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EVALUATION OF FEED ADDITIVES SUPPLEMENTATION ON GROWTH MEASUREMENTS, DIGESTIBILITY, BLOOD METABOLITES AND ECONOMICAL EFFECIENCY OF GROWING RABBITS

RUNNING TITLE: IMPACTS OF FEED ADDITIVES ON PRODUCTIVE MEASUREMENTS OF GROWING RABBITS.

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ABSTRACT: The study aimed to determine effects of natural feed additives such as bee pollen (BP), propolis (PRO), date palm pollen (DPP) and pomegranate peel powder (PPP) on performance, carcass traits, digestion coefficient, and some blood metabolites. A total number of 30 weaned detached rabbits at age of five weeks of age with average weight (650±10.00) were used. Rabbits were randomly dispersed into five collections. The treatments were served diet supplemented with 0.00 or 0.20 % of feed additives. In the 1st, rabbits were established un-supplemented and saved as control. While, those in the 2nd, 3rd, 4th and 5th groups were treated with BP, PRO, DPP, and PPP at 0.20%/kg diet.

The obtained outcomes from this experiment designated that: 1- Growing rabbits that supplemented with BP significantly (P<0.05) increased final live weight and total weight gain and decreased total feed intake as well as improved in feed conversion followed by rabbits supplemented with PRO as compared with other groups.

2- Growing rabbits in BP fed group recorded the highest values of carcass and total edible giblet weights and dressing percentage followed by rabbits in PRO group, while rabbits in PPP group recorded significant (P<0.05) increment for kidneys %.

3- The highest glucose, TP, Glob, TAC and CAT values were recorded in BP fed group. A significant increase in Alb, ALT, AST and SOD and decrease in TChol in PPP fed group, while value of MDA was enhanced significantly for PRO.

4- Digestion coefficient and nutritive values measurements for growing rabbits were increased (P<0.05) significantly for BP group . 5- Supplementation of BP improved total return, net return and economic value and there is no enhancement for economic efficiency value related to other these feed additives.

Conclusively, from this obtained results it could be concluded that the supplementation of natural feed additives; bee pollen, propilis, date palm pollen and pomegranate peel powder at 0.20%/kg diet had supportive effects on rabbit's growth performance, carcass characteristics, blood constituents and its antioxidant and digestibility in growing rabbits.

Key words: Feed additives, performance, digestibility, blood constituents, growing rabbits.

INTRODUCTION

The feed additives supplementation has positive effect in rabbit rations. It can be used safely to improve their performance, which added to the diets with small quantities over superior appetite and better feed efficiency as well as immune system activation and amplified energy (Perić, *et al.*, 2009). Bee pollen is collected and combined of several plant sources with blossom pollen by honeybees subsequent millions of floral pollen grains and mixing it with plant juice and bee spit rich in enzymes which altering its composition and enhancing its medicinally potential (Leblanc *et al*., 2009).

Bee-pollen (BP) charity as a familiar growth promoter from nature, it has been recycled as antibiotics alternatives, in the nutritional and therapeutic purposes as an anti-aging substance and antioxidants, to advance the recital and protected response and intestinal health in the livestock (Attia *et al*. 2011b; Tu *et al*. 2015) payable to rich macro-nutrients and micro-nutrients in addition to digestive enzymes or coenzymes, polyphenolic substances and other healthy compounds that added by the bees(Attia *et al*., 2014a and Taha, 2015).

Propilis (PRO) is a composite mixture of viscous, sticky, and balsamic materials brought by bees from plant flowers, and emissions (Alvarez-Suarez, 2017; AL-Kahtani, *et al.*, 2022). PRO has antioxidant, immune-stimulant, and antimicrobial properties (Hashem *et al.*, 2017), due to its high satisfied of polyphenols components as flavonoids and phenolic acids (Bhargava *et al*., 2021). many studies investigated the effectiveness of PRO addition on growing rabbits by supplying in capsules form (Attia *et al.*, 2019 a and Attia *et al*., 2019 b), in drinking water (Sierra-Galicia *et al.*, 2022), orally suspension (El-Kott and Owayss ;2008 Attia *et al*., 2015; Attia *et al*., 2011a or b) or by mixing into the basal diet (Hashem *et al*., 2017; Waly *et al.*, 2021; Al-Homidan *et al*., 2022). These previous studies showed that PRO supplementation in the diet improved serum immunoglobulin concentration , enhanced cecum health and decreases the attendance of pathogenic bacteria, increased the antioxidant profile of the birds (Hashem *et al.*, 2017). It has no poisonous effects and supports to diminish the severity signs and mortality rate (Nassar *et al*., 2012).

Date palm pollen (DPP), in ancient times, had been used as a traditional Egyptian herbal medicine for improving fertility for people (Amin *et al*., 1969; Abbas and Ateya, 2011). Studies of DPP showed that a positive effects as well as strengthen and enlargement the resistance of different tissues of body to different damaging pathogens and toxicants due to their high phenolic composites and flavonoids (Campos *et al*., 1997).

Pomegranate peels are reflected inedible elements or by-product obtained through juice process. PPP are important source of phenolics, flavonoid, minerals, and complex polysaccharides (Seeram *et al.*, 2005). It safe natural substitute to imitation antimicrobial mediators such as tannins (Rosas-Burgos *et al.*, 2017), which improve immune perform of rabbits and intestinal ecosystem of broiler chicks (Shabtay *et al.*, 2008; Li *et al*., 2006 and Ahmed and Yang, 2017).

MATERIALS AND METHODS

The present study was carried out during the period from April to June, 2022) at Animal and Poultry Research Farm, Animal and Poultry Production Department, Faculty of Agriculture,

Minia University. All experimental procedures were carried out in accordance with the local Experimental Animal Care Committee and authorized by the Institutional Committee of the Department of Animal Production, Faculty of Agriculture, Minia University, Egypt.

Feed additives preparations

Date palm pollen were obtained from local palm tree at the season of date palm male tree flowers before pollination, then left until completely air dried and ground to powder to save in a glass jar. Pomegranate fruits were purchased from the local market, peels were separated, cleaned, air dried and ground to a fine powder using an electric dry mill and stored in closed container. The powders of DPP and PPP were then stored at room temperature (25°C) until used as described by Al- Samarrai *et al.*, (2017). Bee pollen (Berseem) and crude propolis were collected from beehives (apiary) belonging to Plant Protection Department, Faculty of Agriculture, Minia University. For proper protection, the BP was dried at 40° C and stored in amber jars at room temperature (Campos *et al*., 2008) Subsequently, PRO was cleaned, crushed, smoothed and stored in amber jars under refrigerated conditions until usage (Hsiao *et al.*, 2022).The doses of BP and PRO were chosen based on a previous reports which supplementation reported that supplementation with nearly these doses improved the productive measurements in growing rabbits (Attia *et al*., 2010; Attia *et al.*, 2011 a or b ; Zeedan *et al*., 2017; Nassar *et al*., 2012). The doses of date palm pollen and pomegranate peel meal were located according to Abdulameer *et al.*, (2022).Chemical proximate analyses of feed additives was determined according to (AOAC, 2010) to confirmation the dry matter, organic matter, crude protein, crude fiber, ether extract, nitrogen free extract and ash contents. As shown in Table (1).

Animals and experimental design

A total number of 30 males and females (California × New Zealand White) rabbits at 5 weeks old with nearly identical initial live body weight (650.00± 10.0gm) were used in the current study. All rabbits were housed individually in a naturally ventilated building and kept in wire galvanized cages (50L × 50W × 40H), under similar management, hygienic and environmental conditions throughout the whole experimental period. The batteries were accommodated with stainless-steel nipple drinkers and feeders. The experimental rabbits were given almost 17 hrs of light daily including 11 hrs of natural day light and 6 hrs of supplementary electric light in the night. Ambient temperature (AT) and relative humidity (RH) were measured and recorded in the rabbitry house four times each month. Averages of ambient temperature, relative humidity were 25-32°C and 50-60% respectively. All rabbits were fed the same basal and fresh water diet (ad libitum). The rabbits were randomly divided into five equal groups (n = 6 each) as follows: control group which was fed basal diet without any supplementations. The second, third, fourth and fifth treatments were saved as bee pollen (BP), propolis (PRO) ,date palm pollen (DPP), and pomegranate peel powder (PPP) groups respectively which were fed basal diets supplemented with 0.20% of BP, PRO , DPP, or PPP during a 8-weeks experimental period (from 5-13) weeks of age. All additives were added during diet formulation the control diet and mixed in the diet except propolis

was saved in the refrigerator then added daily with the same dose on the offered feed intake for each group to avoid effects missing. The basal diet was formulated to meet the nutritive requirements of growing rabbits according to (NRC, 1977) as presented in Table (2).

Growth performance

Live body weights (LBWs) of rabbits were recorded at the beginning of the experiment to determine the average initial body weight. Live weights and feed intake were recorded every 2 weeks throughout the experimental period. The average weight gain (WG) and feed conversion (FC) were calculated at the same periods as the follow equation:

$WG = LW_2 - LW_1$

FC= consumed feed/ weight gain

Digestibility trial

At the end of the experiment, three males rabbits from each group were taken for digestibility trials to calculate digestibility coefficient of nutrients and nutritive values of the experimental groups. Feed intake and feces for chosen rabbits were daily weighed and recorded. The samples of feces were dried at 70°C over night, then ground and stored for chemical analysis. The feed and feces were chemically analyzed according to AOAC (2010). The digestible crude proteins (DCP) and total digestible nutrients (TDN) values were calculated according to the formula of Cheeke *et al.*, (1982). The digestible energy was calculated by using the following equation: DE (kcal/kg) =TDN × 44.3 according to Schneider and Flatt (1975).

Carcass characteristics

By the end of the experimental study, four rabbits (2 males+ 2 females) from each group were randomly chosen, individually weighed, and directly slaughtered. The carcass, liver, kidney, heart, and spleen, were weighed and presented as percentage of pre-slaughter weight (Hassan *et al.*, 2021).

Blood parameters

During the slaughtering, blood samples (5 ml from each rabbit) were collected in un- heparinized tube. Then all tubes were moved to the physiology laboratory, faculty of Agriculture, Minia university to centrifugate at 3000 rpm for 15 minutes, and then the collected serum immediately was stored at - 20 ºC until chemistry analysis. All blood metabolites were measured using commercial diagnostic kits that were obtained from Biodiagnostic Company, Giza, Egypt.

Statistical analysis

The obtained data were statistically analyzed by one-way analysis of variance (ANOVA), using the general linear model (GLM) procedure of SAS® software (Statistical Analysis SAS, 2003). Duncan's multiple range tests were used to compare the significant differences at 5% level of significance ($P < 0.05$) in treatment means (Duncan, 1955).

Economic efficiency

Economical efficiency values were calculated as described by Zeweil (1996) using the input–output data.

RESULTS

Chemical composition of feed additives:

The laboratory proximate analysis of different feed additives is presented in Table 1. The obtained data revealed that 21.0% CP, 0.90%CF, 1.5% EE and 2.5 % ash for BP. Also, 2.6% CP, 28.0%CF, 9.0% EE and 1.0 % ash for PRO. Meanwhile, DDP contained 32.0% CP, 12.0%CF, 32.0% EE and 9.5 % ash. And PPP was 3.2% CP, 20.0%CF, 0.50% EE and 5.5 % ash.

Growth performance:

Effect of bee pollen, propilis, date palm pollen and pomegranate peel powder on live body weight, feed intake, weight gain and feed conversion ratio are shown in Table 3. The obtained results revealed that there were significant ($P< 0.05$) differences among different treatments in live weight (LW) and feed intake (FI) at all different periods of age except at initial weight and at (9-11) weeks of age for LW and FI respectively. The highest value of LW was noticed for T2 followed by T3 then T4 followed by T5 compared to control diet of NZW rabbits at 7, 9 ,11 and 13 weeks of age. Feed intake values was affected by feed additives too, the little FI ($P< 0.05$) was for growing rabbits that feed control diet with bee pollen addition at all and whole periods of experiment compared to other rabbits in different treatments. While the highest FI ($P< 0.05$) was recorded for T5 which fed control plus pomegranate peel powder (PPP) at whole period (5-13) weeks of age compared to others. Weight gain (WG) and feed conversion ratio (FCR) values affected significantly ($P< 0.05$) with supplementation of different additives at period (5-7), (11-13) and total period (5-13). While the periods of (7-9) and (9-11) were changed insignificantly. The greatest values of WG and FCR were recorded to T2 at the previous different periods compared to other different treatments at the same periods. While the poorest values of WG and FCR were calculated for control and PPP group respectively at whole period (3-15) weeks of age.

Digestibility:

Effect of the additives in Table 4 on digestion coefficient and nutritive values for growing rabbits disclosed that significant differences were found. Rabbit in T2 was logged significant increase at digestion coefficient of dry matter, organic matter, crude protein , crude fiber and nitrogen free extract followed by rabbits in T3 compared to other rabbits. Also, the highest value of crud fat digestibility was noticed for T2 followed by T5 compared to residual groups.

Nutritive values of digestible crude protein, total digestible nutrients and digestible energy was enhanced for all treated groups compared to un treated group, and greatest values were recorded for rabbits in T2 followed by rabbits in T3 then rabbits in T5.

Carcass traits:

Effect of feed additives on carcass characteristics of NZW growing rabbits is present in Table 5. These results exposed that control diet supplemented with different additives increased significantly ($P< 0.05$) carcass measurements such as pre slaughter weight, hot carcass weight, dressing %, kidney %, total edible giblet weight and total edible giblet percentage. While there were insignificant differences among treatments in liver, heart, spleen, edible giblets and head percentages. Growing rabbits in T2 recorded the highest values of pre slaughter weight, hot carcass weight, dressing percentage, total edible giblet weight and total edible giblet percentage followed by rabbits in T3 compared to rabbits in the other treatments. While the biggest kidney % was recorded for rabbits in T5 compared to the others.

Blood metabolites and antioxidants measurements:

Effect of different treatments on blood constituents and antioxidants measurements of growing rabbits is present in Table 6. These results revealed that addition of different feed additives to

control diet of growing NZW rabbits recorded significant (P< 0.05) changes in all blood measurements as glucose, total protein, albumin, globulin, total cholesterol, high density lipo-protein, low density lipo-protein, ALT, AST, ALP, urea and creatinine except ALT\AST ratio, and antioxidants profile as total antioxidant capacity, super oxide dismutase, melano di-aldehyde and catalase. The highest glucose, TP ,Glob, TAC and CAT values were recorded to T2. Whereas, growing rabbits in T5 recorded significant increase in Alb, ALT, AST and SOD. Value of MDA was enhanced significantly for T3 followed by T2 . while, rabbits performance in T4 indicted that improvement in HDL value followed by rabbits in T5. All feed additives caused significant decrease in total cholesterol compared to un-supplemented control and the lowest T.Chol was recorded to T5 followed by T4. The control group showed significant increase for LDL, ALP, urea and creatinine in comparison for other supplemented group.

Economic value

Effect of feed supplements on total feed cost, total return, net return and economic efficiency is present in Table 7. Data specified that feeding total cost of growing rabbits increased with supplementation of different additives. The calculated steps from these results publicized that total feed cost was highest in T3 followed by T2. While total return, net return and economic efficiency were recorded highest values for T2 (bee pollen group). Although, there was no enhance in economic value for other treated groups compared to control group.

DISCUSSION

Chemical composition of feed additives

From Table 1, about this study, it was cleared that the high crude protein was recorded for DDP followed by BP and the lowest of the share of PPP then PRO. While, the highest value of digestible energy was calculated to BP followed by DPP then PPP and finally PRO. Zeedan et al., (2017) indicated that bee pollen contained 29.94 %CP, 1.17% CF , 2.83 % ash and 4.35% EE on DM basis. Sierra-Galicia et al., (2022) showed that the chemical analysis of the PRO was 90.26% DM, 2.55% CP, 9.31% EE, and 0.85% ash. Fayed et al., (2012) concluded that PPP gave 3.65 CP, 0.61% EE, 23.4% CF and 5.4% ash. Also, Khan et al., (2017), Jayaprakash, (2017) and El-Sissi, et al.,(2018) recorded that, PPP has shown strong anti-oxidant activity because of its polyphenols includes flavonoids as well as condensed and hydrolysable tannin.

Growth performance

Results offered in Table 3, displayed that the rabbit in all treated groups had increased significantly (P<0.05) LW and WG compared to un treated group. The top increase was for BP followed by PRO fed rabbits. This increase in BP group could be recognized to higher value for digestibility of protein, which path to improving protein utilization and protein anabolism with intestinal absorptive capacity resulting in body weight and weight gain (Zeedan *et al*., 2017). These optimistic developments could be owing to the beneficial value of macro- and micro-nutrients of bee-pollen such as polyunsaturated fatty acids, minerals flavonoids, carotenoids and phenolic constituents as well as protective agents for intestinal tract which improved digestion, absorption and availability of

nutrients for promoting animal growth (Attia *et al*., 2009; Attia *et al*., 2014 ;Liu *et al*., 2010; Attia *et al*., 2011a,b).

These results agree with those of Soha and El-Rayes (2016). Also, Attia *et al.*, (2014) resolved that addition of bee pollen alone or with propilis to control diet of growing rabbits improved significantly live weight, weight gain and feed conversion. The positive effect of propolis on body gain or feed conversion in this study may be related to that propolis is an alternate source to antibiotics in diet, it could increase the levels of beneficial bacteria and decrease the pathogenic types in intestine because of it has antimicrobial, anti-inflammatory agents, and immune modulatory belongings which permitting for healthier utilization of nutrients and progress growth acts and feed conversion of animals (Kacaniova *et al*., 2012 ; Itavo *et al.*, 2011;Sarker and Yang, 2010;Daneshmand *et al*., 2015 Waly *et al.*, 2021). Dissimilarly, Dias *et al*., (2013) indicated that addition BP did not enhance weight gain of weaned rabbits until market age. Value of feed intake was decreased significantly when control diet supplemented with BP. This result may be due to usage bee pollen for growing rabbits in diets might increase lactic acid fermenting bacteria resulting in increasing fermentation in the gut due to enhance the digestibility of feed and utilization of ammonia. Also, may be due to content BP of nutrients such as minerals and vitamins that accelerate nutrients metabolism (Zeedan *et al*., 2017).The findings in Table 3 indicated that feed conversion improved significantly in all feed additives except PPP compared to control. T2 recorded greatest value (Zeedan and El-Neney 2014) followed by T3 (Hashem *et al*. 2017). This improvement may be related the role of BP in decreasing NH3–N, pathogenic bacteria counts, increasing moral bacteria and increasing nutrients digestion. Also, this may be due to high levels of amino acids, enzymes and coenzymes in bee pollen which added by bees during creation, which play important role in better digestion and cell growth (Zeedan *et al*., 2017).. In addition , lowering feed intake in tendency of gain in BP treated group (Table 3).The worst feed conversion in PPP group may be connected to high feed intake to those rabbits. This was similar with Hassan *et al.*, (2020) who showed that significant increase ($P < 0.05$) in average of feed intake for rabbits fed diet supplemented with 200 mg/kg pomegranate by-product extract (PBE) compared to control rabbits.

Digestibility:

These results agree with El-Neney and El-Kholy (2014), Zeedan and El-Neney (2014) and Zeedan *et al*., (2017) indicated that supplementation BP to control diet of growing rabbits increased significantly digestion coefficient of all nutrients compared to control. The improvement in digestibility for BP group may be attributed to that BP contains digestive enzymes from the resulting in improvement in digestibility of all nutrients. In addition of, the reduction in feed intake that occurred in this group (Table 3) enhanced feed conversion and digestibility (Khojasteh and Shivazad , 2006 and Wang *et al*., 2007). The improvement of digestion coefficient (for PRO group) may be due to the ability of propilis to stimulate the activities of saccharase, amylase and phosphatase resulting in enhancing digestibilities of nutrients and absorption. In addition, the contents of benzoic and 4-hidoxibenzoic

acid in propolis, which may improve the digestibility of protein and ash (Seven, 2008; Seven *et al.*, 2012; Waly *et al.*, 2021). The middle improvement in crude fat digestibility for PPP rabbits group after BP rabbits group (80.16 after 81.82) respectively, may be due to PPP which have proanthocyanidin , that increased the activity of lipase in the pancreas which improved the digestibility and absorption of crude fat (Jang *et al*. 2007; Banerjee *et al*. 2013; Hassan *et al*., 2020).

Carcass traits:

The significant (P<0.05) escalation in carcass characteristics for supplemented groups may be mainly correlated to the improvement of growth performance and nutrients digestibility of treated rabbits compared to control rabbits. These findings agree with Zeedan and El-Neney (2014) and Hosseini *et al*. (2016). Also, Attia *et al*., (2014) disclosed that carcass index and carcass dressing were higher in propilis group followed by bee pollen group when compared with control group for growing rabbits. On the same line of our study, Hassan *et al*.,(2020) revealed that control diet of growing rabbits which added with different levels 100,150 and 200 mg pomegranate extract increased significantly kidney % compared with control. The same result was founded by Ibrahim *et al*. (2017) when added pomegranate peel powder to growing rabbits control diet. Also, growing rabbits when treated with 1.5% pomegranate peel extract in drinking water had significantly (P≤0.05) higher kidneys relative weight (Nassraalah *et al.*, 2016).

Blood constituents and antioxidants

Referring to glucose level, these findings showed that plasma glucose concentration augmented significantly (P<0.05) for BP than that of the others. The increased plasma glucose may be reflecting the increasing energy availability by digestion and absorption sugars for the physiological and biochemical functions. These findings agree with those of Zeedan and El-Neney (2014) and Attia *et al.* (2015). The increased blood proteins in rabbits received BP may be linked with enhancement of CP digestibility (Table 6). Attia *et al*. (2015) they noted that the addition of BP for rabbits has a positive effect on blood proteins. Also, Attia *et al.*, (2014) revealed that BP growing rabbits group had higher significantly TAC value compared to other feed additives rabbits.

The finding of this study is according with Khalil and El-Sheikh (2010) who presented that a significant increase in TP and insignificant decrease in ALP activity, urea and creatinine of rats blood that treated with Propolis at levels of (0.10 and 0.20 %) in the diets.

Attia *et al.*, (2014) publicized that total cholesterol decreased significantly with BP supplementation. Harmony with those of Zeedan *et al*., (2017) indicated that urea and creatinine in all treated groups with different levels of BP decreased significantly compared to control group. The reduction in urea and creatinine may be related to that BP inhibited the pathogenic bacteria and increase protein combination with a following lessening in NH3 production (Attia *et al*. ,2014b and El-Neney and El-Kholy ,2014). The affirmative effect of DPP supplementation on HDL changes can be accredited to the attendance much of effective nutrients such as amino acids, essential fatty acids, antioxidants, vitamins and mineral, enzymes, etc. (Abuoghaba *et al*., 2017; Taghian, *et al*., 2017), plus may be related to a vital role of volatile unsaturated fatty acid and

flavonoid as potent antioxidants in DPP (Saleh *et al*., 2021). Furthermore, a positive effect of high content of unsaturated fatty acids on stopping the accumulation of lipid peroxidation products (Abuoghaba *et al*., 2017). Hassan *et al*., (2020) concluded that the levels of total cholesterol and LDL were lower ($p<0.05$) in growing rabbits that fed control diet treated with 0.15% pomegranate by product extract in comparison with other levels. Also, Yaseen *et al*., (2014) reported the same result when pomegranate peel extract was added at 0.05 and 0.1 g/kg to broiler diets.

The reduction in cholesterol and LDL values may be due to the presence of proanthocyanidin in PPP and it's activity mechanism in preventing and inhibition activity biosynthesis by lowering cholesterol acyltransferase (Yuberro *et al.*, 2013) and may contribute to the conquest of oxidized LDL and the prevention of cholesterol absorption from the small intestine by transfers protein in the liver which (Andreadou *et al*., 2006). Or may be due to that reducing the oxidation of LDL by antioxidants and reduction the concentration of free radicals, which inactivate nitric oxide and stand effective in withdrawing endothelial function associated with hypercholesterolemia (Bok *et al*., 1999).

Concerning to the result of increasing SOD for rabbits fed diet plus PPP, This result was agree with (Subash *et al.*, 2014; Sharifiyan *et al.*, 2016; Hassan *et al*., 2020) .The increase in SOD value due to PPP addition may be related to an excellent natural antioxidant agent that of the pomegranate peel or by-products extract like as tannins, ellagic, and gallic acids (Bharani and Namasivayam, 2016; Khan *et al.*, 2017).

Economic value:

Bee pollen, propilis and date palm pollen increased the total costs of feeding for growing rabbits in comparison to control group, but pomegranate peel powder supplementation did not increase this criteria, among the additives, the increase was maximized with propolis group. So, form the current study, it could be showed that addition of these growth promoters did not enhanced economic efficiency except bee pollen supplementation. The highest economic value was related to BP group. This finding was agree with Zeedan *et al*., (2017) and Attia *et al.,* (2014) who noted that the best economical efficacy and relative economic efficiency were the best in rabbits fed bee pollen supplementation.

CONCLUSION

Adding some natural feed additives such as bee pollen, propilis, date palm pollen or pomegranate peel powder at level of 0.20% each to growing rabbit diets as growth promoters, enhanced growth performance indicates, carcass traits digestibility and some blood metabolites compared to un-supplemented diet. Supplementation of bee pollen had net return enlargement and then had positive effect on economic value of growing rabbits compared with control or other additives.

Table (1): The laboratory proximate analysis of different feed additives

Additives		Nutrients %						
	DM	OM	CP	CF	EE	NFE	NDF*	DE**
BP[1]	94.5±0.4	96.6±0.5	21.0±0.7	0.90±0.3	1.5±0.6	73.0±0.7	29.52	2910.56
PRO[2]	93.2±0.5	98.3±0.4	2.6±0.6	28.0±1.5	32.0±1.0	40.0±3.0	47.32	2036.59
DPP[3]	96.0±0.3	91.0±0.6	32.0±0.5	12.0±0.8	9.0±0.5	40.0±2.0	36.81	2552.63
PPP[4]	95.6±0.7	94.0±0.5	3.2±0.7	20.0±1.0	0.50±0.3	70.30±1.0	42.06	2294.85

1BP= bee pollen, 2PRO= propolis, 3DPP= date palm pollen, 4PPP=pomegranate peel powder.DM= dry matter, OM= organic matter, CP= crude protein , CF= crude fiber, EE= ether extract, NFE=nitrogen free extract, NFE and DE calculated according to Cheek, 1987, NDF= 28.924+ (0.657CF%), DE= 4.36- (0.0491NDF%).

Table (2): Composition, calculated and determined analysis of control diet

Ingredients	%	Calculated analysis	(%)	Determined analysis	(%)
Yellow corn	39.90	Crude protein, CP	17.75	Dry matter, DM	86.00
Soybean meal (44%)	20.00	Metabolizable Energy (Kcal/kg)	2503.20	Organic matter,OM	88.20
Clover hay	25.00	Crude fiber, CF	12.26	CP	17.35
Berseem straw	5.00	Ether extract, EE	2.53	CF	12.41
Course wheat bran	4.90	Calcium	1.14	EE	6.52
Di-calcium phosphate	1.10	Available phosphorus	0.45	NFE	52.72
Limestone	1.00	Lysine	0.68	NDF**	37.07
Oil	2.50	Methionine+ cysteine	0.59	ADF***	20.74
Vit-min premix*	0.30			Hemicellulose****	16.33
Food salt	0.30				
Total	100.00				

* Each 1kg of premix of vitamins, minerals (Vit-min) mixture contains: Vit. A: 4,000,000 IU; Vit. D3: 1,000,000 IU; Vit. E:3.3 mg; Vit. K3: 1.0 mg; Vit. B1: 66.7 mg: Vit. B2: 1.7 mg Vit. B6: 1.0 mg: Vit. B12: 5.0 mg; Biotin: 16.7 mg; Folic acid: 0.3 mg; Nicotinic acid: 11.7 mg: Pantothenic acid: 3.3 mg; Mn: 26.7 g; Cu: 2.9 g; Zn: 23.3 g; Fe: 11.7 g; I: 3.3 g; Co: 0.05g and Se: 0.1g.

NDF** = 28.924+(0.657×CF%), ADF*** = 9.432+ (0.912× CF%), Hemicellulose**** = the difference between NDF% and ADF%.

Table (3): Effect of feed additives supplementation on growth performance of growing rabbits

Item	Groups					SEM	p-value
	T1	T2	T3	T4	T5		
Live weight, LW (g)							
5 Wks.	656.17	656.23	654.23	656.36	657.83	5.97	0.995
7 Wks.	955.26^{b}	1058.60^{a}	1011.48^{ab}	984.10^{b}	970.50^{b}	17.20	0.012
9 Wks.	1398.70^{b}	1530.30^{a}	1455.20^{ab}	1423.74^{b}	1421.30^{b}	24.07	0.023
11 Wks.	1844.50^{b}	1999.26^{a}	1925.43^{ab}	1865.23^{b}	1852.80^{b}	32.97	0.036
13 Wks.	2294.06^{b}	2553.83^{a}	2379.43^{b}	2328.16^{b}	2298.73^{b}	32.71	0.001
Feed intake, FI (g)							
5-7 Wks.	1151.20^{a}	1066.83^{b}	1160.76^{a}	1157.73^{a}	1112.13^{ab}	19.95	0.032
7-9 Wks.	1462.70^{b}	1362.83^{d}	1393.30^{cd}	1433.00^{bc}	1524.96^{a}	18.05	0.0007
9-11 Wks.	1615.66	1567.00	1613.43	1606.17	1612.33	37.34	0.872
11-13 Wks.	1827.90^{ab}	1775.70^{b}	1810.30^{ab}	1825.70^{ab}	1853.06^{a}	16.18	0.067
5-13 Wks.	6057.13^{a}	5738.66^{b}	5977.56^{a}	6019.93^{a}	6102.50^{a}	45.06	0.001
Weight gain, WG (g)							
5-7 Wks.	299.10^{b}	402.30^{a}	357.23^{ab}	327.73^{b}	312.33^{b}	21.13	0.039
7-9 Wks.	443.43	471.76	443.73	439.60	451.13	22.61	0.854
9-11 Wks.	445.80	468.96	469.56	441.53	431.56	39.19	0.938
11-13 Wks.	449.56^{b}	554.56^{a}	444.53^{b}	462.93^{b}	445.93^{b}	22.81	0.0290
5-13 Wks.	1637.90^{b}	1897.60^{a}	1715.20^{b}	1671.8^{b}	1640.90^{b}	32.22	0.0010
Feed conversion ratio, FCR (g feed/g gain)							
5-7 Wks.	3.86^{a}	2.73^{b}	3.28^{ab}	3.53^{a}	3.55^{a}	0.183	0.0148
7-9 Wks.	3.32	2.90	3.14	3.28	3.38	0.149	0.2452
9-11 Wks.	3.63	3.36	3.44	3.79	3.77	0.306	0.8065
11-13 Wks.	4.09^{a}	3.20^{b}	4.08^{a}	3.90^{a}	4.18^{a}	0.197	0.0343
5-13 Wks.	3.69^{ab}	3.03^{c}	3.48^{b}	3.59^{ab}	3.72^{a}	0.068	0.0002

^{a,b,c,d} Within the same rows, means have similar letter(s) are not significant different at 0.05.
SEM = standard error of mean.

Table (4): Effect of feed additives supplementation on digestion coefficient and nutritive values of growing rabbits

Items	Groups					SEM	p-value
	T1	T2	T3	T4	T5		
Dry matter%	64.04^{b}	72.63^{a}	70.71^{a}	68.90^{ab}	69.93^{ab}	1.944	0.0900
Organic matter% Crude	65.14^{b}	74.72^{a}	72.43^{a}	70.05^{ab}	71.73^{a}	1.649	0.0349
protein%	74.28^{c}	81.43^{a}	79.66^{ab}	77.26^{bc}	77.68^{abc}	1.154	0.0137
Crude fiber%	43.64^{b}	57.58^{a}	55.39^{a}	51.64^{ab}	53.75^{a}	2.745	0.0392
Crude fat%.	73.16^{b}	81.82^{a}	79.84^{ab}	75.39^{ab}	80.163^{ab}	2.326	0.1149
NFE%	59.69^{b}	69.68^{a}	68.16^{a}	65.73^{ab}	67.093^{a}	1.920	0.0339
Nutritive values							
DCP%**	12.45^{b}	14.69^{a}	13.95^{ab}	13.03^{ab}	13.27^{ab}	0.628	0.1864
TDN%*	70.28^{b}	82.72^{a}	78.75^{ab}	73.54^{ab}	76.49^{ab}	3.56	0.2067
DE***	3113.55^{b}	3664.49^{a}	3488.62^{ab}	3257.81^{ab}	3388.51^{ab}	157.82	0.2067

^{a,b,c,d} Within the same rows, means have similar letter(s) are not significant different at 0.05.
SEM = standard error of mean.,NFE=nitrogen free extract, DCP=digestible crude protein, TDN=total digestible nutritients, DE= digestible energy. *TDN % = DCP % + DCF % + DEE % (2.25) + DNFE %. **DCP % = Digestibility coefficient of CP × CP% of the diet. ***DE (kcal / kg) = TDN × 44.3.

Table (5): Effect of feed additives supplementation on carcass traits of growing rabbits

Items	Groups					SEM	p-value
	T1	T2	T3	T4	T5		
Pre-slaughter w.	2209.16^{c}	2490.86^{a}	2354.43^{bc}	2301.06^{bc}	2254.93^{bc}	35.70	0.0021
Hot carcass w.	1120.67^{c}	1446.55^{a}	1358.76^{ab}	1259.06^{b}	1264.16^{b}	41.72	0.0029
Dressing%	50.70^{b}	58.09^{a}	57.71^{a}	54.72^{ab}	56.04^{a}	1.492	0.0354
Liver%	3.93	3.66	3.54	3.50	3.57	0.518	0.9751
Heart%.	0.41	0.52	0.45	0.49	0.48	0.076	0.8700
Kidney%	0.48^{d}	0.60^{bc}	0.67^{b}	0.54^{cd}	0.82^{a}	0.024	<.0001
Spleen%	0.32	0.34	0.33	0.50	0.30	0.108	0.6498
EG W	57.93	73.56	67.22	57.50	66.34	7.927	0.5879
EG%	5.15	5.09	4.88	4.70	5.26	0.53	0.8905
TEGW	1178.61^{c}	1519.46^{a}	1425.53^{ab}	1316.16^{bc}	1330.27^{b}	44.27	0.0032
TEG%	53.32^{b}	62.06^{a}	60.86^{a}	57.86^{a}	59.02^{a}	1.427	0.0124
Head%	8.83	8.90	8.66	9.30	8.86	0.905	0.9905

^{a,b,c,d} Within the same rows, means have similar letter(s) are not significant different at 0.05.
SEM = standard error of mean., EG W.= edible giblets weight (liver+heart+ kidney+ spleen), EG%= edible giblets percentage, TEGW=total edible giblets weight (hot carcass+edible giblets), TEG%= total edible giblets percentage.

Table (6): Effect of feed additives supplementation on blood metabolites and antioxidants measurements of growing rabbits

Items	Groups					SEM	p-value
	T1	T2	T3	T4	T5		
Glucose (mg\dl)	68.46^{c}	88.77^{a}	85.05^{ab}	78.53^{b}	62.06^{c}	2.27	<.0001
TP (g\dl)	4.63^{c}	6.91^{a}	5.92^{ab}	5.56^{bc}	6.26^{ab}	0.32	0.0071
Alb. (g\dl)	2.20^{b}	2.30^{b}	2.16^{b}	2.36^{b}	3.46^{a}	0.12	<.0001
Glob. (g\dl)	2.43^{b}	4.61^{a}	3.32^{ab}	3.20^{ab}	2.80^{b}	0.43	0.0453
T.Chol. (mg\dl)	125.00^{a}	103.00^{c}	115.66^{b}	93.66^{d}	86.00^{d}	2.77	<.0001
HDL (mg\dl)	40.00^{d}	63.33^{c}	55.66^{c}	76.33^{a}	65.33^{c}	1.86	<.0001
LDL (mg\dl)	51.00^{a}	43.00^{b}	36.33^{c}	31.66^{c}	25.66^{d}	1.61	<.0001
ALT (U\L)	56.00^{b}	54.00^{b}	45.53^{c}	48.76^{c}	61.66^{a}	1.58	0.0003
AST (U\L)	35.16^{ab}	30.20^{c}	29.30^{c}	31.66^{bc}	38.40^{a}	1.45	0.0068
ALT\AST	1.59	1.81	1.55	1.54	1.60	0.087	0.2598
ALP(U\L)	15.16^{a}	12.57^{bc}	11.28^{c}	12.07^{bc}	13.53^{b}	0.51	0.0030
Urea (mg\dl)	36.10^{a}	30.30^{ab}	26.00^{bc}	34.33^{a}	22.83^{c}	2.00	0.0043
Creatinine (mg\dl)	1.21^{a}	0.94^{b}	0.88^{b}	0.67^{c}	0.85^{b}	0.057	0.0008
Anti-oxidants indicates							
TAC(Mmol\L)	0.75^{d}	3.16^{a}	1.40^{c}	2.03^{b}	2.43^{b}	0.14	<.0001
SOD(U\L)	25.66^{d}	37.33^{b}	31.00^{c}	38.70^{b}	44.00^{a}	1.43	<.0001
MDA(nmol\L)	16.79^{c}	21.70^{ab}	23.76^{a}	20.26^{b}	19.68^{b}	0.84	0.0021
CAT (U\L)	290.00^{b}	416.66^{a}	395.33^{a}	340.66^{ab}	397.00^{a}	23.84	0.0210

^{a,b,c,d} Within the same rows, means have similar letter (s) are not significant different at 0.05. SEM = standard error of mean. TP: total protein, Albumin: Alb; Globulin: Glob, Aspartate Aminotransferase: AST, alanine aminotransferase: ALT, , alkalin phosphatase, ALP, T.Chol: total cholesterol, HDL: high-density lipoprotein cholesterol, LDL: low-density lipoprotein cholesterol TAC: total antioxidant capacity SOD: superoxide dismutase, CAT: catalase, and MDA: malondialdehyde.

Table (7): Effect of different treatments on total feed cost, net return and economic values of growing rabbits

Items	Groups				
	Con.	BP	PRO	DPP	PPP
Feed intake, kg (3-15) weeks	6.058	5.738	5.977	6.019	6.102
Feed cost	41.50	39.31	40.94	41.23	41.79
Total feed cost*	41.50	45.05	58.87	44.84	41.79
Final weight, kg	2.294	2.554	2.379	2.328	2.299
Total return	114.70	127.70	118.95	116.40	114.95
Net return	73.20	82.65	60.08	71.56	73.16
Economic efficiency	1.76	1.83	1.02	1.60	1.75

*Total feed cost= feed intake × price of kg control diet + price of feed additive, kg of control diet = 6.85 EGP, kg of bee pollen = 500.00 EGP, kg of propilis= 1500.00EGP, kg of date palm pollen = 300.00 EGP, kg of pomegranate peel powder= free, price of kg live weight= 50.00 EGP.

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الملخص العربي

تقييم بعض الاضافات الغذائية على الاداء الانتاجى و معاملات الهضم و قياسات الدم والكفاءة الاقتصادية للارانب النامية

مها أحمد عبد اللطيف عمر
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اجريت هذه الدراسة لتقييم تأثير بعض الاضافات الغذائية مثل حبوب لقاح النحل، البوبوليس، طلع النخيل وكذلك مسحوق قشور الرمان المجففة على الاداء الانتاجى و مواصفات الذبيحة ومعاملات الهضم للمواد الغذائية و مقاييس الدم وكذلك الكفاءة الاقتصادية للارانب النامية. تم استخدام عدد 30 ارنب (كاليفورنيا× النيوزلندى الابيض) عمر 5 اسابيع بمتوسط وزن (650± 10 جم) تم تقسيمهم الى 5 معاملات (3مكررات×2 ارنب) وكانت المعاملات كالتالي:-

1- 1-مجموعة الكنترول: تغذت على عليقة الكنترول بدون أية اضافات.
2- 2-مجموعة حبوب لقاح النحل: تغذت على عليقة الكنترول + 0,2 % حبوب اللقاح.
3- 3-مجموعة البروبوليس: تغذت على عليقة الكنترول + 0,2 % بروبوليس.
4- 4-مجموعة طلع النخيل: تغذت على عليقة الكنترول + 0,2 % طلع نخيل مجفف.
5- 5-مجموعة مسحوق قشور الرمان المجففة: تغذت على عليقة الكنترول + 0,2 % مسحوق قشر الرمان.

النتائج المتحصل عليها من هذه الدراسة هى:

6- اضافة حبوب لقاح النحل بمستوى 0,2% الى العليقة ادى الى زيادة معنوية فى مؤشرات النمو(وزن الجسم النهائى، الزيادة فى وزن الجسم) ، كما ان الاضافة ادت الى تقليل الغذاء المستهلك ومن ثم ادت الى تحسن معنوى فى معدل التحويل الغذائي، يليها مجموعة الكنترول المضاف اليها البروبليس

7- اضافة حبوب لقاح النحل بمستوى 0,2% الى العليقة ادى الى زيادة معنوية فى وزن الذبيحة ووزن الاجزاء المأكولة وكذلك نسبة التصافى . يلى ذلك مجموعة البروبليس . بينما مجموعة قشور الرمان المجففة سجلت اعلى زيادة معنوية بالنسبة لوزن الكليتين.

8- اضافة حبوب لقاح النحل بمستوى 0,2% الى العليقة ادى الى تحسن مستوى الجلوكو و البروتين الكلى و مضادات الاكسدة الكلية وكذلك الكتاليز.بينما مجموعة مسحوق قشور الرمان اظهرت زيادة معنوية فى كل من قيم الالبيومين و انزيمات الكبد وكذلك ادت الى انخفاض ملحوظ فى قيمة الكوليسترول الكلى.

9- اظهرت معاملات هضم العناصر الغذائية تحسنا ملحوظا عند اضافة حبوب لقاح النحل الى عليقة الكنترول.

10- ادت ايضا اضافة حبوب لقاح النحل الى زيادة الدخل الصافى والكفاءة الاقتصادية.

نستنتج من هذه الدراسة أن اضافة حبوب لقاح النحل ادت الى تحسن الكفاءة الانتاجية وصفات الذبيحة ومعاملات الهضم وصفات الدم وكذلك الكفاءة الاقتصادية للارانب النامية.