي النامية أدي لتحسن الأداء الإنتاجي ومعامل هضم بعض العناصر الغذائية وتحسن بعض صفات الذبيحة وجودة اللحم.