EFFECT OF ADDING LIPIDOL ON THE UTILIZATION OF BROCCOLI BY-PRODUCT IN GROWING RABBIT DIETS

Fatma T.F. Abd El-Ghany; A. R.H. Habeb; Amal M. Hekal and A.M.M. Saidahmed

Animal Production Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

(Received 18/1/ 2017, Accepted 22/3/ 2017)

SUMMARY

The aim of the present study was to evaluate the effect of the partial replacement of clover hay (CH) by broccoli product with or without lipidol on growth performance of growing New Zealand White (NEW) rabbits. A total of sixty growing NZW rabbits at four weeks of age were randomly divided into six groups (10 rabbits each). Three different levels of broccoli by- product (0, 5 and 10%) of the diet were used, each level of broccoli by- product was fed without or with 0.05% lipidol. The results showed that there were no negative effect on live body weight and live body weight gain due to levels of broccoli by-product regardless of lipidol. Addition of lipidol during the first period (4-9 weeks of age) improved both of live body weight and live body weight gain, while there was no significant difference between the values during the total experimental period (4-14 weeks of age). And the best treatment compared to the control (T1) was T5 (5% B+L), while there were no significant differences between the other treatment.Supplementation both broccoli by-product and lipidol significantly ($P \leq 0.05$) reduced fed intake but did not effect on feed conversion. There was a positive effect on all digestion coefficients of nutrients and nutritive values due to level 10% of broccoli by-product regardless of lipidol treatment. T4(10%B) and T6 (10%B+L) resulted in maximum values for carcass dressing %. Both of the lipidol and broccoli by-product decreased EE% of rabbit meat. Addition of lipidol to the control and the other groups with broccoli showed an increase in length and slight increase in width of intestinal villi with normal epithelial lining and 5% replacement was the best. Almost all microbial counts decreased significantly ($P \leq 0.05$) due to broccoli replacement and lipidol supplementation. The best relative economical efficiency value was (133%) for T5(5%B+L). From the results of this experiment it could be concluded that addition of lipidol with replacement up to 10% of broccoli by-product in rabbit's diet, resulted in better performance, better economic efficiency and there were no adverse effect on physiological responses and carcass quality.

Keywords: *Lipidol, Broccoli by-product, growth performance, blood parameters, caecum microorgannisms, nutrients digistibilities, carcass traits, rabbit.*

INTRODUCTION

The feeding is the major input cost in animal production, accounting for 65-70% of the total rearing cost. Poor nutrition of animals has been identified as the major constrain to animal production across the developing world (FAO, 2000). On the mean time, agricultural by-products (field and food industrials) amount reached around 32 million tons annually (Egyptian Ministry of Agriculture, 2002), more than two third of this amount is left without use annually. Vegetables vines are the cheapest source of essential amino acids, vitamins and minerals. Using Broccoli by-product can help to reduce feeding cost in rabbit ration, and helps to avoid its environmental pollution hazardous. Broccoli is a plant in the cabbage family whose large flower head is used as vegetables. It belongs to the *Brassicacease* family. It contains a lot of promoting compounds like minerals, vitamins and fiber. Moreno *et al.*(2006) found that broccoli contains 103 mg Ca , 78 mg P, 1.1 mg Fe,15 mg Na, 38 mg K , thiamin 0.1 mg, riboflavin 0.23 IU, niacin 0.9 IU and ascorbic acid 113 IU. Lipidol is prepared from the phospholipids found in soya bean lecithin using enzymes, which remove one of fatty acid chain from the lecithin. Once this chain is removed the molecule has very different chemical and biological properties. Several biologically active phospholipids have been formulated in lipidol as a performance enhancer in animal feed. Lipidol has several benefits that it enhances absorption from the gut, improves bioavailability of feed additives, maximizes enzymatic digestion of feed, helps in maximum nutritional value for high density ration, improves feed conversion and animal performance and improves immunity and reduces mortality (Apsaspecialities Company, 2012).

Various experimental tests performed with lipidol in broiler chickens in Dankook University, South Korea in 2010 and 2011 showed a linear improvement in weight gain and feed conversion when lipidol was included at 0.5 and 1kg / ton of feed.

Therefore, this study aimed to evaluate incorporation of broccoli by- product, as an untraditional feedstuff in growing New Zealand White rabbit diets with or without lipidol supplementation**.**

MATRIALS AND METHODS

The present study was carried out at private farm belong to Ismael Radwan Farm, Sahl- Elhosainya, Sharqia Governorate, Egypt**.** The experimental work lasted for 70 days. Three different levels of broccoli by- product (0, 5 and 10%) of the diet. Each level of broccoli by- product was fed without or with lipidol (0 and 0.05%). Accordingly, a total of experimental diets were used 6 treatments (3 levels of broccoli by-product x 2 levels of lipidol). Table (1) showed the chemical analysis of the tested broccoli by-product. Table (2) showed the formulation and chemical analysis of the experimental diets.

Table (1): Chemical composition of broccoli by-product.

Item	Component
DM	77.0
Component, % on DM basis	
CP	14.02
CF	27.56
Cell wall constituents,% on DM basis	
NDF	45.87
ADF	35.13
ADL	2.25
EE	0.11
Ash	8.43
NFE	26.88
Minerals,%	
Ca	1.03
P	0.87
DE, Kcal/Kg	2073.5
Total Glugosinolate	2.17

Tested materials:

Broccoli by- product (the residual of the plant after taking of large flower head) was chopped into 3-5 cm and was strained, and then lipidol was added to treatments with it. Chemical composition of broccoli by- product was determined according to AOAC (2000). Anti-nutritional factor (glucosinolates) was determined according to Saman *et al*. (2016). Lipidol is a Korean commercial product developed jointly by Apsaspecialities and Pathway Intermediates Companies; prepared to be used as animal feed additive; it contains lysophospholipids (3%), other lipids (47%) and calcium silicate (50%). Lipidol was supplementated at 0.5 Kg / ton of feed (0.05%).

Animals:

A total number of sixty growing New Zealand White (NZW) rabbits at four weeks of age were randomly divided into six experimental groups (10 rabbits in each) with approximately similar initial body weights. Rabbits were assigned, individually. Rabbits were housed in galvanized metal rabbit battery cages (60 x 50 x 40) supplied with separated feeders and fed the experimental diet to meet their nutrients requirements during the growing period according to Agriculture Ministry Decree (1996) recommendations. Diets were offered in pellets form *ad libtum*, and fresh water was available all times from automatic nipple drinkers. All animals were kept under the same managements and hygienic conditions. Any health problems or death were recorded.

Table (2): Formulation and chemical analysis of experimental diets.

Ingredient	T1 (Control)	T2 (Control + L)	T3 (5%B)	T4 (10%B)	T5 (5%B+L)	T5 (10%B+L)
Barley grains	16	16	16	16	16	16
Wheat bran	27.0	27.0	27.0	23.5	27.0	23.5
Yellow corn	8	8	8	8	8	8
Soybean meal (44%)	12.5	12.5	12.5	16	12.5	16
Clover hay(17%)	30	30	25	20	25	20
Broccoli by-product	0	0	5	10	5	10
Lime stone	1.35	1.35	1.35	1.35	1.35	1.35
Dicalcium phosphate	1.3	1.3	1.3	1.3	1.3	1.3
Molawses	3.0	3.0	3. 0	3. 0	3. 0	3.0
DL. Methonine	0.1	0.1	0.1	0.1	0.1	0.1
Salt	0.45	0.45	0.45	0.45	0.45	0.45
*Vit. & M. mix.	0.3	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100	100
Chemical analysis						
CP%	17.07	17.07	17.12	17.13	17.12	17.13
CF%	13.04	13.04	13.01	12.84	13.01	12.84
EE%	2.13	2.13	2.09	2.03	2.09	2.03
NFE%	60.27	60.27	59.53	59.43	59.53	59.43
Ash%	7.65	7.65	8.25	8.37	8.25	8.37
NDF%	37.49	37.49	37.47	37.36	37.47	37.36
ADF%	19.84	19.84	20.34	15.93	20.34	15.93
ADL%	6.35	6.35	6.52	5.18	6.52	5.18
**DE, Kcal/Kg	2519	2519	2520	2525	2520	2525
C/P ratio	147.57	147.57	147.20	147.40	147.20	147.40
Ca, %	1.18	1.18	1.18	1.18	1.18	1.18
Total Phosphorus, %	0.8	0.8	0.8	0.8	0.8	0.8

B= Broccoli by-product, L= Lipidol, MSE= Mean standard error

**Supplied per kg of diet: Vit. A, 12000IU; Vit. D_3, 2200 IU; Vit. E, 10mg; Vit.K_3, 3.0; Vit. B_1, 1.0mg; Vit. B_2, 4.0mg; Vit. B_6, 1.5mg; Vit. B_{12}, 0.12mg; Pantothenic acid, 5.3mg;Vit.B5, 5.23;Biotin, 2.12mg; Folic acid, 1.67mg;Choline chloride,400mg; Zn, 22.3mg; Mn, 10mg;Fe,25mg; Cu, 1.67mg; I,0.25mg; Se 0.033mg and Mg, 133mg. **DE(Kcal/kg) = 4.36-0.0491x NDF%. Where, NDF% = 28.924 + 0.657x CF% (Calculated according to Cheeke, (1987).*

Growth performance traits:

Both live body weight and feed intake were recorded weekly, and then body weight gain and feed conversion ratio were calculated.

Digestibility trail:

At the end of the experimental period (at 14 weeks of age), digestibility trail was carried out using four rabbits of each treatment. Feces were collected daily, weighed and dried at 60-70 ^{o}C for 24 hours, finely ground and stored for chemical analysis. Data of quantities and chemical analysis of feed and feces were used to calculate the nutrients digestion coefficients and the nutritive values of the dietary treatments, as described by Cheeke *et al*. (1982). Neutral detergent fiber (NDF), acid detergent fiber

(ADF) and acid detergent lignin (ADL) were determined by method of Van Socest (1982). The samples of feed and feces were chemically analyzed according to AOAC (2000).

Table (3): Effect of the experimental diets on live body and live weight gain.

Item	Live body weight (g)			Live body weight gain (g)		
	4 wk	9 wk	14 wk	4-9 wk	9-14 wk	4-14 wk
Effect of Broccoli (B):						
B (0%)	551.65	1509.75[b]	2536.75	958.10	1027.00	1985.10
B (5%)	556.05	1600.25[a]	2636.50	1044.20	1036.25	2080.45
B (10%)	544.40	1516.00[b]	2535.25	971.60	1019.25	1990.85
MSE	8.81	61.01	41.74	61.40	51.84	42.72
Effect of lipidol (L):						
L (0.0 Kg/Ton)	549.40	1505.83[b]	2528.00	973.63[b]	1022.17	1977.97
L (0.5 Kg/Ton)	551.37	1578.17[a]	2611.00	1026.80[a]	1032.83	2059.63
MES	14.95	72.62	57.75	75.90	64.37	62.36
Effect of interaction:						
T1(Cont.)	558.80	1455.50	2533.00[b]	896.70	1077.50	1978.60[b]
T2 (Cont.+L)	544.50	1564.00	2540.50[b]	1019.50	976.50	1996.00[ab]
T3 (B5%)	556.90	1569.00	2576.00[ab]	1012.10	1007.00	2019.10[ab]
T4 (B10%)	534.40	1493.00	2475.00[b]	958.60	982.00	1940.60[b]
T5 (B5%+L)	555.20	1631.50	2697.00[a]	1076.30	1065.50	2141.80[a]
T6 (B10%+L)	554.40	1539.00	2595.50[ab]	984.60	1056.50	2041.10[ab]
MSE	9.53	60.65	46.15	61.73	54.71	48.68

[a, b….] *Means within each column have no similar letter(s) are significantly different ($P \leq 0.05$).*

B= Broccoli by-product, L= Lipidol, MSE= Mean standard error

Carcass traits:

At the end of the experimental period (at 14 weeks of age), three rabbits from each group were randomly slaughtered and carcass traits were studied. Relative weight of giblets (heart, liver and kidney) and dressing percentage were calculated according to Steven *et al*. (1981). Boneless meat of breast and thigh muscle was determined according to AOAC (2000)**.**

Blood parameters:

Blood samples were collected by vacuum pump into dry clean tubes using heparin as an anticoagulant at 14 weeks of age. The collected samples were centrifuged at 3000 rpm for 15 min, then stored at -20°C for subsequent analysis. Blood plasma was used for determination total protein (g/dl), albumin (g/dl), globulin (g/dl) (was calculated by subtraction of albumin from total protein), A/G ratio, alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatinine (mg/dl), glucose (mg/dl) (immediately measured) and cholesterol (mg/dl). All those parameters which were determined calorimetrically using available commercial kits purchased from Diamond Diagnostics Company, Egypt.

Caecum activities and microbial counts:

Samples of caecum contents from the same slaughtered rabbits from each treatment groups were taken and used immediately for estimation of caecum pH, total volatile fatty acids, ammonia nitrogen concentration and microbiological analysis. The samples of caecum contents were strained through four folds of gauze and divided into two portions, the first portion was used immediately for estimation of PH and ammonia nitrogen concentration. The second portion was preserved by addition of 1 ml N/10 HCL and 2 ml Orthophosphoric acid to each 2 ml of caecum contents juice for determination total volatile fatty acids. The pH was measured immediately by using a digital pH meter. The ammonia nitrogen concentration was determined by applying method of Conway (1958). The total volatile fatty acids were determined by steam distillation of the distillate as mentioned by Eadie *et al*. (1967).

The microbial counts were studied using their selective media, as described by Postage (1969) for Aerobic total bacterial counts and Difco (1989) for Fecal coliforms and E.coli, while, the methods described by Baired Parker (1962) and Kim and Goepfert (1971) were used for Enterococcus count and Bacillus cereus, respectively and Difco (1989) for Enterobacter count, Clostridium sp.; while the method described by Lodder (1952) was used for yeasts determination. Salmonella and Shigella were enumerated according to the methods described by AOAC. (2000). Technique of colony forming unit (CFU) was adopted. Incubation took place at 30oC for 2-7 days. The ammonia nitrogen concentration was determined by applying method of Conway (1958).The total volatile fatty acids were determined by steam distillation of the distillate as mentioned by Eadie *et al*. (1967).

Histopathological examination:

Small specimens from small intestine of slaughtered animals were collected and fixed in neutral buffered formalin 10%, dehydrated in alcohol and cleared in xylene then embedded in paraffin. 4-5 mm sections were obtained and stained with Hematoxyline and Eosin (Bancroft *et al*., 1996).

Statistical analysis:

Data from all response variables were subjected to a factorial analysis using SAS (2001). Variables having significant differences were compared using Duncan's multiple range test (Steel and Torrie, 1960). The significance level was set at 0.05 ($p \leq 0.05$).

The following model was applied for the statistical analysis;

$Y_{ijk}= \mu+B_i+L_j+BL_{ij}+ E_{ijk}$;

where;

Y_{ijk} = Individual observation.

μ = Overall mean.

B_i = Effect of broccoli by- product levels ($_i$ = 1, 2 and 3).

L_j = Effect of lipidol levels ($_j$= 1and 2).

BL_{ij} =Effect of the interaction between broccoli replacement and effect of lipidol.

E_{ijk} =Random experimental error.

RESULTS AND DISCUSSION

Chemical composition of Broccoli by-product:

Data of Table (1) revealed that broccoli by-product contained a good value of CP (14.02%), this may be due to good contents of broccoli leaves. Values of CF (27.56%), NDF (45.87%) and ADF (35.13%), this may be due to high contents of the cellulose and hemi cellulose in roots of broccoli by-product. Also, Ca and P values were in a good amount (1.03 and 0.87 % respectively). These results were very close to those reported by Ibrahim *et al*.(2011) who found that broccoli by-product contained 14.26 CP, 23.87 CF, 37.14 NDF, 2.35% EE. Also, Ca and P values were not far from those indicated by Hu *et al*. (2011) who found that broccoli by- product contained 1.408% Ca and 0.524% P.

Productive performance:

Live body and live weight gain:

Table (3) showed that there was no negative effect on both live body weight and live body weight gain due to levels of broccoli by-product regardless of lipidol. The total live body weight gain values from 4-14 weeks of age were 1985.1, 2080.45 and 1990.85 g for 0, 5 and 10% broccoli by-product, respectively, there were no significant differences ($P \leq 0.05$) between the previous values. Addition of lipidol during the first period (4-9 weeks of age) improved significantly ($P \leq 0.05$) both of live body weight and live body weight gain, while there was no significant difference between the values during the total experimental period (from 4-14 weeks of age). Live body weight gain value was 2059.63 for lipidol vs. 1978.60 g for the non treated groups. The best value compared to the control (T1) was for T5 (5% B+L), while there were no significant ($P \leq 0.05$) differences between the other treatments. These results agreed with Hu *et al*.(2011) who indicated that increasing dietary supplementation (0,30,60 and 90 g/Kg) of dried broccoli stem and leaves meal had no significant effect on production performance of laying hens. Moreover, the study of Apsaspecialities company (2012**)** that conducted in Sungkyunkwan University (South Korea) of piglets showed that lipidol inclusion at1kg/ton significantly ($P < 0.05$) improved weight gain by 12%.

Feed intake and Feed conversion:

Table (4) indicated that there was a significant effect on both feed intake and feed conversion due to levels of broccoli by-product regardless of lipidol supplementation. The total feed intake was decreased. The values from 4-14 weeks of age were 5130.85, 5129.30 and 5091.44 g for 0, 5 and 10% broccoli by-product, respectively. There were significant differences ($P \leq 0.05$) between rabbits fed on 10% compared with those fed on 0%. There was a significant ($P \leq 0.05$) difference between the values of feed conversion ratio during first period (4-9 weeks of age). The values were 2.26, 1.90 and 2.05 for 0, 5 and 10% broccoli by-product, respectively. Addition of lipidol during the second period (from 9-14 weeks of age) and total period (4-14 weeks of age) significantly ($P \leq 0.05$) decreased feed intake, while there was no significant improvement for feed conversion during all periods. Feed intake value was 5204.62 g for the non treated groups vs. 5029.77 g for lipidol groups during the total period (4-14 weeks). The best feed conversion value compared to the control (T1) recorded with T5 (5% B+L) .These results may be due to the effect of using broccoli by- product as reported by Ibrahim *et al*. (2011) who noticed performance improving for rabbits fed broccoli by-product related to the beneficial effect on gastrointestinal health. Also, results may be related to the effect of lipidol addition, which has several benefits, it enhances absorption from the gut, improves feed conversion and animal performance and improves immunity and reduces mortality (Apsaspecialities Company, 2012).

Table (4): Effect of the experimental diets on feed intake and feed conversion.

Item	Feed intake (g/rabbit)			Feed conversion ratio (feed intake, g/weight gain, g)		
	4-9 wk	9-14 wk	4-14 wk	4-9 wk	9-14 wk	4-14 wk
Effect of Broccoli (B):						
B (0%)	1985.05 ^{a}	3145.80	5130.85 ^{a}	2. 26 ^{a}	3.23	2. 61
B (5%)	1948.80 ^{b}	3180.50	5129.30 ^{ab}	1.90 ^{b}	3.10	2.47
B (10%)	1942.94 ^{b}	3148.50	5091.44 ^{b}	2.05 ^{ab}	3.20	2.57
MSE	29.15	35.06	59.84	0.14	0.21	0.06
Effect of lipidol (L):						
L (0.0 Kg/Ton)	1954.62	3250.00 ^{a}	5204.62 ^{a}	2.13	3.27	2.64
L (0.5 Kg/Ton)	1963.24	3066.53 ^{b}	5029.77 ^{b}	2.01	3. 10	2. 46
MES	38.09	36.10	53.80	0.26	0.29	0.09
Effect of interaction :						
T1(Cont.)	2070.86 ^{a}	3250.00 ^{a}	5320.86 ^{a}	2.420 ^{a}	3.119	2.716 ^{a}
T2 (Cont.+L)	1899.24 ^{bc}	3041.60 ^{c}	4940.84 ^{c}	2.093 ^{ab}	3.331	2.504 ^{bc}
T3 (B5%)	1891.04 ^{c}	3297.00 ^{a}	5188.04 ^{ab}	1.914 ^{ab}	3.296	2.578 ^{ab}
T4 (B10%)	1901.95 ^{bc}	3203.00 ^{ab}	5104.95 ^{bc}	2.055 ^{ab}	3.409	2.634 ^{ab}
T5 (B5%+L)	2006.55 ^{ab}	3064.00 ^{c}	5070.55 ^{bc}	1.882 ^{b}	2.903	2.368 ^{c}
T6 (B10%+L)	1983.93 ^{abc}	3094.00 ^{bc}	5077.93 ^{bc}	2.050 ^{ab}	2.998	2.504 ^{bc}
MSE	35.73	44.07	59.07	0.17	0.22	0.07

[a, b, c….] Means within each column have no similar letter(s) are significantly different ($P \leq 0.05$).

B= Broccoli by-product, L= Lipidol, MSE= Mean standard error

Digestibility trail:

Data presented in Table (5) indicated that there was a positive effect on all digestibility coefficients of nutrients and nutritive value for diet contained 10% broccoli by-product regardless of lipidol treatment. Values were 67.70, 63.80,78.76,57.10,83.24,78.17,70.22 and 13.49 for DM,OM,CP,CF,EE,NFE, TDN and DCP, respectively. There were no significant differences ($P \leq 0.05$) between the previous values and control, while there was significantly difference between those values and level of 5%. Addition of lipidol significantly ($P \leq 0.05$) improved DM and OM digestibility, while, there was no significant difference between the values of CF, EE and NFE digestibility, while significantly ($P \leq 0.05$) decreased CP digestibility. Addition of lipidol significantly decreased both TDN and DCP values. These results revealed that 10% broccoli by-product, improved digestion coefficients of nutrients. The results at that level may be due to the balanced of fiber fraction percentage, NDF (45.87%) and ADF (35.13%), soluble fiber has high water holding capacity, readily forms gel, increases luminal viscosity, and is easily degraded by micro-flora in the large bowel. On the contrarily, insoluble fiber has little water holding capacity, decreases transit time. These results agreed with Ibrahim *et al*. (2011) who indicated that the improving in digestion coefficients may be due the large bowel ecosystem in rabbits fed broccoli by-product and conversely to be protected by fermentable oligosaccharides. The positive effect of lipidol reported by Apsaspecialities Company (2012) was noticed only on digestion coefficients of DM and OM, but the opposite effect was noticed on TDN and DCP. Apsaspecialities Company (2012) reported that lipidol has several benefits; it enhances absorption from the gut, improves bioavailability of feed additives, maximizes enzymatic digestion of feed, and helps in extract of maximum nutritional value from high density ration.

Table (5): Effect of the experimental diets on digestibility coefficients of nutrients (%) and nutritive values.

Item	DM	OM	CP	CF	EE	NFE	Nutritive values	
							TDN	DCP
Effect of Broccoli (B):								
B (0%)	66.77 ^{ab}	62.86 ^{a}	76.95 ^{ab}	56.52^{a}	81.82^{ab}	78.24 ^{a}	70.56 ^{a}	13.16 ^{a}
B (5%)	65.13^{b}	62.20 ^{b}	74.94 ^{b}	53.03^{b}	79.89 ^{b}	76.64^{b}	67.54 ^{b}	12.82 ^{b}
B (10%)	67.70 ^{a}	63.80 ^{a}	78.76 ^{a}	57.10^{a}	83.24 ^{a}	78.17 ^{a}	70.22 ^{a}	13.49 ^{a}
MSE	0.48	0.63	0.49	0.91	0.42	0.40	0.48	0.08
Effect of Lipidol (L):								
L (0.0 Kg/Ton)	66.40 ^{b}	62.79 ^{b}	79.18^{a}	56.13	82.37	78.43	70.14^{a}	13.56^{a}
L (0.5 Kg/Ton)	68.81 ^{a}	66.67 ^{a}	74.58^{b}	54.97	80.93	76.94	68.74^{b}	12.74^{b}
MES	0.48	0.52	0.68	0.72	0.53	0.91	0.59	0.12
Effect of interaction :								
T1 (Cont.)	64.73 ^{c}	60.70 ^{b}	77.19 ^{b}	55.13 ^{b}	81.17 ^{b}	78.15 ^{a}	71.55 ^{a}	13.22 ^{b}
T2 (Cont.+L)	68.81 ^{a}	65.02 ^{a}	76.70 ^{b}	57.91 ^{a}	82.47 ^{ab}	78.33 ^{a}	69.57 ^{bc}	13.09 ^{b}
T3 (B5%)	66.97 ^{b}	64.22 ^{a}	80.10 ^{a}	55.24 ^{b}	82.43 ^{ab}	77.81 ^{ab}	68.09 ^{cd}	13.72 ^{a}
T4 (B10%)	67.49 ^{ab}	63.45 ^{a}	80.25 ^{a}	58.02 ^{a}	83.51 ^{a}	79.32 ^{a}	70.78 ^{ab}	13.74 ^{a}
T5 (B5%+L)	63.28 ^{c}	60.17 ^{b}	69.78 ^{c}	50.82 ^{c}	77.35 ^{c}	75.46 ^{b}	66.99 ^{d}	11.91 ^{c}
T6 (B10%+L)	67.91 ^{ab}	64.15 ^{a}	77.27 ^{b}	56.17 ^{ab}	82.96 ^{a}	77.02 ^{ab}	69.65 ^{bc}	13.23 ^{b}
MSE	0.50	0.68	0.53	0.76	0.52	0.77	0.55	0.09

$^{a, b,c, d....}$ *Means within each column have no similar letter(s) are significantly different (P ≤ 0.05).*

B= Broccoli by-product, L= Lipidol, MSE= Mean standard error

Carcass traits:

Table (6) showed that there was no negative effect on all carcass traits due to levels of broccoli by-product regardless of lipidol treatment. Dressing % values were 52.11, 52.20 and 54.24 for 0, 5 and 10% broccoli by-product, respectively. There were significant differences (P≤0.05) between rabbits fed on 10% broccoli and control. Addition of lipidol had significant effect on dressing % values and intestinal thickness, intestinal thickness was 16.16 for lipidol vs. 16.34 for the non treated groups. While, there was no significant difference between the values of other carcass traits. The best treatment compared to the control (T1) was T4 (10% B) the dressing % value for was 54.40 vs. 51.41 for T1 (control). These results may be due to the ability of broccoli in preventing fat disposition (Ibrahim *et al*., 2011).

Data of Table (7) revealed that EE content of rabbit meat decreased due to levels of broccoli by-product regardless of lipidol treatment. EE% values were 1.96, 1.72 and 1.38 for 0, 5 and 10% broccoli by-product, respectively. There were significant differences (P≤ 0.05) between 10% and control and between 10% and 5%, while there were no significant differences between 5% and control. Addition of lipidol significantly increased CP content and decreased EE content when compared to non treated groups. CP% and EE% values were 24.77 and 1.350 for lipidol vs. 23.85 and 2.02 for the non treated groups. While, there was no significant difference between the values of other chemical composition of meat. The best treatment compared to the control (T1) was T6 (10%B+L), that CP % and EE% values for

T6 (10% B+L) were 24.95 and 1.09, respectively vs. 23.84 and 2.29, respectively for T1 (control). The previous results agreed with Apsaspecialities Company (2012) who indicated that lipidol addition contribute to decrease EE% in meat. Also, these results may be related to the benefits effect of broccoli by-product, broccoli has strong antioxidative properties; lipid oxidation is one of the primary processes of quality deterioration in meat and meat products. Enhanced antioxidant capability in the muscle tends to improve meat quality and extend the shelf life (Tavarez *et al.*, 2011). Impairment of muscle cell membrane integrity could affect the ability of biomembrane to act as a semipermeable barrier and might contribute to exudative loss from meat (Huff-Lonergan and Lonergan, 2005). The volume of drip loss is related to the lipid peroxide contents in the muscle (Juncher *et al.*, 2001 and Tavarez *et al.*, 2011).

Table (6): Effect of the experimental diets on carcass traits and small intestine measurements.

Item	Carcass traits								Small intestine measurements		
	Carcass (%)	Liver (%)	Kidneys (%)	Heart (%)	Lungs (%)	Spleen (%)	Head (%)	Dressing (%)	Impiety intestinal weight (%)	Intestinal length (cm)	Intestinal thickness (mm)
Effect of replacement of broccoli (B):											
B (0%)	47.67 [b]	3.34	0.77	0.35	0.70	0.05	6.03	52.11 [b]	1.74	234.50	17.09
B (5%)	48.44 [ab]	2.67	0.74	0.35	0.63	0.04	6.36	52.20 [ab]	1.93	262.00	16.16
B (10%)	50.05 [a]	2.98	0.81	0.39	0.64	0.05	6.54	54.24 [a]	2.35	302.00	15.51
MSE	0.73	0.40	0.06	0.05	0.09	0.01	0.30	0.53	0.23	29.69	1.26
Effect of lipidol (L):											
L (0.0 Kg/Ton)	48.68	3.05	0.74	0.36	0.63	0.04	6.31	52.82	2.03	268.22	16.34 [a]
L (0.5 Kg/Ton)	48.76	2.95	0.80	0.36	0.68	0.05	6.31	52.88	1.98	264.11	16.16 [b]
MES	0.39	0.24	0.06	0.04	0.06	0.01	0.07	0.54	0.21	21.11	0.43
Effect of interaction:											
T1 (Cont.)	46.81 [b]	3.53	0.75	0.33	0.67 [b]	0.04	5.82	51.41 [c]	1.64 [b]	219.33 [b]	18.04
T2 (Cont.+L)	48.52 [ab]	3.16	0.78	0.36	0.73 [a]	0.05	6.24	52.81 [abc]	1.85 [ab]	249.67 [ab]	16.14
T3 (B5%)	48.96 [ab]	2.69	0.67	0.33	0.63 [b]	0.04	6.59	52.65 [abc]	2.03 [ab]	278.00 [ab]	15.11
T4 (B10%)	50.26 [a]	2.92	0.81	0.41	0.60 [b]	0.05	6.52	54.40 [a]	2.42 [a]	307.33 [a]	15.88
T5 (B5%+L)	47.92 [ab]	2.65	0.81	0.36	0.63 [b]	0.04	6.13	51.74 [bc]	1.83 [ab]	246.00 [ab]	17.21
T6 (B10%+L)	49.84 [a]	3.05	0.82	0.37	0.67 [b]	0.05	6.56	54.08 [ab]	2.27 [ab]	296.67 [ab]	15.13
MSE	0.89	0.35	0.05	0.04	0.07	0.01	0.24	0.75	0.21	25.28	1.03

[a, b ,c….] *Means within each column have no similar letter(s) are significantly different ($P \leq 0.05$).*

Dressing %=[carcass weight (g) + liver + kidneys + heart/preslaughter weight (g)] x 100.

B= Broccoli by-product, L= Lipidol, MSE= Mean standard error

Histopathology of small intestine:

Results in Figures (1-6) showed that addition of lipidol to control group and broccoli groups replacement showed increased in length and slight increase in width of intestinal villi with normal epithelial lining and 5% broccoli was the best one without a wide bad changes. These results might be related to the effect of lipidol. Results agreed with Apsaspecialities Company, (2012) who indicated that the lipidol has several benefits that it enhances absorption from the gut. That, Transverse section through small intestine of rabbit received 10% broccoli by-product with lipidol showing increase in length and width of intestinal villi with a normal epithelial lining and increase in a number of goblet cells which modified simple columnar epithelial cell whose function is to secrete gel-forming mucins, the major components of mucus. The goblet cells mainly use the merocrine method of secretion, secreting vesicles into a duct, but may use apocrine methods, budding off their secretions, when under stress**.** Also, the remainder of the cell's cytoplasm is occupied by membrane-bound secretory granules containing mucin which improved intestine health. The goblet shape is due to the mucus laden granules in the apical part expanding, causing that part of the cell to balloon. The apical plasma membrane projects microvilli to give an increased surface area for secretion and absorption (Lohmann-Matthes *et al*., 1994).

Table (7): Effect of the experimental diets on chemical composition of carcass meat.

Item	Moisture	CP	EE	Ash
Effect of replacement of broccoli (B):				
B (0%)	72.72 [b]	24.22	1.96 [a]	1.10
B (5%)	72.83 [b]	24.32	1.72 [a]	1.13
B (10%)	73.14 [a]	24. 40	1.38 [b]	1.08
MSE	0.04	0.04	0.06	0.03
Effect of lipidol (L):				
L (0.0 Kg/Ton)	73.01	23.85 [b]	2.02 [a]	1.12
L (0.5 Kg/Ton)	72.79	24.77 [a]	1.35 [b]	1. 09
MES	0.03	0.03	0.06	0.03
Effect of interaction:				
T1 (Cont.)	72.76 [cd]	23.84 [d]	2.29 [a]	1.11 [ab]
T2 (Cont.+L)	72.68 [d]	24.59 [c]	1.63 [c]	1.10 [ab]
T3 (B5%)	72.88 [bc]	23.86 [d]	2.09 [b]	1.17 [a]
T4 (B10%)	73.38 [a]	23.84 [d]	1.69 [c]	1.09 [b]
T5 (B5%+L)	72.78 [cd]	24.77 [b]	1.34 [d]	1.11 [ab]
T6 (B10%+L)	72.90 [b]	24.95 [a]	1.09 [e]	1.06 [b]
MSE	0.05	0.03	0.04	0.02

[a, b,c,d , e….] *Means within each column have no similar letter(s) are significantly different (P ≤ 0.05).*

B= Broccoli by-product, L= Lipidol, MSE= Mean standard error

Blood constituents:

From data presented in Table (8) it could be noticed that no negative effect on all blood plasma constituents due to levels of broccoli by-product regardless of lipidol addition. Plasma cholesterol values were 80.30, 77.63 and 82.49 for 0, 5 and 10% broccoli by-product, respectively. There were significant differences (P≤ 0.05) between level of 5% and 10% broccoli only. Addition of lipidol had no significant effect on all plasma constituents values. T3 (5% B) recorded the highest significantly (P≤ 0.05) globulin value 2.83 vs. 2.29g/dl for T1 (control diet). This treatment resulted in (P≤0.05) least cholesterol value.

Table (8): Effect of the experimental diets on plasma parameters.

Item	Total proteins (g/dl)	Albumin (A) (g/dl)	Globulin (G) (g/dl)	A/G ratio	Cholesterol (mg/dl)	Creatinine (mg/dl)	Glucose (mg/dl)	AST (U/I)	ALT (U/I)
Effect of replacement of broccoli (B):									
B (0%)	**5.78**	**3.32**	**2.46 [b]**	**1.36 [a]**	**80. 30 [ab]**	**0.96**	**190.21**	**32.37**	**23.48**
B (5%)	**5.90**	**3.26**	**2.65 [a]**	**1.27 [b]**	**77.63 [b]**	**0.97**	**189.12**	**33.20**	**23.68**
B (10%)	**5.72**	**3.39**	**2.47 [b]**	**1.38 [a]**	**82.49 [a]**	**0.99**	**189.38**	**33.87**	**22.32**
MSE	**0.18**	**0.23**	**0.14**	**0.14**	**3.43**	**0.04**	**6.36**	**1.63**	**1.60**
Effect of lipidol (L):									
L (0.0 Kg/Ton)	**5.75**	**3.29**	**2.54**	**1.32**	**80.22**	**0.98**	**189.79**	**33.02**	**23.46**
L (0.5 Kg/Ton)	**5.86**	**3.35**	**2.50**	**1.35**	**80.05**	**0.96**	**189.34**	**33.21**	**22.86**
MES	**0.19**	**0.19**	**0.07**	**0.10**	**3.92**	**0.03**	**8.81**	**1.78**	**0.91**
Effect of interaction:									
T1(Cont.)	**5.64**	**3.35**	**2.29 [b]**	**1.47**	**83.73**	**0.99**	**187.80**	**32.31**	**23.70**
T2 (Cont.+L)	**5.93**	**3.29**	**2.63 [ab]**	**1.25**	**76.86**	**0.92**	**192.61**	**32.43**	**23.25**
T3 (B5%)	**6.02**	**3.19**	**2.83 [a]**	**1.14**	**74.07**	**0.95**	**189.90**	**33.01**	**23.76**
T4 (B10%)	**5.58**	**3.34**	**2.51 [ab]**	**1.34**	**82.87**	**0.99**	**191.67**	**33.73**	**22.91**
T5 (B5%+L)	**5.79**	**3.32**	**2.46 [ab]**	**1.39**	**81.18**	**0.98**	**188.33**	**33.18**	**23.60**
T6 (B10%+L)	**5.85**	**3.44**	**2.42 [ab]**	**1.42**	**82.11**	**0.98**	**187.08**	**34.01**	**21.72**
MSE	**0.15**	**0.18**	**0.15**	**0.13**	**3.83**	**0.04**	**6.03**	**1.67**	**1.30**

[a , b….] *Means within each column have no similar letter(s) are significantly different (P ≤ 0.05).*

B= Broccoli by-product, L= Lipidol, MSE= Mean standard error

These results may be related to benefits of broccoli by-product that, it enhanced antioxidant capability in blood constituents and decreased cholesterol (Tavarez *et al*., 2011). Also, results agreed with Apsaspecialities Company (2012) who reported that a source in diet has important effects in blood parameters in animals. Besides, lysolecitins (as lipidol) increase tocopherol and cholesterol absorption. Moreover, Young Hyun *et al*., (2016) indicated that There was the quadratic response of glucose level in blood **(**P<0.01**)** with increasing LIPIDOLTM level. Furthermore, the broilers fed diet containing 0.10% LIPIDOLTM was greater high density lipoprotein than that of in positive control group **(**P<0.05**)**.

Caecum activities and microbial counts:

Data in Tables (9) showed that there was a significant effect on caecum activities due to levels of broccoli by-product regardless of lipidol addition. pH, ammonia and TVFAs values were 6.73, 11.64 mg/100ml and 3.66 ml eq/100ml, respectively for 0% broccoli by-product, 7.42,10.66 and 3.51 respectively for 5% broccoli by-product, and 7.70, 10.35 and 3.44 respectively for 10% broccoli by-product. There were significant differences (P≤ 0.05) between the previous values. Addition of lipidol increased significantly (P≤ 0.05) TVFA value. TVFA value was 3.70 for lipidol vs. 3.24 for the control. T2 (Cont.+L) resulted in maximum TVFA value (3.81 vs. 3.51 for T1 control diet), while T6 (10% B+L) resulted in (P≤0.05) least ammonia value (10.14 vs.11.72). These results agreed with Ibrahim *et al*.(2011) who indicated that**,** there was improving in caecum activities attributed to the ability of broccoli in the utilization of low protein diet by conferred some protection in terms of colon morphology.

Table (9): Effect of experimental diets on caecum activities.

Item	pH	Ammonia (mg/100ml)	TVFA (ml eq/100ml)
Effect of replacement of broccoli (B):			
B (0%)	6. 73 ^{c}	11.64 ^{a}	3.66 ^{a}
B (5%)	7.42 ^{b}	10.66 ^{b}	3.51 ^{ab}
B (10%)	7.70 ^{a}	10.35 ^{c}	3.44 ^{b}
MSE	0.04	0.03	0.03
Effect of lipidol (L):			
L (0.0 Kg/Ton)	7.65	10.56	3.24 ^{b}
L (0.5 Kg/Ton)	7.33	10.73	3.70 ^{a}
MES	0.04	0.03	0.03
Effect of interaction:			
T1(Cont.)	6.67 ^{c}	11.72 ^{a}	3.51 ^{c}
T2 (Cont.+L)	6.78 ^{c}	11.55 ^{b}	3.81 ^{a}
T3 (B5%)	7.38 ^{b}	10.82 ^{c}	3.36 ^{d}
T4 (B10%)	7.65 ^{a}	10.56 ^{d}	3.24 ^{e}
T5 (B5%+L)	7.46 ^{b}	10.50 ^{d}	3.65 ^{b}
T6 (B10%+L)	7.74 ^{a}	10.14 ^{e}	3.64 ^{b}
MSE	0.05	0.03	0.03

a, b,c,d , e.... Means within each column have no similar letter(s) are significantly different (P ≤ 0.05).

B= Broccoli by-product, L= Lipidol, MSE= Mean standard error

Table (10) revealed a decrease in microbial counts due to levels of broccoli by-product regardless of lipidol addition. That, almost all microbial count significantly (P≤ 0.05) decreased. Salmonella and Shigella were not detected in all treatments. Aerobic total counts were $8.99x10^{8}$, $6.18x10^{8}$ and $6.06x10^{8}$, respectively for 0, 5 and 10% broccoli by-product, respectively. There were significant differences (P≤ 0.05) between levels of 5% and 10% broccoli and control. Also, Addition of lipidol decreased significantly (P≤ 0.05) almost all microbial counts. The best treatment compared to the control (T1) was T6 (B10%+L) which resulted in (P≤ 0.05) least values all microbial counts. These results may be related to replacement of broccoli**,** as reported by Manici *et al.* (1997) who found that the glucosinolates and some its metabolites have antifungi effect. Glucosinolates occur as secondary metabolites of almost all plants of the order Brassicales. Also, Ibrahim *et al*. (2011) indicated that, any significant results may be attributed to the medicinal substances or the bioactive compounds (glucosinolates) of broccoli.

Economical efficiency:

Data presented in Table (11) revealed that economical efficiency was high for using broccoli and addition of lipidol at all levels and T5 recorded (133.41) the best relative economic efficiency followed by

T6 125.60% when compared with the control without lipidol addition. These results may be due to decreasing the prices of diets containing broccoli by-product with and without addition of lipidol, and increasing the weight gain for rabbit fed broccoli by-product with addition of lipidol when compared with control diet. Addition of lipidol improve animal performance as a reported by Apsaspecialities company (2012). These results also, agreed with Ibrahim *et al*. (2011) who indicated that, high economic effeciency may be attributed to the ability of broccoli in improving the utilization of low protein diet.

Table (10): Effect of the experimental diets on caecum microbial counts (x10^8 CFU/ml).

Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Effect of replacement of broccoli (B):									
B (0%)	8.99 ^{a}	6.10 ^{a}	6.79 ^{a}	4. 39 ^{b}	4. 72 ^{a}	1.49 ^{a}	3.86 ^{a}	5.58 ^{a}	ND
B (5%)	6.18 ^{b}	4.03 ^{b}	3.77 ^{b}	5.65 ^{a}	3.68 ^{b}	1. 09 ^{b}	4.04 ^{a}	4.44 ^{b}	ND
B (10%)	6.06 ^{b}	3.97 ^{b}	3.56 ^{b}	4.26 ^{c}	3.23 ^{c}	1.03 ^{b}	3.49 ^{b}	3.85 ^{c}	ND
MSE	0.13	0.24	0.15	0.15	0.15	0.05	0.13	0.01	-
Effect of lipidol (L):									
L (0.0 Kg/Ton)	7.28	5.11 ^{a}	5.26 ^{a}	5.00 ^{a}	4.32 ^{a}	1.36 ^{a}	4.19 ^{a}	4.71	ND
L (0.5 Kg/Ton)	6.87	4.30 ^{b}	4.16 ^{b}	4.53 ^{b}	3.43 ^{b}	1.04 ^{b}	3.40 ^{b}	4.53	ND
MES	0.20	0.29	0.16	0.16	0.19	0.05	0.15	0.15	-
Effect of interaction:									
T1(Cont.)	9.27 ^{a}	6.98 ^{a}	7.25 ^{a}	4.77 ^{c}	5.32 ^{a}	1.95 ^{a}	4.61 ^{a}	5.82 ^{a}	ND
T2 (Cont.+L)	8.72 ^{b}	5.22 ^{b}	6.33 ^{b}	4.01 ^{d}	4.12 ^{b}	1.03 ^{b}	3.10 ^{d}	5.33 ^{b}	ND
T3 (B5%)	6.27 ^{c}	4.12 ^{c}	4.37 ^{c}	6.13 ^{a}	4.25 ^{b}	1.11 ^{b}	4.22 ^{b}	4.50 ^{c}	ND
T4 (B10%)	6.30 ^{c}	4.23 ^{c}	4.15 ^{c}	4.10 ^{d}	3.38 ^{c}	1.03 ^{b}	3.73 ^{c}	3.82 ^{d}	ND
T5 (B5%+L)	6.08 ^{cd}	3.95 ^{c}	3.18 ^{d}	5.17 ^{b}	3.11 ^{c}	1.08 ^{b}	3.85 ^{c}	4.38 ^{c}	ND
T6 (B10%+L)	5.81 ^{d}	3.72 ^{c}	2.97 ^{d}	4.42 ^{cd}	3.07 ^{c}	1.02 ^{b}	3.25 ^{d}	3.87 ^{d}	ND
MSE	0.14	0.18	0.13	0.13	0.12	0.04	0.11	0.11	-

(1)= Aerobic total count, (2)= Fecal coliforms, (3)= E. Coli, (4)= Bacillus cereus, (5)= Enterobacter, (6)= Clostridium, (7)= Enterococcus, (8)= Yeasts, (9)= Salmonella & Shigella.
B= Broccoli by-product, L= Lipidol, MSE= Mean standard error
$^{a, b,c \text{ and } d....}$ *Means within each column have no similar letter(s) are significantly different (P ≤ 0.05).*
Each value is an average of 3 observations. ND =Not detected.
Number of bacterial cells per gram of caecum content (X10^8 CFU/ml). CFU (Colony forming unite).

Table (11): Effect of the experimental diets on economical efficiency of rabbits during the period from 4-14 weeks of age.

Item	Experimental treatments					
	T1 (Cont.)	T2 (Cont.+L)	T3 (B5%)	T4 (B10%)	T5 (B5%+L)	T6 (B10%+L)
Price diet/kg L.E	3.55	3.60	3.30	3.25	3.35	3.30
Total feed intake (g)	5320.86	4940.84	5188.04	5104.95	5070.55	5077.93
Total weight gain (g)	1974.20	1996.00	2019.10	1940.60	2141.80	2041.10
Total feed cost (L.E)	18.89	17.79	17.12	16.59	16.99	16.76
Price of kg rabbit weight	25	25	25	25	25	25
Total revenue (L.E)	49.36	49.90	50.48	48.52	53.55	51.03
*Net revenue (L.E)	30.47	32.11	33.36	31.93	36.56	34.27
**Economic efficiency	161.30	180.49	194.86	192.47	215.19	202.60
***Relative economic efficiency (%)	100	111.90	120.81	119.32	133.41	125.60

*B= Broccoli by-product, L= Lipidol, prices of the Egyptian market during the experimental period (2017). selling price of kg rabbit 25 L.E. *Net Revenue = Total Revenue - Total feed cost. **Economic efficiency = Net Revenue / Total feed cost * 100. ***Relative economical efficiency (%) assuming the control treatment equal= 100 %.*

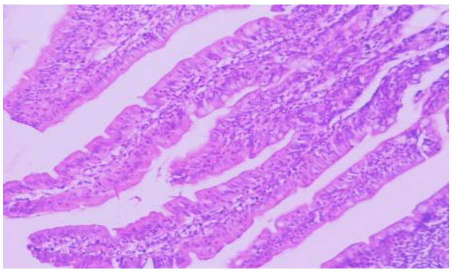

Figure (1): Transverse section through small intestine of rabbit (control group) showing normal histological structure; H&E (200 X).

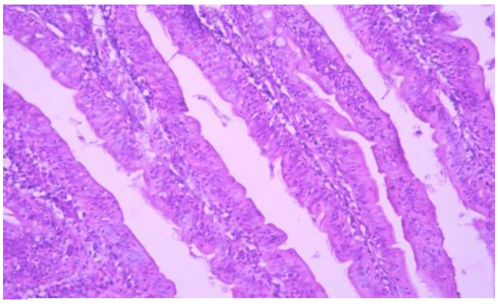

Figure (2): Transverse section through small intestine of rabbit received control diet with lipidol, showing increase in length and slight increase in width of intestinal villi with normal epithelial lining,; H&E (200 X).

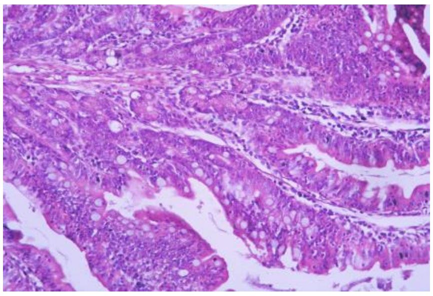

Figure (3): Transverse section through small intestine of rabbit received 5% broccoli by-**product showing normal length and width of intestinal villi with a normal epithelial lining and increase in a number of**

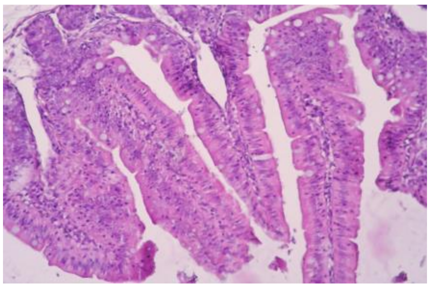

Figure (4): Transverse section through small intestine of rabbit received 10% broccoli by-**product showing slight decrease in length some of them decrease in width with a normal structure of intestinal gland, with inflammatory cells infiltration; H&E (200 X).**

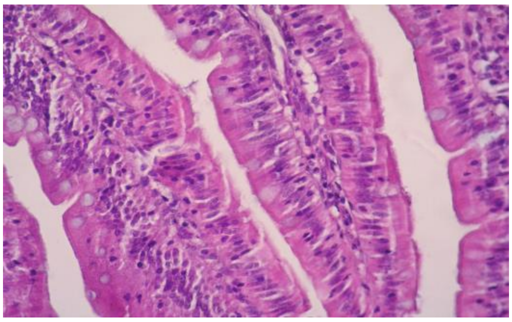

Figure (5): Transverse section through small intestine of rabbit received 5% broccoli by- **product with lipidol showing increase in intestinal length and width with a normal structure of intestinal gland; H&E (200 X).**

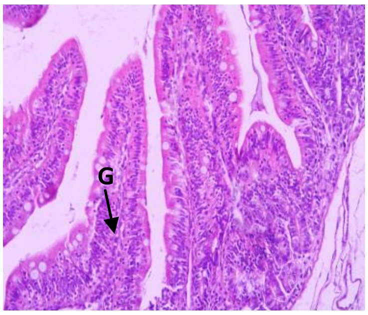

Figure (6): Transverse section through small intestine of rabbit received 10% broccoli by-**product with lipidol showing increase in length and width of intestinal villi with a normal epithelial lining and increase in a number of Goblet cells (G) ; H&E (200 X).**

CONCLUSION

It could be concluded from the present study that addition of lipidol with replacement 10% of broccoli by-product in rabbit's diet, resulted in better performance without any adverse effect on physiological responses and carcass quality.

AKNOWLEDGEMENTS

The authors thank each of Apsaspecialities & Pathway Intermediates Companies Team and Prof. Dr. Kamal Y. El-Nagmy, Poultry Feeding Research Department (APRI) for supplying of Lipidol that used in the study and for his support.

REFERENCES

Agriculture Ministry Decree (1996). The standard properties for ingredients, feed additives and feed manufactured for animal and poultry. El-Wakaee El-Masria, Amirria Press, Cairo, Egypt 192: 95.

AOAC (2000). Association of Official Analytical Chemists. Official Methods of Analysis 15th ed. Washington,DC., USA.

Apsaspecialities company (2012). Beneficial effects have been observed from the use of lipidol in all species. Available online at: www.a2m EGYPT.com .

Bancroft, J.D.; A. Stevens and D.R. Turner (1996). Theory and practice of Histological Techniques. 4th ed. New york, Churchill, livingstone.

Baired Parker, A.C. (1962). The occurrence and enumeration of micrococci and staphylococci in becon and on human and pig skin. J. Appl. Bact., 25: 352-361.

Cheeke, P.R.; N. Patton and G.S. Templton (1982). Rabbit Production.5th Ed. The Intersate Printers and Publishers DanvilleII.

Cheek, P.P. (1987). Rabbit Feeding and Nutrition. Orlando: Academic Press, Inc. Harcourt, Brace, Jovanovich, Publishers.

Conway, E.J. (1958). Micro-diffusion analysis and volumetric error (4th Ed.) The McMillan Co., New York.

Difco(1989). Difco Laboratories Incorporated, Difco manual of dehydrated culture media and reagents for the microbiology. Difco Lab., Detroit, Michigan, USA.

Eadie, J.M.; P.N. Hobson and S.O. Mann (1967). A note on somecomparisons between the rumen content of barley fed steers and that of young calves also fed on high concentrate rations. J. Anim. Prod., 9: 247.

Egyptian Ministry of Agriculture (2002). Egyptian Agriculture Economics. Bull.,Centeral Dept. of Agri.,Economics, Cairo, Egypt.

FAO (2000). Statistical Database. (Internet).

Hu,C.H.; A.Y. Zuo; D.G. Wang; H.Y. Pan; W.B. Zheng; Z.C. Qian; and X.T. Zou (2011). Effects of broccoli stems and leaves meal on production performance and egg quality of laying hens. Anim. Feed Sci. & Tech., 170:117-121.

Huff-Lonergan, E. and S. M. Lonergan (2005). Mechanisms of water holding capacity of meat: The role of postmortem biochemical and structural changes. Meat Sci., 71:194–204.

Ibrahim, Sh. A.M.; H.A.A. Omer; F.A.F. Ali and R.I. El-Kady (2011). Broccoli By-Products as a Partial Replacement of Lucerne Hay in Rabbit Diets Containing Different Levels of Protein. American-Eurasian J. Agric. & Environ. Sci., 11: 685-696.

Juncher, D.; B. Ronn, E. T. Mortensen; P. Henchel; A. Karlsson, L. Skibsted and G. Bertelsen (2001). Effect of pre-slaughter physiological conditions on the oxidative stability of colour and lipid during chill storage of pork. Meat Sci., 58:347–357.

Kim, H.U. and J.M. Goepfert (1971). Enumeration and identification of *Bacillus cereus* in foods, 1,24-hours presumptive test edium. Appl. Microbiol., 22: 581-587.

Lodder, J. (1952). The yeasts. 1st Ed. Pup. Inc., N.Y.

Lohmann-Matthes, M.L.; C. Steinmüller; G. Franke-Ullmann (1994). "Pulmonary macrophages". European Respiratory Journal. 7 (9): 1678–1689.

Manici, L.M.; L. Lazzeri and S. Palmieri (1997). *In vitro* fungitoxic activity of some glucosinolates and their enzyme derived products toward plant pathogenic fungi. J. of Agric. and Food Chem., 45: 2768-2773.

Moreno, D.A.; M. Carvajal; C. Lopez-Berenguer and C.G. Viguera (2006). Chemical and biological characterization of nutraceutical compounds of Brocooli, J. of Pharm. and Biomed. Analysis, 1508-1522.

Postage, J.R. (1969). Viable counts and viability. In: methods in microbiology. Norris, J. R., Robbens, D.W. (eds), vol. 1. Academic Press, London, N.Y.: 611-628.

SAS (2001). SAS User's guide: Statistics, Version 9th Ed. SAS Institute Inc., Cary N.C., USA.

Saman, E.; Q. Muhammad; A. Zainul and M. Ajmal Khan(2016). Secondary metabolites as anti-nutritional factors in locally used halophytic forage/fodder. Pakistan J. of Botany, 48:629-636.

Steel, R. G. D. and J. H. Torrie (1960). Principles and Procedures of Statistics. (With special Reference to the Biological Sciences.) McGraw-Hill Book Company, New York, Toronto, London,

Steven, W.D.; W.D. Hohenboken; P.R. Cheeke; N.M. Patton and W.H. Kennick (1981). Carcass and meat characteristic of Flemish Giant and New Zealand White purebred and terminal cross rabbits. J. Appl. Rabbit Res., 4: 66.

Tavarez, M. A.; D. D. Boler; K. N. Bess; J. Zhao ; F. Yan; A. C. Dilger; F. K. Mckeith and J. Killefer (2011). Effect of antioxidant inclusion and oil quality on broiler performance, meat quality, and lipid oxidation. Poult. Sci., 90:922–930.

Van Socest, P.J. (1982). Nutritional ecology of ruminant O and B Books. Inc., Corvallis, Oredon. 112: 126-127.

Young Hyun, Yoon Kyung Hyun, Waewaree Boonitam, Yoo Yong Kim, Byoungyun Jung (2016). Effect of Lysophospholipids product (LIPIDOLTM) supplementation on growth performance, nutrient digestibility, blood profiles, and carcass traits in broiler chickens. International Poultry Scientific Forum Georgia World Congress Center, Atlanta, Georgia January 25-26, 2016.

أثر إضافة الليبيدول علي الإستفادة من مخلف نبات البروكلي في علائق الأرانب النامية

فاطمة طلعت فرج عبد الغنى ، أيمن رزق حسن حبيب ، أمل مغاورى هيكل و عادل محمد محمد سيد أحمد

معهد بحوث الإنتاج الحيوانى - مركز البحوث الزراعية - دقى - جيزة- مصر.

أجري هذا البحث بهدف دراسة تأثير الإحلال الجزئى للعليقة بمخلف نبات البروكلي مع أو بدون إضافة الليبيدول على الأداء الإنتاجى والإستجابة الفسيولوجية للأرانب النامية. أستخدم فى هذه الدراسة عدد 60 أرنب نيوزيلاندي أبيض عمر4 أسابيع وتم تقسيمهم إلى 6 مجاميع عشوائياً وتضم كل مجموعة 10 أرانب وأستمرت التجربة لمدة 70 يوماً غذيت فيها الأرانب على علائق تبعا لمقررات مرسوم **وزارة الزراعة لسنة 1996** وتم إستبدال العليقة المقارنة بمخلف نبات البروكلي سواء مع أو بدون الليبيدول فى العلائق التجريبية الأخرى بنسبة 5% و10% مع عليقة مقارنة مضاف إليها الليبيدول. و أظهرت النتائج الآتى:

لم يكن هناك تأثير سلبي لمستويات إستبدال البروكلي بغض النظر عن إضافة الليبيدول علي كلا من الوزن الحي والوزن المكتسب. كما كان لإضافة الليبيدول خلال الفترة من 4-9 أسابيع تأثيرمعنوي محسن لقيم كلا من الوزن الحي والوزن المكتسب بينما لم يكن هناك تأثير معنوي علي قيمهم أثناء الفترة الكلية (4-14 أسبوع) وكانت أفضل قيم بالمقارنة بالعليقة المقارنة الأولي هي العليقة الخامسة التي أحتوت علي 5% بروكلي مع إضافة الليبيدول ولم يكن هناك فروق معنوية بين العلائق الأخرى . أدت إضافة كل من مخلف البروكلي والليبيدول إلي تقليل قيم كمية الغذاء المأكول الا انها لم تؤثر علي كفاءة التحويل الغذائي . كان هناك تأثير إيجابي لمستوي إستبدال البروكلي 10% بغض النظر عن إضافة الليبيدول علي كافة معاملات الهضم المختلفة. كما كان هناك تأثير إيجابي لمستويات إستبدال البروكلي بغض النظر عن إضافة الليبيدول علي التركيب الكيميائى للحم حيث أدت إلي زيادة نسبة البروتين وإنخفاض نسبة الدهن. أوضح الفحص الهستولوجي أن إضافة الليبيدول أدت إلي زيادة طول خملات الأمعاء الدقيقة وزيادة طفيفة في السمك وكانت أفضل نسبة إستبدال للبروكلي هي 5%. لم يكن هناك تأثير سلبي معنوي لمستويات إستبدال مخلف البروكلي بغض النظر إلي إضافة البروكلي علي مكونات بلازما الدم وأدت إضافة الليبيدول إلي إنخفاض نسبة الكوليستيرول غير معنويا. كان هناك تأثير معنوي جيد لمستويات إستبدال مخلف البروكلي بغض النظر لاضافة البروكلي علي نشاط الأعور حيث أدت زيادة نسبة إضافة مخلف البروكلي إلي ارتفاع قيم نسبة الأحماض الطيارة الدهنية. كان هناك تأثير إيجابي لمستويات إستبدال البروكلي بغض النظر عن إضافة الليبيدول علي عدد العشائر الميكروبية في الأعور حيث قل تقريباً عدد كل العشائر الميكروبية معنوياً. كما قل أيضا تقريباً عدد كل العشائر الميكروبية نتيجة إضافة الليبيدول .

كما أوضحت النتائج أنه أزدادت قيم الكفاءة الإقتصادية مع التغذية على العلائق المحتوية على مخلف نبات البروكلي بجميع النسب مع إضافة الليبيدول مقارنة بالعليقة المقارنة التي لم يضف إليها الليبيدول .

الخلاصة: وجد من هذه الدراسة أن إضافة الليبيدول مع إستبدال العليقة حتي 10% من مخلف نبات البروكلي أدى إلى تحسن الأداء الإنتاجى للارانب وزيادة الكفاءة الإقتصادية بدون أى تأثير سيئ على الحالة الفسيولوجية وجودة الذبيحة فى الأرانب .