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INFLUENCE OF A HERBAL FEED ADDITIVES (DIGESTAROM®) ON PRODUCTIVE PERFORMANCE AND BLOOD CONSTITUENTS OF GROWING RABBITS

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SUMMARY

A total of 45 unsexed weaned Alexandria rabbits line (a paternal rabbit line), at four weeks of age (with an average initial weight 513 gm) were randomly distributed into three groups (15 each). First group (G1) was fed the basal diet (control). The other groups were fed the control diet supplemented with 300 and 400 gm digestarom®/ ton feed. The experimental period extended for five weeks.

The results showed that dietary supplementation with digestarom showed the highest live body weight, body weight gain, digestion coefficients, and caecal activity. Treatment with digestarom also improved meat composition, carcass, dressing, liver and caecum percentages. The improvements of feed conversion ratio and mortality rate with digestarom® groups were also found. The experimental additives significantly increased hemoglobin, red blood cells count, serum phosphorus, insulin, T_3 and growth hormones concentration. Blood constituents significantly differed between groups and serum total lipid, cholesterol and triglyceride concentrations decreased with dietary supplementation with digestarom. Blood serum total protein, albumin, globulin, glucose, alanine aminotransferase (ALT), aspartate aminotransferase AST, calcium (Ca), creatinine levels showed insignificant differences between the rabbit groups.

It can be concluded that herbal feed additives (digestarom) administration improved productive performance, some blood constituents and carcass characteristics of growing Alexandria rabbit's line.

Keywords: rabbits, herbal additives, digestarom®, blood constituents, carcass traits, growth performance

INTRODUCTION

During the last decade, many feed additives were available as enzymes, probiotics and medical plants. Herbal feed additives comprise of a wide variety of herbs, spices, and essential oils. A part from enhancing the taste and improving the flavor of the feed, such feed additives are believed to have positive effects on digestion and intestinal health. Some of the important aspects associated with herbal additives are their ability to prevent digestive disturbances, improve feed utilization and enhance animal performance (Krieg *et al.*, 2009). Herbal feed additives were added to the growing and fattening diets in order to improve the performance of livestock in buffaloes and rabbits (El-Ashry *et al.*, 1993; El-Basiony *et al.*, 2003 and Fatma *et al.*, 2005).

All plants contain oils give the plants their flavor and aroma, but many of these components are potentially hazardous. However, usually they are generally considered safe due to the proportional little oil in the majority of herbs and spices (Rinzler, 1990). Herbal extracts, probiotics and enzymes could help to improve the growth performance of birds (Radwan *et al.*, 1995 and Abdel-malak *et al.*, 1995). Natural digestibility enhancers promote the inner secretion and stimulate bile and the body's enzyme production. Therefore, the digestion of the feedstuff becomes optimized and the productions of harmful metabolite substances are reduced. Herbs have been found to have anti-microbial activity and anti-viral properties (Smith-Palmer *et al.*, 1998 and Hammer *et al.*, 1999). There are spices which have a positive effect on cold like anise, peppermint, fennel or caraway. Other spices are helpful for stomach problems and digestion problems.

Diarrhoea in rabbits occurs mainly within the first three weeks post weaning causing a mortality rate up to 50% (Gidenne and Garcia, 2006). It is also reported that using phytogenic flavors reducing mortality due to optimization of immune system (Fortun and Boullier, 2007). Digestarom is used as a potential additive acts as growth promoters and could be combined with all other feed additives.

Phytogenic flavors were identified to have an influence on feed conversion rate in broilers (Alcicek *et al.*, 2004). The environment is also protected when using phytogenic flavors, as there is a reduction in the quantity of egested pollutants in turkey (Alçiçek *et al.*, 2003). In former times the health of the population was stabilized by antibacterial growth promoters.

Because of new guidelines for feed additives the uses of these growth promoters have been for bitten in broilers (Jamroz *et al.*, 2003). So herbal feed substances like digestarom® with their stabilizing influence on the intestine became a focus of public discussion.

The aim of this experiment was to investigate the effect of an herbal feed additive (digestarom®) administration on productive performance, some physiological parameters and carcass characteristics of growing Alexandria line rabbits.

MATERIALS AND METHODS

The present study was carried out at the nucleus breeding rabbit unit of the poultry Research Center, Poultry, Faculty of Agriculture, Alexandria University. Digestarom® is a new mixture of natural finely ground herbs and spices enriched with special extracts and essential oils. According to regulation No 1831/2003 on additives for use in animal nutrition, flavors are classified as sensory additives. Therefore, digestarom® is defined as a flavor for animal nutrition and is in accordance to the appropriate regulations of the European Union and the United States (all ingredients are listed by GRAS). Digestarom® 1315, MICRO-PLUS co.-Germany Konzentrate GmbH, Stadtoldendorf, which contained active components: 1-Menthol (3.00% of Peppermint), Anethol (0.45% of Anise, Fennel) and 1- Carvon (0.035% of Caraway).

Animals:

Rabbits used in this study were Alexandria rabbit's line. A new synthetic paternal rabbit line that was established and developed at the nucleus breeding rabbit unit of the poultry research center, Faculty of Agriculture, Alexandria University (El-Raffa, 2010).

Experimental Design:

A total number of 45 unsexed weaned Alexandria rabbits, at four weeks of age with an average initial weight 513±15 g. Rabbits were divided into three equal treatment groups (15 rabbits each). Each treatment was divided into three equal replicates, each of five rabbits. The 1st group fed a complete pelleted diet and served as control (G1). The 2nd group was fed a diet with 300 gm digestarom®/ ton feed (G2) and the 3rd group (G3) was fed a diet with 400 gm digestarom®/ ton feed.

Flock Management:

The rabbits were housed in an open, east-west oriented windowed rabbitry, with a one level design cages having galvanized wire (40 × 50 × 35 cm) cages. Each cage was equipped with a metal feeder and water supply through nipple drinkers.

Rabbits were kept under the same managerial and environmental conditions. Ventilation and temperature were natural. A period of 14-16 hours of day light was provided. Feed and water were available all time *ad libitum* during the experimental period. The commercial pellet diet contained 17.53% crude protein, 12.61% crude fiber, 3.59% fat and 2457 kcal /kg diet were provided with all required vitamins and minerals as recommended by (NRC, 1994). Clean fresh water was available for rabbits all the time.

Data collected for rabbit's performance:

Individual live body weight, body weight gain, feed consumption; feed conversion ratio (FCR) and mortality rate were weekly recorded during the experimental period, from four to nine weeks of age.

Blood Analysis:

At nine week of age, about 3 ml blood, five rabbits from each group were randomly taken at 08:00 – 09:00 am from the marginal ear vein of rabbits under vacuum in clean tubes with or without heparin before slaughtering, coagulated blood samples were centrifuged at 4000 rpm for 15 minutes and the clear serum was separated and stored in a deep freezer at -20°C until biochemical analysis. Non-coagulated blood was tested shortly after collection for estimating blood picture. Red blood cells (RBCs) and white blood cells (WBCs) were counted according to Feldman *et al.* (2000). Hemoglobin concentration and packed cells volume percentages were measured according to Drew *et al.* (2004).

Serum total proteins, albumin, were measured by using special kits delivered from sentinel CH. Milano, Italy by means of spectrophotometer according to guidelines and recommendation of Bogin and Keller (1987). Globulin level values were obtained by subtracting the values of albumin from the corresponding values of total protein. Serum total lipids and serum triglyceride concentration were determined by using special kits delivered from CAL-TECH Diagnostics, INC, (CAL) Chino, California, U.S.A. according to recommendation of Fringes *et al.* (1972).

Serum total cholesterol was determined on individual bases using the specific kits according to recommendation of Bogin and Keller (1987).

Plasma glucose concentration was measured by the method of Trinder (1969). The uric acid level was measured according to the method explained by Patton and Crouch (1977), while creatinine level was estimated according to Husdan and Rapoport (1968).

The activities of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were estimated according to Reitman and Frankel (1957). Alfa amylase and alkaline phosphatase were estimated using commercial kits using the method described by Doumas (1971).

Direct Radioimmunoassay (RIA) technique was performed for the assessment of plasma Triiodothyroxin (T_3) and thyroxin (T_4) concentrations as (ng/ ml) were assessed using ready made kits (DSLABS Webster Texas USA) as described by manufacturer. Serum Insulin hormone was determined by using special kits delivered from CA Diagnostic Products Corporation, Los Angeles, USA. Plasma rabbit growth hormone was measured by radioimmunoassay (RIA) using the method described by manufacture. The intra- and inter-assay coefficients of variation (CV) were 6 and 10%, respectively.

Serum calcium (Ca) and Inorganic phosphorus (IP) were assayed by a colorimetric method using commercial kits of Sclavo Diagnostics Company (Kite Italia S.P.A.).

Digestibility coefficient trails:

At the last week of the experiment, digestibility trials was conducted using 15 rabbits (five rabbits from each treatment group), which were housed individually in metabolism cages that allow faeces and urine separation. The preliminary period continued for seven days and the collection period extended for five days. Feed intake was recorded exactly. Faeces were collected daily, weighed and dried at 60-70°C for 24 hours, bulked, finely ground and stored for chemical analysis. The apparent digestibility coefficients of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NFE) for the experimental diets were estimated according A.O.A.C. (1990).

Slaughter procedure:

At the end of the experimental period (at nine weeks of age), five rabbits from each group were randomly taken, fasted for 12 hours, individually weighted and slaughtered to complete bleeding. After bleeding, rabbits were weighed and skinned. Then, they were weighed after skinning to calculate the pelt weight by the differences between weights of carcass before and after skinning. After slaughtering and skinning the carcasses were eviscerated.

Dressing percentage included relative weights of carcass, giblets and head. While, non-carcass fat included relative weights of carcass, giblets of liver, kidney, heart, pancreas, caecum, full stomach, full intestine, abdominal fat, thyroid and adrenal. Intestine and caecum lengths were also measured.

Caecal measurements:

After slaughtering, individual measurements on length, circumference and full weight of the caecum were taken for all slaughtered rabbits. Also, samples from caecal contents were taken for the determination of dry matter (DM) (A.O.A.C., 1984); concentrations of ammonia nitrogen (NH3-N) and volatile fatty acids (VFAs) of caecum content were determined by applying Conway (1958) and Eadie *et al.* (1967) methods. Values of pH of caecum contents were recorded immediately by using EIL pH meter.

Chemical meat composition:

Meat samples (about 20 g) were taken from fur part which was separated from bone then weighted and kept for chemical analysis of moisture, crude protein, ether extract and a according to the official methods of (A.O.A.C., 1990).

Statistical analysis

The experiment was set in a completely randomized design. Data were analyzed by analysis of variance using the general liner model procedure (Proc GLM; SAS Institute, 1999). Differences among means were calculated using Duncan's test (Duncan, 1955).

RESULTS AND DISCUSSION

Growth performance:

Body weight and body weight gain:

Rabbits of G3 recorded higher ($P \leq 0.05$) final body weight at nine weeks of age (Table 1), than G1 by 6.6 %.

Averages of weekly body gain of Alexandria rabbit increased by increasing the dietary digestarom® levels. Results indicated that, weight gain in the first week of experimental period reached 17.55 and 35.25 % for G2 and G3, respectively, over G1. While, body weight gain increased by about 12.8 and 10.0 % and 7.8 and 8.9 % compared with G1 during the last week (Week 8-9) and the whole experimental period, from four to nine weeks of age, respectively.

Similar results were reported by Jamroz and Kamel (2002) observed improvement of 8.1 % in daily gain in 17 day old poults fed a diet supplemented with a plant extract at 300 ppm. El-Shenawi (1992) noticed that thyme and fennel promote the absorption of fat which lead to more gain when compared with control group. Moreover, Teodorovic *et al.* (1990) showed higher daily weight gain when thyme and fennel were added to pig's diets 1-2 kg/ ton diets than control.

Table 1. Mean ±SE of growth performance of growing rabbits fed 300 mg (G2) or 400 mg (G3) Digestarom compared to control group (G1)

Traits	G1	G2	G3	*P* value
Body weight (gm)				
Week 4	528.3 ± 14.1	499.3 ±16.8	511.3 ± 10.0	0.3
Week 5	754.3 ± 18.7	765.0 ± 20.5	817.0 ± 24.5	0.1
Week 6	989.7 ± 29.3	1014.6 ± 26.16	1044.3 ± 20.1	0.4
Week 7	1242.1 ± 46.0	1276.8 ± 34.9	1330.0 ± 22.0	0.4
Week 8	1521.9 ± 43.8	1552.9 ± 41.5	1612.9 ± 29.0	0.4
Week 9	1776.5 ± 40.8^{b}	1841.1 ± 41.9^{ab}	1893.2 ± 30.2^{a}	0.01
Body weight gain (gm)				
Week 4-5	226.0 ± 3.4^{b}	265.7 ± 20.3^{ab}	305.7 ± 13.9^{a}	0.01
Week 5-6	235.3 ± 11.4	242.0 ± 21.6	223.2 ± 10.9	0.6
Week 6-7	255.8 ± 11.7	288.5 ± 25.5	281.5 ± 10.2	0.3
Week 7-8	289.2 ± 62.3	275.8 ± 15.4	282.2 ± 6.2	1.0
Week 8-9	255.8 ± 11.7^{b}	288.5 ± 25.5^{a}	281.5 ± 10.2^{a}	0.01
Week 4-9	1262.2 ± 71.9^{b}	1360.5 ± 73.3^{a}	1374.0 ± 23.7^{a}	0.01
Feed consumption (gm)				
Week 4-5	674.0 ± 8.3	681.7 ± 28.4	759.3 ± 63.5	0.3
Week 5-6	812.0 ± 7.5	755.5 ± 20.9	750.8 ± 35.4	0.2
Week 6-7	876.3 ± 22.0	922.8 ± 27.3	928.5 ± 17.2	0.4
Week 7-8	940.5 ± 75.2	861.3 ± 57.8	891.8 ± 32.3	0.7
Week 8-9	1000.2 ± 55.3	971.2 ± 55.2	961.8 ± 35.5	0.9
Week 4-9	4303.0 ± 126.1	4192.5 ± 94.7	4292.3 ± 163.7	0.8
Feed conversion				
Week 4-5	3.19 ± 0.17^{a}	2.60 ± 0.13^{ab}	2.49 ± 0.18^{b}	0.04
Week 5-6	3.68 ± 0.17	3.23 ± 0.31	3.33 ± 0.33	0.57
Week 6-7	3.67 ± 0.25	3.32 ± 0.36	3.21 ± 0.09	0.90
Week 7-8	3.44 ± 0.36	3.17 ± 0.29	3.17 ± 0.07	0.34
Week 8-9	3.76 ± 0.32	3.48 ± 0.37	3.40 ± 0.19	0.82
Week 4-9	3.55 ± 0.13^{a}	3.13 ± 0.22^{b}	3.11 ± 0.14^{b}	0.05
Mortality (No.)	4 (26.7%)	2 (13.3%)	1(6.7%)	

a, b, c Different letters within a row denote significant differences between treatments (P≤0.05)

In same results, positive effects of dietary essential oils on body weight were observed by Alçiçek *et al.* (2003) and Denli *et al.* (2004). Hernandez *et al.* (2004) also found that the addition of two plant extracts to a broiler diet significantly improved broiler body weight at 35 days of age. Moreover, Jamroz *et al.* (2003) found that the inclusion of 150 or 300 mg/ kg of a plant extract in a diet improved body weight by 5.4 and 8.1 %, respectively.

Abdel-Azeem *et al.* (2010) showed that growing rabbits fed on diet containing fennel hay replaced clover hay up to 33.33%, had insignificantly higher live body weight and body weight gain.

It is worthy to notice that the improvement in final body weight and weight gain which occurred in rabbits fed digestarom® may be due to the biological functions of the main components of the residual essential oil in digestarom®.

Feed Consumption and Feed Conversion Ratio:

Digestarom® addition to rabbit diets of G2 and G3 had no effect on feed consumption, but improved feed conversion ratio (FCR). Results on Table (1) show that average values of FCR of growing Alexandria line rabbits in G2 and G3 improved significantly by 18.5 and 21.9 % and 11.8 and 12.4 % comparing with G1 during the first week and the total experimental period, respectively. The improvement of FCR as a result of addition of digestarom® to the diets could be attributed to the reduction in feed consumption accompanied with an increase (P≤0.05) in live body weight. Our findings on feed intake and feed conversion are in agreement with those of Lee *et al.* (2003) who studied carvacrol from oregano; Madrid *et al.* (2003) who studied the effect of plant extract and those of Alcicek *et al.* (2004) who used 48 mg/ kg of an essential oil mixture in the diet of broiler. Denli *et al.* (2004) reported that the addition of fennel essential oil to a

quail diet improved feed conversion ratio. Also, Halle *et al.* (2004) noted that the addition of oregano and its essential oil reduced daily feed intake of broilers and significantly improved FCR. Furthermore, Ibrahim *et al.* (2000) showed an increase (P<0.05) in feed conversion when male weaned NZW rabbits fed diets supplemented with Peppermint leaves at 0.5 %. The improvement in feed efficiency achieved with essential oil mixtures could be attributed to their positive effects on nutrient digestibility (Langhout, 2000; Madrid *et al.*, 2003 and Hernandez *et al.*, 2004).

Mortality Rate:

Numbers of rabbits died were 26.7 %, 13.3 % and 6.7 % for G1, G2 and G3 (Table 1) respectively. All animals died during the first growing period (28- 49 days of age). These results may indicate that, digestarom stimulates the immune system by the phytogenic components resulting in reduction of morbidity and mortality (www.info@micro-plus.com). Our findings on mortality rate are also in agreement with those of Teodorovic *et al.* (1990). They noticed lower mortality rate when pigs led diets with 1-2 kg thyme /ton than control. Galib (2010) studied the effect of dry peppermint (0.00%, 0.25%, 0.50%, 1.00% and 1.50%) on mortality rate of Hubbard broiler chicks throughout six weeks of age. He observed that the improvement in the mortality may be due to the role of herbal plant (peppermint) in the immune stimulating factor. Ocak *et al.* (2008) showed that mortality was lower in one-week-old broilers (Ross-308) fed the peppermint diets than in birds fed control diets for the entire growing periods (0.00 *vs.* 2.88 %, respectively).

Hematological profile:

Values of each of blood components including hemoglobin concentration and red blood cells count were significantly ($P \leq 0.05$) higher in Alexandria growing rabbits of G2 and G3 than G1 (Table 2), by 11.63 and 11.44 % and 7.05 and 6.20 %, respectively. But, white blood cells count and packed cell volume were not significantly different in all groups. The improvements in the blood components as a result of treatment with digestarom may be due to the increase of metabolic cycles. Ibrahim *et al.* (2000) found significant increase in RBCs count, Hb and PCV % in males of New Zealand rabbits led diet at age of eight weeks supplemented with 0.5% of peppermint.

Table 2. Mean (±SE) of some blood constituents of growing rabbits fed 300 mg (G2) or 400 mg (G3) Digestarom compared to control group (G1)

Traits		G1	G2	G3	*P* value
Hb	(g/dl)	10.75 ± 0.23^{b}	12.00 ± 0.44^{a}	11.98 ± 0.32^{a}	0.02
RBC	(10^6/ mm^3)	4.68 ± 0.05^{b}	5.01 ± 0.11^{a}	4.97 ± 0.10^{ab}	0.05
WBC	(10^3/ mm^3)	6.93 ± 0.25	7.20 ± 0.39	7.26 ± 0.21	0.67
PCV	(%)	31.48 ± 1.07	33.58 ± 1.15	34.83 ± 0.96	0.25
Total protein	(gm/ dl)	5.59 ± 0.65	6.09 ± 0.49	6.16 ± 0.59	0.82
Albumin	(gm/ dl)	3.14 ± 0.16	3.43 ± 0.47	3.49 ± 0.18	0.73
Globulin	(gm/ dl)	2.45 ± 0.77	2.66 ± 0.93	2.68 ± 0.59	0.98
Total lipid	(mg/dl)	239.15 ± 7.72^{a}	203.37 ± 7.96^{b}	205.80 ± 5.49^{b}	0.05
Cholesterol	(mg/dl)	94.62 ± 1.69^{a}	82.01 ± 1.95^{b}	85.67 ± 4.54^{ab}	0.05
Triglyceride	(mg/dl)	107.45 ± 5.16^{a}	95.63 ± 4.51^{ab}	91.67 ± 5.91^{b}	0.05
Glucose	(mg/dl)	275.73 ± 18.21	334.65 ± 45.62	327.58 ± 26.77	0.53
Uric acid	(mg/dl)	1.35 ± 0.13	1.07 ± 0.12	1.20 ± 0.06	0.33
Creatinine	(mg/dl)	1.29 ± 0.14	1.11 ± 0.14	1.15 ± 0.07	0.65
ALT	(U/L)	28.84 ± 0.79	27.97 ± 1.55	28.60 ± 0.96	0.90
AST	(U/L)	17.09 ± 1.21	17.37 ± 0.85	17.18 ± 0.89	0.98
Alfa amylase	(U/L)	275.73 ± 18.21	334.65 ± 45.62	327.58 ± 26.77	0.53
Alkaline phosphatase	(IU/L)	67.88 ± 8.80	74.67 ± 6.76	83.29 ± 7.31	0.47
T3	(ng/ml)	6.79 ± 0.27^{b}	7.76 ± 0.38^{a}	7.49 ± 0.24^{ab}	0.04
T_4	(ng/ml)	34.37 ± 1.08	35.74 ± 0.37	35.75 ± 0.99	0.52
T_3/T_4	(ratio)	5.11 ± 0.36	4.64 ± 0.22	4.80 ± 0.25	0.41
Insulin	(µIU/ml)	48.16 ± 0.68^{b}	54.27 ± 1.71^{a}	57.98 ± 1.24^{a}	0.01
Growth hormone	(ng/ml)	29.86 ± 0.98^{b}	33.91 ± 0.43^{a}	33.08 ± 0.66^{a}	0.03
Ca	(mg/dl)	10.57 ± 0.51	11.66 ± 0.51	11.30 ± 0.28	0.40
IP	(mg/dl)	4.27 ± 0.14^{b}	5.05 ± 0.04^{a}	4.94 ± 0.25^{a}	0.05

a, b, c Different letters within a row denote significant differences between treatments ($P \leq 0.05$)

In contrast, Galib (2010) found that hematological parameter results indicated no significant differences (P<0.05) between treatments when Hubbard broilers fed diets

supplemented with dry peppermint for six weeks, the values are in correspondence with that of the normal range for healthy birds stated by Mitruka and Rawnley (1977).

Blood Constituents:

Serum total lipid, cholesterol and triglyceride concentrations of rabbits of G2 and G3 decreased ($P \leq 0.05$) by 14.96 and 13.95 %, 13.33 and 9.46 % and 11.00 and 14.69 %, respectively compared with G1 (Table 2). On the other hand, serum phosphorus, insulin, T_3 and growth hormones concentration were increased ($P \leq 0.05$) in diet of G2 and G3 by 18.27 and 15.69 %, 12.69 and 20.39 %, 14.29 and 10.31 % and 13.56 and 10.78%, respectively compared with G1. These results are agreed with Sharma (1984) who found that fenugreek and caraway decreased total lipid and cholesterol values in rats. Also, Zeid (1998) reported that total lipid of goats fed diets containing medicinal plants was decreased. Furthermore, El-Manylawi *et al.* (2005) reported that total lipid and cholesterol of growing rabbits fed diets containing 6 or 9% of spearmint and geranium by-product were significantly decreased.

Data showed that levels of serum total protein, albumin, globulin, ALT, AST, Ca, glucose, alfa amylase, creatinine, uric acid, T_4 and T_3/ T_4 were not significantly different in all groups. These results indicated normal functions of liver and kidneys in all experimental rabbit. However, blood components and enzymes activities are intimately related to metabolism.

These results are agree with those of Ibrahim *et al.* (2000) who reported that the metabolic changes of blood glucose, total protein significantly improved in males of New Zealand rabbits aged eight weeks supplemented with 0.5 % of peppermint. Also, Abdel-Azeem *et al.* (2010) showed that plasma of total protein, albumin, globulin and alanine aminotransferase (ALT) concentration were not significantly affected by adding fennel hay to growing rabbit diets. Sherlock (1975) reported that AST and ALT levels reflect the impairment of liver function when their levels increase. Similar results were obtained by Abdel-Malak *et al.* (1995); Ibrahim, *et al.* (1998) and Abd El-Latif *et al.* (2002) stated that adding thyme or fennel to Japanese quail diets enhanced T_3 hormone at six weeks of age.

DigestibilityCoefficient:

Results given in Table (3) show the digestibility coefficients of nutrients as affected by different levels supplementation of digestarom®. It could be noticed that feeding growing rabbits on the ration of G2 and G3 did not significantly affect the digestibility coefficient values of DM, CP, EE and NEF compared with G1, while OM digestibility significantly increased by 5.15 and 8.00 %, respectively compared with G1. On the other hand, CF digestibility decreased ($P \leq 0.05$) in G2 and G3 as compared with G1.

Similar results were reported by EL-Manylawi *et al.* (2005) who noticed a slight improvement in digestibility coefficients of OM, CP and NFE compared with the control group when growing NZW rabbits feeding diets contained 3, 6, and 9 % Geranium and Spearmint by-product.

Ando *et al.* (2003) and Abd El Latif *et al.* (2004) found that, addition of spearmint by-product at levels 0.3 or 0.5% in Japanese quail diets improved OM, CP, EE and NEF digestibility. Also, Abdel-Azeem *et al.* (2010) showed that digestibility coefficients of DM and OM of growing rabbits fed on diet containing fennel hay replaced clover hay were significantly improved.

Caecal Characteristics and Measurements:

Length and full weight of the caecum and concentrations of VFAs and NH3N in caecal contents were significantly ($P \leq 0.05$) affected by dietary treatments, being higher in G2 and G3 than G1. Meanwhile, caecal circumference and empty weight of the caecum and DM percent and pH of the caecal contents were not significantly affected by adding digestarom to rabbit diets. It might indicate either bacterial overgrowth, increased metabolic bacterial activity in digestarom® groups, or a lower absorptive capacity of the gut wall in the control group.

These results agree with those reported by Krieg *et al.* (2009) who found that VFAs was significantly affected by adding 300 mg digestarom/kg diet to growing rabbit's diets. Djouvinov *et al.* (1997) showed that concentrations of VFAs and NH3N in caecal contents were significantly affected when sheep fed diets contained peppermint by-products compared with the control group.

Chemical Meat Composition:

Data in Table (3) show that, carcass moisture content of rabbits of G2 decreased by 2.6 %, compared with G1. On the other hand, crude protein content significantly increased in G3 by 6.8 % compared with G1.

These results are in agreement with those obtained by Cornowicz *et al.* (2003) they found that addition of the herbs mixture contained Peppermint to the broiler diet at 1.00 to 2.50 % significantly affected chemical meat composition and the sensory tests of meat.

Table 3. Mean (±SE) of Averages of digestibility coefficient, caecal characteristics, caecal activity, meat composition and caecum microbial counts of growing rabbits fed 300 mg (G2) or 400 mg (G3) Digestarom compared to control group (G1)

Traits		G1	G2	G3	*P* value
Digestibility Coefficient					
Dry mater	(DM)	65.14 ± 1.23	68.56 ± 1.32	69.04 ± 1.18	0.13
Organic mater	(OM)	67.58 ± 0.65^{b}	71.06 ± 1.22^{a}	72.98 ± 0.97^{a}	0.02
Crude protein	(CP)	72.55 ± 0.92	75.85 ± 1.06	75.11 ± 0.45	0.11
Crude fiber	(CF)	32.55 ± 1.07^{a}	29.60 ± 1.66^{ab}	28.26 ± 0.61^{b}	0.05
Ether extract	(EE)	73.51 ± 0.47	75.15 ± 1.94	77.27 ± 1.30	0.35
Nitrogen free extract	(NEF)	70.91 ± 0.74	73.12 ± 0.74	72.81 ± 1.68	0.47
Caecal characteristics					
Length	(cm)	45.70 ± 0.87^{b}	53.30 ± 2.04^{a}	54.20 ± 2.80^{a}	0.05
Circumference	(cm)	8.87 ± 0.77	8.73 ± 0.26	8.63 ± 0.59	0.97
Full weight	(gm)	82.00 ± 1.15^{b}	88.00 ± 1.73^{a}	90.67 ±1.20^{a}	0.02
Empty weight	(gm)	26.67 ± 0.88	30.00 ± 2.08	31.33 ± 1.76	0.29
Caecal measurements					
DM ca. content	(%)	23.23 ± 0.45	24.14 ± 0.88	23.77 ± 0.20	0.33
VFAs	(mEq/ 100gm)	8.92 ± 0.48^{b}	10.44 ± 0.26^{a}	10.75 ± 0.18^{a}	0.02
NH_3N	(mg/ 100gm)	17.00 ± 0.08^{b}	19.73 ± 0.38^{a}	19.52 ± 0.73^{a}	0.04
PH of Caecal		6.23 ± 0.07	6.21 ± 0.06	6.26 ± 0.03	0.85
Meat composition					
Moisture	(%)	74.47 ± 0.36^{a}	72.56 ± 0.24^{b}	73.04 ± 0.43^{ab}	0.05
Crude protein	(%)	19.98 ± 0.03^{b}	21.95 ± 0.48^{ab}	21.34 ± 0.30^{a}	0.05
Ether extract	(%)	3.67 ± 0.32	3.78 ± 0.21	3.80 ± 0.09	0.92
Ash	(%)	1.88 ± 0.04	1.71 ± 0.07	1.82 ± 0.07	0.29

a, b, c Different letters within a row denote significant differences between treatments (P≤0.05)

Carcass characteristic:

Data of carcass traits presented in Table (4) shows that rabbits of G3 had significantly higher weight percentages of carcass; dressing and relative percentage weights of liver than G1 7.7 %; 7.2 % and 19.2 %, respectively. Also, relative percentage weights of caecum were significantly increased in G2 and G3 by 10.8 and 18.5%, respectively compared G1.

Table 4. Mean (±SE) of carcass characteristic of growing rabbits fed 300 mg (G2) or 400 mg (G3) Digestarom compared to control group (G1)

Traits		G1	G2	G3	*P* value
Pre-slaughter	gm	1835.00 ± 14.43^{c}	1903.33 ± 40.96^{b}	1965.00 ± 20.21^{a}	0.008
Carcass	%	55.67± 0.41^{b}	58.17 ± 1.32^{ab}	59.96 ± 0.59^{a}	0.03
Dressing	%	61.96± 0.47^{b}	64.16 ± 0.76^{ab}	66.41 ± 0.73^{a}	0.04
Skin	%	15.53 ± 0.24^{a}	14.53 ± 0.22^{a}	12.23 ± 0.71^{b}	0.02
Liver	%	3.80 ± 0.20^{b}	4.23 ± 0.24^{ab}	4.53 ± 0.07^{a}	0.03
Kidney	%	0.79 ± 0.05	0.85 ± 0.03	0.80 ± 0.02	0.41
Heart	%	0.39 ± 0.02	0.41 ± 0.02	0.43 ± 0.01	0.48
Pancreas	%	0.33 ± 0.04	0.32 ± 0.04	0.30 ± 0.19	0.73
Caecum	%	4.17 ± 0.02^{c}	4.62 ± 0.01^{b}	4.94 ± 0.08^{a}	0.001
Full Stomach	%	3.93 ± 0.08^{a}	3.72 ± 0.07^{b}	3.44 ± 0.03^{c}	0.008
Full Intestine	%	10.17± 0.12^{a}	9.81 ± 0.15^{ab}	9.25 ± 0.20^{b}	0.03
Abdominal fat	%	1.31± 0.10^{a}	0.80 ± 0.12^{ab}	0.68 ± 0.10^{b}	0.05
Thyroid	%	0.0163 ± 0.0007	0.0177 ± 0.0186	0.0179 ± 0.0005	0.38
Adrenal	%	0.0067 ± 0.0007	0.0074 ± 0.0011	0.0083 ± 0.0004	0.49
Intestine length	cm	331.00 ± 5.85	337.33 ± 8.97	346.67 ± 5.54	0.11

a, b, c Different letters within a row denote significant differences between treatments (P≤0.05)

However, rabbits fed high level of digestarom® had significantly decreased percentage of skin, full stomach, full intestine and abdominal fat than control group. But, kidney, heart, pancreas, thyroid and adrenal glands weight percentages were not significantly differ among experimental groups. These improvements in relative

weights of hot carcass, dressing, liver and caecum as a result of the reduction in the alimentary tract percentage may be due to that addition of digestarom resulted in increase in digestibility coefficient of nutrients and maintaining the acidic condition in the hindgut which is optimal for better feed utilization.

Our findings are in agreement with the results of Abd El-Latif *et al.* (2002), they stated that, the highest values of dressing and edible giblets were noticed when Japanese quail fed either dietary Fennel compared with control group, but decreasing percentage, skin and legs were not significantly differ among experimental groups.

These results were also in accordance with those found by El-Manylawi *et al.* (2003) when he added peppermint and thyme leaves to growing rabbit's diets. Also, Abdel-Azeem *et al.* (2010) showed that higer dressing and hot carcass weight percentages were recorded with growing rabbits fed fennel hay, but, total non-carcass fat (%) was significantly decreased by using fennel hay levels. While, Hernandez *et al.* (2004) found no differences in gizzard, liver and pancreas weights of broiler chickens fed diet containing an essential oil extract from oregano, cinnamon and pepper and a labiatae extract from sage, thyme and rosemary. Similar results were observed by Jamroz *et al.* (2005) who used essential oils in broiler diets based on maize and locally grown cereals. In contrast, Denli *et al.* (2004) indicated that inclusion of thyme and black seed essential oil increased intestinal weight and intestinal length in quail.

CONCLUSION

It could be concluded that a herbal feed additive (digestarom®) is a good unconventional feedstuff for growing rabbits and can be included in their diets up to 300 gm digestarom® per ton feed without adverse effects on productive performance and blood constituents of growing rabbits.

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تأثير إضافة الدايجستروم كإضافة عشبية على الأداء الإنتاجى وصفات الدم فى الأرانب النامية

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أستخدم فى هذة الدراسة عدد 45 أرنب فطام (ذكور وإناث) من خط إسكندرية (خط أبوى) عمر 4 أسابيع بمتوسط وزن جسم 513 جم وتم تقسيمهم الى ثلاث مجاميع كل مجموعة بها عدد 15 ارنب فطام. المجموعة الاولى كنترول. المجموعة الثانية والثالثة تم أضافة 300 و 400 جرام دايجستروم/ طن علف إليها على الترتيب. أستمرت التجربة لمدة 5 أسابيع.

أوضحت النتائج الى أن اضافة الدايجستروم الى العليقة ادى الى زيادة وزن الجسم الحى ووزن الجسم المكتسب ومعاملات الهضم. أيضا تحسن تركيب نسيج اللحم فى الذبيحة ونسبة التصافى والوزن النسبى للكبد والأعور.

ادت المعاملة بالدايجستروم الى تحسن نسبى فى معدل الكفاءة الغذائية وقلة معدل النفوق.

تشير تقديرات الدم الهيموتولوجية أن نسبة الهيموجلوبين وعدد كرات الدم الحمراء وتركيز الفسفور والانسولين وهرمون T3 وهرمون النمو فى الدم أرتفعت معنوياً بإضافة الدايجستروم بينما كان محتوى سيرم الدم من نسبة الدهون الكلية والكوليسترول والاحماض الدهنية الثلاثية منخفض معنويا بالمقارنة بالمعاملات المضاف اليها دايجستروم.

بينما وجد ان مستوى البرونين الكلى والالبيومين والجلوبيولين والجلوكوز وانزيمات الكبد (ALT – AST) والكالسيوم والكيرياتين فى الدم لم يتأثر معنويا بالمعاملة بالدايجستروم.

تشير النتائج بصفة عامة إلى ان إضافة الدايجستروم كمادة عشبية أدى الى تحسن الأداء الانتاجى وبعض صفات الدم وخصائص الذبيحة للأرانب النامية لخط اسكندرية.