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Effect of Dietary Supplementation of Dried Chicory (*Cichorium intybus L.*) Leaves in Diets on Growth Performance of Rabbits.

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ABSTRACT

This study was conducted to estimate the effect of different levels of dried chicory leaves (DCL) as feed additives in growing New Zealand White (NZW) rabbit rations on their growth performance, nutrient digestibilities, feeding values, carcass traits, haematological parameters, microbiological and caecal microflora. Fourty eight weaned rabbits at 5 weeks of age and 578g as an average weight were randomly distributed into four similar groups (12 each) using complete randomized block design. The experimental animals of the control group (G1) were fed on a basal diet, while those of the tested ration groups were fed on the basal diet in addition to 0.5% (G2); 1% (G3) and 2% (G4) of their body weight of dried *Cichorium intybus* leaves. Results indicated that rabbits fed diets supplemented with 1% (DCL) G3 recorded the highest ($P<0.05$) final body weight (BW) and daily gain, followed by those in G2 that contained 0.5% (DCL), while rabbits in G1 (control) and G4 had the lowest values. However, rabbits fed diets containing (DCL) at 0.5, 1% or 2% led to an insignificant differences in comparison with control diet in respect of daily feed intake. The best feed conversion and feed efficiency values were associated with the tested rations G2 and G3 compared with the poorest one that occurred with the control and G4 diets. Also, nutrient digestion coefficients and feeding values were significantly the highest with G3 in comparison with the control and the other tested diets. Also, pre-slaughter and carcass weights and dressing percentage were significantly the highest with G3-diet compared with the other ones. Edible offal including liver, heart and kidney were behaved the similar trend to that of carcass weight. Likewise, economical efficiency was significant increased with G3 diet being the highest value among all the experimental dietary treatments. It could be concluded that supplemented the CFM with chicory leaves at level 1% in the rations of rabbits led to an improvement in rabbits growth performance.

Keywords: Rabbits, chicory leaves, growth performance, digestibility, carcass traits, hematological parameters, blood biochemical, caecum microflora.

INTRODUCTION

Feed additives are important raw materials that can improve the efficiency of feed utilization and animal performance. Many efforts to use natural materials such as medical plants could be widely accepted as feed additives. Chicory (*Cichorium intybus* L.) is a perennial herbal plant of the *(Asteraceae)* family with blue lavender, or occasionally white flowers, (New Medical College of Jiangsu, 1977), and this herb being native to the Mediterranean region, northern Africa areas and mid Asia. Historically, chicory was grown by the ancient Egyptian as a medical plant, vegetable crop, coffee substitute, and occasionally for animal forage (Plmuier, 1972and Munoz, 2004).

Ministry of Health of the People's Republic of China in 2005 (Wang and Cui, 2010a) reported that chicory used as both health care food and medicine. In addition, chicory is found to be positively affect productive performance in monogastric animals (rabbit, chicken, pig and rat), especially during the young phase (Yusrizal and Chen, 2003; SooBo, 2005 and Castellini *et al*., 2007). Likewise, chicory is palatable for ruminants, high in nonstructural carbohydrates and low in fiber (Athanasiadou *et al*., 2007) and has a nutritional quality compared to lucerne as it contains similar proportions of lipid, protein, minerals and other nutrients (Wang and Cui, 2011). The last 10 years ago chicory forage has been studied for its secondary compounds such as polyphenols and the generated results proved that such bioactive compounds can be reduce intestinal infections in grazing animals (Marley *et al.,* 2003). Furthermore, chicory forage is containing minerals composition, highly palatable with good digestion for livestock and poultry (Sanderson *et al*., 2003 and Scharenberg *et al*., 2007) and also considered as a good feedstuffs substitute for condense feedstuff (e.g. grain in China) and highly palatable to rabbits, sheep, cows, deer, cattle, horse, geese duck, ostrich and fish (Moloney and Milne, 1993; Foster *et al*., 2002;). Still there is a potential further researchs necessity to be done in order to gain a better understanding and further elucidate the mechanisms of chicory and its extracts that are rationally suggested for increasing the productive performance of rabbits.

This work aimed to estimate the effect of supplementing rabbit rations with three levels of chicory leaves on the productive performance of growing rabbits, digestibility coefficient, feeding values, carcass characteristics, some blood parameters and biochemical traits of caecum content.

MATERIALS AND METHODS

The current work was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture during January 2017.

Experimental rabbits and diets:

Fourty eight rabbits (5 weeks of age and 578g LBW), were used in a randomized complete block design of four treatments during feeding period from weaning up to marketing age, (preferable weight in markets). Rabbits were housed in separate cages, where they were divided into four groups (12 rabbits each). The experimental feeding period was continued along one month after weaning up to marketing age (63 days). All rabbit groups were fed on the experimental dies one week preceded the start point of the experiment to serve as a preliminary period. The experimental animals of the control group (G1) were fed on the basal diet, while those of the tested ration groups were fed on the basal diet in addition to 0.5% (G2); 1% (G3) and 2% (G4) of their body weight of dried chicory (*cichorium intybus*) leaves. The experimental diet was formulated to be iso-caloric (~2500 kcal DE/kg diet) and iso-nitrogenous (~17% CP). Diet was in pelleting form to satisfy the nutrients requirements of growing rabbits according to Agriculture Ministry Decree (1996). The basal ration was consisted of the following ingredients: 30.00, 17.00, 10.00, 17.00, 20.00, 3.50, 0.10, 0.50, 0.50, 1.05 and 0.35% of Clover hay, Barley grains, Yellow corn, Soybean meal (44%CP), Wheat bran, Molasses, DL-Methionine, Vitamins & minerals mixture, Salt, Limestone and Di-Calcium phosphate, respectively. The mixture of Vitamins & minerals was contained per kg of diet on: 12000 IU Vit. A; 2200 IU D3; 10mg Vit.B1; 4.0 mg Vit.B2; 1.5 mg Vit.B6; 0.0010mg Vit.B12; 6.7 mg Vit. B5; 1.07mg Vit.E; 2.0 mg Vit.K3; 1.0 mg Vit. Pantothenic acid; 6.67 mg Biotin; 1.67 mg Folic acid; 400 mg Choline chloride; 22.3 mg Mn; 25 mg Zn;10 mg Cu; 0.25mg Fe; 1.67 mg I; 0.033 mg Se and 133.4 mg Mg. Chemical composition (calculated) of the basal diet are presented in Table (1).

Table 1.Calculated Composition of the basal diet (as fed,%).

DM	87.10
CP	17.08
EE	2.41
CF	13.52
NFE	48.27
Ash	5.82
DE (kcal/kg)[2]	2513
CF	13.52
NDF	37.81
ADF	21.76
Calcium	1. 01
Total phosphorus	0.519
Methionine	0.36
Lysine	0.82

1- According to MOA (2001).

3- DE was calculated according to Cheeke (1987) as: DE (Kcal/g) = 4.36 – 0.0491 × NDF% where NDF% = 28.924 + 0.657 × CF%.

Housing and management

Rabbits were individually housed in galvanized wire cages (40 x 50 x 60 cm) and fresh water was automatically available at all time. All rabbits were kept under the same managerial, hygienic and environmental conditions, allowing recording individual feed intake for each rabbit in these cages.

Experimental procedures

Live body weight and feed intake were weekly recorded throughout the experimental feeding period. Then, daily weight gain, feed conversion, feed efficiency ratios and economic efficiency were calculated.

Digestibility trials

The digestibility trial was undertaken at the last week of the experimental period on three animals from each group. Rabbits, were individually housed in metabolic cages. The experimental diet was offered daily and fresh water were supplied all the time. Individual feed intake was carefully determined and feces were daily collected quantitatively for 7-d collection period, to determine the nutrient digestibility coefficients and feeding values of the experimental diets. The daily samples of feces for each animal were immediately frozen at -20^{o}C until the end of the collection phase and then composited samples for each animal was prepared for analysis. Faeces of each animal was mixed, dried at 60^{o}C for 24 hours, then representative samples were ground for chemical analysis. Chemical analysis of diets and feces were determined according to A.O.A.C. (1995). The feeding values as TDN and DCP were calculated for the dietary treatments.

Carcass traits

At the end of the experimental period, 3 representative rabbits from each treatment were randomly chosen and fasted for 12 hours before slaughtering according to Blasco et al. (1993) to determine the carcass measurements. Edible offal (Giblets) included heart, liver, spleen, kidneys and lungs were removed and individually weighed.

Blood parameters

At the end of the experimental period, blood samples were collected from slaughtered rabbits (3 in each group) in two clean sterile tubes for each animal immediately after slaughtering. The 1st blood samples were collected in heparinized tubes to obtain whole blood samples for determined haematological parameters including haemoglobin concentration using cyanomethemoglobin technique (Mitruka and Rawnsley, 1977). Red blood cells (RBCs) and white blood cells (WBCs) counts of fresh blood were immediately estimated using haematocytometer according to Mitruka and Rawnsley (1977). The 2nd blood samples were let to coagulate and centrifuged at 3000r.p.m for 15 minutes and then serum was separated and stored at -20°C until used for analysis. Serum was used for determination total protein by the Biuret method according to Henry et al. (1974), total albumin (Doumas et al., 1971) and globulin concentration was calculated as the difference between total protein and albumin. Assay of serum Aspartate (AST) and Alanine (ALT) aminotransferase activities were conducted according to procedures of Reitman and Frankel (1957), and Urea N and NH3 according (Patton and Crouch, 1977). All biochemical blood constituents were determined using spectrophotometer (Spectronic 21 DUSA) and commercial diagnostic kits (Combination, Pasteur Lap.).

Caecum microflora:

Samples of caecum contents were taken individually from three animals from each group after slaughter at the end of the experimental period (marketing age) after being fasted for 12 hrs.

Caecal contents of slaughtered rabbits were taken for determining pH using Bechman pH meter, caecum microflora (Total counts of anaerobic bacteria and total counts of *Escherecia coli.*) were estimated according to the microbiological method as described by Bergey's manual (2001).

Economical efficiency

Economical efficiencies of experimental diets were calculated according to the local market price of ingredients and rabbit live body weight as following:

Net revenue = total revenue - total feed cost.

Economical efficiency (%) =net revenue/total feed cost%.

Statistical analysis

The experimental data were statistically analysis according to Sndecor and Cochran (1980) using SAS program (1999). Difference among means between groups were determined using Duncan multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

Chemical composition

Chemical analysis of chicory leaves and experimental rations are presented in Table (2). Result showed that dried chicory leaves (DCL) had an acceptable values of CP, CF, EE, NFE and ash contents and therefore it can be potentially added value to the rabbit,s diet when incorporated into it. Data showed that DCL had 14.70% CP on DM basis which seemed to be lower than that recorded (20.33%) by Wang and Cui (2011) with cultivar of *Puna* chicory leaves. They were added that chicory forage having nutritional qualities comparable to these of lucerne as it contains similar proportions of lipid, minerals, protein and other nutrients. Protein in chicory has been ranked as high quality where it contains 17 kinds of amino acids, including 9 needs for human beings and animals and for instances, lysine content at 1.2% in chicory is similar to that of alfalfa (1.05 ~ 1.38 %) (Zhang *et al*., 2005). Regarding CF content, the value obtained here (16.78%) was much lower than that explored by Wang and Cui (2011) with chicory forage (26.83%) which seemed to be similar to that of alfalfa (28.89%). Results showed that EE content (3.68%) was similarly to that obtained by Wang and Cui (2011) who recorded 3.78% in chicory forage that higher than that of the average of 10 varieties in alfalfa shoot and leaves (2.99%). In present study, ash content (10.91%) was markedly lower than that reported by Wang and Cui (2011) being 14. 91% for chicory forage. In general chicory forage is containing minerals and highly palatable with good digestion for livestock and poultry (Sanderson *et al*., 2003 and Scharenberg *et al*., 2007), and likewise rich in ascorbic acid, carotene, and minerals Na, Ca, P, Mg, K, Fe, S, Mn, Cu, Zn, Sr and Se (Wang and Cui 2010b).

Table 2. Chemical analysis of the chicory leaves and experimental rations (on DM basis, %).

Items	Chicory Leave	Experimental rations			
		G1	G2	G3	G4
DM	90.55	87.10	88.23	89.11	92.61
OM	89.09	94.18	93.75	92.28	91.9
CP	14.70	17.08	18.00	18.53	19.21
CF	16.78	13.52	14.18	14.52	15.03
EE	3.68	2.41	2.89	3.31	3.95
NFE	53.93	61.17	58.68	55.92	53.71
Ash	10.91	5.82	6.25	7.72	8.10

***G1, control ration (0.0) Chicory, G2, with 0.5% Chicory, G3, with 1% Chicory and G4, with 2% Chicory.**

Body weight for Rabbits

Data of growing New Zealand White (NZW) rabbits fed ration supplemented with 1% DCL (G3) had significantly the highest (P<0.05) final body weight compared with that of control and other tested ration groups (Table 3). Comparable results were found along the weeks of the experiment. Similar results were reported by (Yusrizal and Chen, 2003 and SooBo, 2005) recorded that addition chicory or inulin were affect growth performance positively in monogastric animals (rabbit, chicken, pig and rat), especially in young animals. Also, (Castellini *et al*., 2007 and Attia *et al*., 2014) showed that root and forage of chicory are of interest as fiber source in poultry nutrition. Further results obtained by Castellini *et al*. (2007) indicated that dietary administration of fresh chicory to young rabbits before weaning was improved caecal biochemical traits contents, where, the lowered NH3 (0.5 vs. 0.6 μ mol g, P<0.05) and pH values (5.9 vs. 6.1, P<0.05) and the higher VFA content (52 vs. 46 mmol/ L, P<0.01) indicated a higher fermentation of gut microflora in comparison with control diet (free from chicory). The same authors also found that, addition of chicory at post-weaning phase slightly affected rearing performance, rabbits fed chicory recorded a higher daily gain (35.3 vs. 33.7 g/d; P<0.05) and fed intake (134.0 vs. 124.5 g/d, P<0.05) and. While, Ivarsson *et al*. (2011) reported that inclusion up to 160g chicory /kg diet for weaned piglets did not negatively affect performance and was promising as feedstuffs for these animals. However, Di Grigoli *et al*. (2012) mentioned on the potential of chicory to provide lasting good quality herb and the positive effect on dairy performance in grazing ewes. In a recent paper, Dylan Laws and Liz Genever (2013) reported that lambs grazed on chicory have similar growth performances to those grazing forage legumes and better growth than those grazing grass based pastures and also they added that the rates of lamb growth can be 70% higher with grazing chicory in comparison to a standard grass sward.

Table 3. Initial and final body weight of growing NZW rabbits as affected by different levels of chicory in diets (Means ± SE).

Traits	Growing periods (Weeks)	Experimental rations			
		G1	G2	G3	G4
Initial body weight at 35 days age (gm)		581.3±27.41	579.2±30.3	568.9±25.8	587.3±33.8
	1st week	761.2 ±36.2 ^{c}	829.3 ±29.3 ^{ab}	864.2 ±33.4 ^{a}	790.2 ±30.9 ^{bc}
Body weight weekly	2nd week	947.6 ±42.3 ^{b}	1038.3 ±39.6 ^{a}	1107.5 ±44.2 ^{a}	932.6 ±46.7 ^{b}
(gm)	3rd week	1252.3 ±48.2 ^{b}	1360.4 ±51.3 ^{a}	1432.9 ±44.9 ^{a}	1170.5 ±37.6 ^{b}
	4th week	1425.8 ±48.3 ^{c}	1624.3 ±52.6 ^{b}	1780.3 ±51.9 ^{a}	1290.6 ±47.4 ^{d}

Means bearing different letter superscripts (a,b,c,d) within the same row are significantly (P ≤ 0.05) different.

Feed intake and daily weight gain:

Results of the feed intake by growing (NZW) rabbits during the experimental period are summarized in Table (4). Feed intake was the highest (P>0.05) for groups fed 1% (DCL) ration (98.1 ±5.4 g) and 2% (98.8 ±5.9g) ration compared the other groups, being (89.5 ±4.9g) for control and (92.3 ±4.6g) for 0.5% ration with no significant differences among the experimental rations. The present results are supported by Volk and Marounek (2011) who showed that no significant differences in rabbits feed intake and daily weight gain (DWG) with chicory root inclusion and control diet. Also, Ivarsson *et al*. (2011) showed that no differences in feed intake, (DWG) between chicory diets and cereal based diet for weaned piglets.

Data of daily weight gain are presented in Table (4). Higher DWG was recorded for G3 (P<0.05), followed by those fed G2, then control (G1) ration, while the lowest was recorded with those fed G4. This result is supported with those obtained by, Guermah and Maertens (2012) who cleared that weanlings rabbits fed diet with 20% chicory pulp had a significant (P<0.05) higher final weight and DWG compared to those control diet. Also, Castellini *et al.* (2007) reported that chicory intake slightly increased in the post weaning (52 d) and a best daily gain (35.27 g/d versus 33.79 g/d) compared with the (control) group. In matching with the present results, the findings of El-Basiony *et al.* (2015) indicated that using *Chicorium intybus* as additive in the dairy goats' diets tend to improve nutrient digestibilities and increase milk quality and quality.

Table 4. Daily feed intake and weight gain of growing rabbits as affected by different levels of chicory in diets (Means ± SE).

Traits	Growing periods (Weeks)	Treatments			
		G1	G2	G3	G4
Daily feed intake (gm)	1st week	70.3±4.2	71.1±4.7	73.2±4.9	72.9±4.2
	2nd week	82.9 ±5.3	86.6 ±4.9	91.3 ±5.8	93.2 ±6.1
	3rd week	94.6±7.2	96.3±7.0	96.2±8.3	99.7±7.6
	4th week	110.3 ±8.2 ^{b}	115.2 ±9.0 ^{ab}	131.6 ±9.3 ^{a}	129.4 ^{ab} ±11.2
Means ± SE		89.5 ±4.9	92.3 ±4.6	98.1 ±5.4	98.8 ±5.9
Daily weight gain (gm)	1st week	25.7 ±1.4 ^{c}	35.7 ±1.9 ^{b}	42.2 ±2.6 ^{a}	29.0 ±2.2 ^{d}
	2nd week	26.6 ±1.2 ^{b}	29.9 ±2.4 ^{ab}	34.8 ±2.9 ^{a}	20.3 ±2.6 ^{c}
	3rd week	43.5 ±1.9 ^{a}	46.0 ±2.1 ^{a}	46.5 ±2.4 ^{a}	34.0 ±2.9 ^{b}
	4th week	24.8 ±2.1 ^{c}	37.7 ±2.7 ^{b}	49.6 ±2.7 ^{a}	17.2 ±2.4 ^{d}
Means ± SE		30.2 ±1.6 ^{c}	37.3 ±2.4 ^{b}	43.3 ±2.2 ^{a}	25.1 ±1.9 ^{d}

Means bearing different letter superscripts (a,b,c,d) within the same row are significantly (P ≤ 0.05) different.

Feed conversion and feed efficiency:

Feed conversion and feed efficiency data of rabbits are shown in Table (5). An improvement in feed conversion and feed efficiency values were noticed for rations contained 0.5 and 1% chicory herb additives, while the poorest one were found with those fed 2% herb. These results agree with that of Guermah and Maertens (2012) who showed that feed conversion ratio was improved (P<0.05) significantly for groups of weanling rabbits that fed 20% chicory pulp (CP) compared to control diet. Also, they showed this effect was clear during the first week and to a lesser extent also during the 5th week. Also, Castellini *et al.* (2007) recorded that during the post-weaning of rabbits period, the feed efficiency was improved significantly in the chicory group compared with the control one. On the other hand, Volk and Marounek (2011) recorded that there were no significant effect respecting feed conversion ratio with rabbits fed chicory root inclusion diet compared with those fed the free one. Also, Ivarsson *et al.* (2011) reported that no significant differences in feed conversion ratio between the chicory diets and cereal based diet for weaned piglets.

Table 5. Feed conversion and efficiency of growing rabbits as affected by different levels of chicory in diets (Means ± SE).

Traits	Growing periods (Weeks)	Treatments			
		G1	G2	G3	G4
Feed conversion (Feed intake/ weight gain)	1st week	2.74 ±0.19 ^{a}	1.99 ±0.16 ^{b}	1.73 ±0.17 ^{b}	2.51 ±0.19 ^{a}
	2nd week	3.12 ±0.27 ^{b}	2.90 ±0.32 ^{b}	2.62 ±0.24 ^{b}	4.59 ±0.41 ^{a}
	3rd week	2.17 ±0.30 ^{ab}	2.09 ±0.26 ^{b}	2.07 ±0.28 ^{b}	2.74 ±0.29 ^{a}
	4th week	4.45 ±0.38 ^{b}	3.06 ±0.33 ^{c}	2.65 ±0.37 ^{c}	7.52 ±80 ^{a}
Means ± SE		3.12 ±0.24 ^{b}	2.51 ±0.20 ^{c}	2.27 ±0.14 ^{c}	4.34 ±0.37 ^{a}
Feed efficiency (weight gain/ (Feed intake) (%)	1st week	36.56 ±2.71 ^{b}	50.21 ±3.12 ^{b}	57.65 ±3.41 ^{a}	39.78 ±2.63 ^{b}
	2nd week	32.09 ±1.98 ^{b}	34.53 ±1.99 ^{ab}	38.12 ±2.74 ^{a}	21.78 ±1.55 ^{c}
	3rd week	45.98 ±2.81 ^{a}	47.77 ±2.91 ^{a}	48.34 ±2.96 ^{a}	34.10 ±2.02 ^{b}
	4th week	22.48 ±1.41 ^{c}	32.73 ±1.84 ^{b}	37.69 ±2.82 ^{a}	13.29 ±0.82 ^{d}
Means ± SE		34.28 ±1.15 ^{c}	41.31 ±1.42 ^{b}	45.45 ±1.69 ^{a}	27.24 ±1.49 ^{d}

Means bearing different letter superscripts (a,b,c,d) within the same row are significantly (P ≤ 0.05) different.

Digestibility and feeding values:

Results of nutrient digestibilities when using dried chicory leave (DCL) herb additives in rabbits diet (Table 6) showed that differences among groups for nutrient digestibilies were significant (P<0.05). It was found that G3 had significantly (P<0.05) the highest values in respect of digestibility of DM, OM, CP, CF, EE and NFE, followed by those of ration contained G2, while the lowest values were found with G4 which received 2% (DCL). Practically, Clark *et al.* (1990) cleared that proportions of 70% leaves and 30% stems could be eligible in forage chicory because of the higher digestibility of leaves compared to stems. Regarding the addition of herbs into rations of farm animals, it could be improved rumen fermentation and digestibility (Ando *et al.*, 2003). Additionally, El Basiony *et al.* (2015) showed the results of lactating goats fed diet containing (10g *Cichorium intybus*) showed better utilized the diet than the control diet respecting the entire nutrient digestibilies (DM, OM, EE, CP, CF, and NFE). This preference may be due to the ability of the *C. intybus* herb to purification of the digestion track from the parasites that may affect the balance of the rumen environment and therefore adversely affect the process of digestion of different nutrients (Molan *et al.,* 2003) and Athanasiadou *et al*. (2007). While, Ivarsson *et al*. (2011) illustrated that inclusion of chicory had a minor negative impact on the coefficient of total tract apparent digestibilities (CTTAD) of DM, OM and CP, whereas, chicory herbs have a higher digestibilities of fiber in comparison to cereal based diet for weaned piglets.

The feeding values were related to nutrients digestibility where they kept the same trend being ranged from (62.47 to 69.60) for TDN and (10.94 to 13.01) for DCP Table (6). Mostly, significant differences among treatments respecting TDN and DCP values were found with the highest values being associated with G3 diet and the lowest values were occurred with G4 for TDN and G1 for DCP. Definitely, Hanafy *et al*. (2009) concluded that using some medical herbage as feed additives in rations of growing barki lambs could be improve the nutrient digestibilities and feeding values. Moreover, chicory forage is containing mineral composition, highly palatable with good digestion for livestock and poultry was observed by (Sanderson *et al*., 2003 and Scharenberg *et al*., 2007). Generally, The present results are in harmony with those reported by El Basiony *et al.* (2015) who added 10g/h/d into dairy goats' diets of *Cichorium intybus* that lead to significant improvement in digestibility and consequently the feeding value of the supplemented diet in comparison with the free one.

Table 6. Digestibility and feeding values as affected by the different levels of chicory in diets of growing rabbits (Means ± SE).

Digestibility coefficients (%)	Treatments			
	G1	G2	G3	G4
DM	53.63± 0.363 ^{c}	56.81±0.343 ^{b}	60.54±0.173 ^{a}	52.07±0.40 ^{d}
OM	57.40±0.230 ^{c}	60.44±0.254 ^{b}	65.20±0.115 ^{a}	58.44±0.254 ^{d}
CP	64.06± 1.29 ^{b}	65.92±1.40^{b}	70.19± 2.16^{a}	61.32 ± 1.29^{c}
CF	39.37± 0.69 ^{b}	42.89±0.75^{a}	42.57± 0.77^{a}	36.07± 0.64 ^{c}
EE	71.99± 1.35 ^{b}	73.87±1.58 ^{ab}	76.51± 1.47^{a}	67.78± 1.25 ^{c}
NFE	75.44± 1.57 ^{bc}	77.38±1.65 ^{ab}	80.00± 2.07^{a}	73.11± 1.96 ^{c}
Feeding values				
TDN	66.3±0.173 ^{c}	68.14±0.080 ^{b}	69.6 ±0.346 ^{a}	62.47 ± 0.271 ^{d}
DCP	10.94±0.034 ^{c}	11.87±0.075 ^{b}	13.01 ±0.063 ^{a}	11.78 ± 0.127 ^{b}

Means bearing different letter superscripts (a,b,c,d) within the same row are significantly (P ≤ 0.05).

Carcass traits:

Carcass traits of slaughtered NZW rabbits in the experimental groups are presented in Table (7). Results recorded that, the pre-slaughter and carcass weights were significant higher with G3 than those of control (G1) and the other tested rations (G2 and G4). The high level DCL-diet (G4) had the lowest of such two values. Similar trend was found among treatments respecting dressing percentage being 56.48, 59.86, 63.33 and 53.76% for G1, G2, G3 and G4, respectively.

The same trend was observed with giblet organs (spleen, kidneys, liver, heart and lungs), where all organ weights were the highest significantly with G3 followed G2 and then G1 and G4 treatments. These present result are similar to those reported by Castellini *et al*. (2007) who illustrated that chicory intake slightly increase in the post weaning of rabbits (52 d) and slaughtering weight (77 d) compared with the control group. On the other hand, Guermah and Maertens (2012) reported that slaughter yield was not significant differ between group of rabbits that fed chicory and control group. Also, Volk and Marounek (2011) showed that there were no significant responces in rabbit carcass traits with chicory root inclusion in their diets. Recently, Dylan Laws and Liz Genever (2013) found that, grazing lambs on chicory appears to have no adverse effect on carcass characteristics in terms of weight and fatness in comparison to a standard grass sward. Also they were reported that steers grazing the chicory and perennial ryegrass PRG swards had no differences in carcass characteristics including conformation, carcass weight, fat grade and killing out%.

Table 7. Dressing percentage; internal organs weight and Post weaning mortality rate of growing rabbits as affected by different levels of chicory in diets (Means ± SE).

Traits	Treatments			
	G1	G2	G3	G4
Pre-slaughter weight (gm)	1431.2 ±44.2 ^{c}	1644.3 ±47.5 ^{b}	1732.6 ±45.2 ^{a}	1299.3 ±36.6 ^{d}
Carcass weight (gm)	808.3 ±27.3 ^{c}	984.2 ±33.2 b	1097.3 ±41.3 ^{a}	698.5 ±21.9 ^{d}
Dressing (%)	56.48 ±1.4 ^{c}	59.86 ±1.5 ^{b}	63.33 ±1.9 ^{a}	53.76 ±1.2 ^{d}
Spleen weight (gm)	1.11 ±0.11 ^{b}	1.29 ±0.24 ^{ab}	1.75 ±0.29 a	1.09 ±0.14 ^{b}
Kidneys weight (gm)	10.31 ±0.94 ^{bc}	12.08 ±1.14 ^{b}	14.71 ±1.29 ^{a}	9.81 ±0.84 ^{c}
Liver weight (gm)	33.21 ±2.87 ^{b}	40.12 ±3.09 ^{a}	45.17 ±3.41 ^{a}	31.28 ±2.19 ^{b}
Heart weight (gm)	4.92 ±0.67 ^{bc}	6.18 ±0.72 ^{b}	7.84 ±0.69 ^{a}	4.37 ±0.88 ^{c}
Lungs weight (gm)	5.31 ±0.89 ^{bc}	6.94 ±1.22 ^{ab}	8.54 ±1.61 ^{a}	5.01 ±0.69 ^{c}
Post weaning mortality rate (%)	10.64 ±0.208 ^{b}	8.51 ±0.288 ^{c}	4.26 ±0.427 ^{d}	14.89 ±0.289 ^{a}

Means bearing different letter superscripts (a,b,c,d) within the same row are significantly (P ≤ 0.05) different.

Finally, the data in Table (7) showed that mortality rates was decreased (P<0.05) significantly in the low additive groups (G2 and G3) compared with other groups (G1 and G4). However, Guermah and Maertens (2012) reported that the mortality rate was not influenced by chicory pulp in comparing with the control group. Moreover, Castellini *et al.* (2007) cleared that high intake in the chicory group could explain the high fresh chicory appetibility, but the high inulin and low energy value and fructan type oligosaccharides (FOS) contents could be explain the tendency in reduction of mortality rates (3.9 % versus 7.7%) and consequently could improved animal health.

Blood haematology and biochemical Parameters:

Haematological parameters data (Table 8) showed that red blood cells count, white blood cells counts, concentration of hemoglobin and haematocrit%, were higher with group fed 1% (DCL) (G3) as addition to rabbits diet, while the lower values were occurred with either those received G4 or those of (control) one. While the intermediate value was recorded with G2 diet.

Blood serum of rabbits are presented in Table (8) showed that animals of G3 had the highest (P<0.05) concentrations of total blood protein, albumin and globulin, whereas, the lowest values (P<0.05) was found in G4, with insignificant differences between G1 (control) and G4 or between G2 and G3 treatments in these metabolites. In line with the present results El Basiony *et al.* (2015) recorded that slightly increases of each blood total protein and globulin concentrations in diet of goats that supplemented with 10g *cichorium intybus*/h/d. Rats received chicory at level (10% w/w) cleared a significant increase in serum total protein and albumin compared with un-received one (Hanna and Mokhtar, 2010).

The concentrations of blood serum urea N and NH3 Table (8) were ranged between 12.78 to 17.13mg/dl and 3.00 to 4.31μ/dl, respectively, being lower significantly for G2 and G3 than those received the control and G4 ration. Similar trend of blood serum urea concentration, where it was decreased with dried chicory addition into the diet of dairy goats in comparison with the un-supplemented one (El Basiony *et al.*, 2015).

Finally, G3 showed significantly (P<0.05) the highest AST and ALT levels being (41.91and 27.01, respectively) followed by G2 being (40.02 and 25.49, respectively) while, the lowest value was reported with the control and G4 diets. While, El Basiony *et al.* (2015) recorded that chicory addition into the diet of dairy goats tended to decrease both AST and ALT numerically but not significantly when compared with the control group that free from chicory supplement. In perspective, *Cichorium intybus* contains organic acid, alkaloid, saccharides, coumarins, triterpenes, sesquiterpenes, ect. and it has a function of lowering the blood lipid and glucose, decreasing hepatoprotection, and uric acid was observed by (Wang and Cui 2009).

Table 8. Blood picture and some blood serum constitutes of rabbits as affected by different levels of chicory in diets (Means ± SE).

Traits	Treatments			
	G1	G2	G3	G4
Red blood cells (N x 10^6 /mm^3)	5.32± 0.19 ^{c}	5.93 ± 0.28 ^{b}	6.98 ± 0.36 ^{a}	5.04±0.20 ^{c}
White blood cells (Nx10^3/mm^3)	6.00 ± 0.31 ^{c}	7.01 ± 0.42 ^{b}	7.94 ± 0.50 ^{a}	5.49 ± 0.33 ^{c}
Hemoglobin (gm/ dl)	9.11 ± 0.48 ^{b}	11.74± 0.59 ^{a}	12.03 ± 0.49 ^{a}	8.88 ±0.37 ^{b}
Hematocrite (%)	38.41 ± 1.00 ^{b}	40.18±1.10 ^{ab}	41.99 ± 0.94^a	38.32± 0.92 ^{b}
Total protein (mg/ 100ml)	5.32 ± 0.19 ^{b}	5.95 ± 0.21 ^{a}	6.31 ± 0.17 ^{a}	5.17 ± 0.13 ^{b}
Albumin (mg/ 100ml)	2.90 ± 0.14 ^{b}	3.26 ± 0.19 ^{ab}	3.61 ± 0.22 ^{a}	2.74 ± 0.10 ^{b}
Globulin (mg/ 100ml)	2.42 ± 0.08 ^{b}	2.69 ± 0.09 ^{a}	2.70 ± 0.07 ^{a}	2.43 ± 0.05 ^{b}
Blood Urea N (mg/ dl)	16.54 ± 1.01 ^{a}	13.24 ± 0.96 ^{b}	12.78 ± 0.91^b	17.13 ± 1.34 ^{a}
Blood NH3 (μg/ ml)	4.01 ± 0.49 ^{a}	3.12 ± 0.38 ^{b}	3.00 ± 0.32 ^{b}	4.31 ± 0.62 ^{a}
Activity of AST (U/ L)	38.12 ± 1.32 ^{bc}	40.02±1.24 ^{ab}	41.91 ± 1.44 ^{a}	37.93 ± 1.09 ^{c}
Activity of ALT (U/ L)	22.59± 0.69 ^{b}	25.49 ± 0.72 ^{a}	27.01 ± 0.80 ^{a}	22.50 ± 0.48 ^{b}

Means bearing different letter superscripts (a,b,c,d) within the same row are significantly (P ≤ 0.05) different.

Caecum microflora:

Caecal pH value was decreased in a linear manner with increasing (DCL) herb (Table 9) in the diets of rabbits in comparison with that of control one. This finding agrees with those reported by, Volk and Marounek (2011) who cleared that rabbits fed with the chicory diets showed lower caecal pH (P=0.048) than those fed the control diet. Also, Castellini *et al*. (2007) indicated that dietary administration of fresh chicory was improved caecal biochemical traits contents, where, the lowered NH3 (0.5 vs. 0.6 μ mol g, P<0.05) and pH values (5.9 vs. 6.1, P<0.05) and the higher VFA content (52 vs. 46 mmol/ L, P<0.01) indicated a higher fermentation of gut microflora in comparison with control diet (free from chicory) to young rabbits before weaning. In the present study, total anaerobic bacteria and *E. Coli* counts were significantly decreased (P<0.05) for groups of rabbits that received 1% (DCL) diet (G3) compared with un-received one (G1) and 2% diet (G4). Also, (Ando *et al*., 2003) showed that addition of herbs into rations of farm animals could be improved rumen fermentation and digestibility. Furthermore, grazing chicory can decrease some internal parasites in livestock and therefore has potential to reduce the use of anthelmintics (Wang and Cui, 2010b). Similarly, chicory roots has a high content of fructo-oligosaccharides (FOS) and inulin, which can be used to manipulate the composition of microflora in the gut and enhances its integrity (Flickinger *et al*., 2003). In order to modulate caecal fermentation, some authors have used various (FOS) (Maertens *et al*., 2004), which are not digested in the upper intestine and remain available for fermentation by the caecal flora (Fishbein *et al*., 1988). While, Ivarsson *et al*. (2011) showed that coliform counts was not affected by chicory inclusion for weaned piglets. but decreased with increasing age (P<0.05).

Table 9. Caecum microflora of growing rabbits as affected by different levels of chicory in diets (Means ± SE).

Items	Treatments			
	G1	G2	G3	G4
Caecum microflora:				
Caecum pH value	6.47±0.012 [b]	6.26± 0.032 [a]	6.20±0.029 [a]	6.18 ±0.028 [a]
Total anaerobic bacteria count (log cfu/g)	6.29 ±0.006 [a]	5.37 ±0.011 [b]	5.23 ±0.006 [d]	5.28±0.010 [c]
E.Coli count (log cfu/g)	6.18 ±0.014 [a]	5.32 ±0.040[c]	5.22 ±0.135 [d]	5.41±0.029 [b]

Means bearing different letter superscripts (a,b,c,d) within the same row are significantly ($P \leq 0.05$).

Economic efficiency:

Results in Table (10) illustrated, that average daily feed cost was typically similar for the different groups. The highest daily weight gain of rabbits, price of daily gain (PDG), economical return and relative economic efficiency (REE) were found in G3 diet, while, the lowest values were occurred with G4 diet. This findings agreed with those reported by Wang and Cui (2010b) who found that incorporating fresh leaf of chicory in cattle farm diet was decrease feeding cost by 50%. Hanafy *et. al*. (2009) concluded that using some medical herbage as feed additives in rations of growing barki lambs could be improve lambs performance and economic efficiency. Also, Jenkins (2010) reported that chicory is highly digestible with low to moderate protein contents and could be included in beef cattle diet as an economical feed source.

Table 10. Economical effeciency of growing rabbits as affected by different levels of chicory in diets.

Traits	Treatments			
	G1	G2	G3	G4
Average daily feed cost (L.E)	290	290.05	290.1	290.2
Daily weight gain (g/h)	30.2±1.6 [c]	37.3 ±2.4 [b]	43.3 ±2.2 [a]	25.1 ±1.9 [d]
Price of daily gain (L.E)	0.72	0.90	1.04	0.60
Economical return (L.E /h/d)	4.34	6.05	7.49	3.12
Relative economic efficiency (L.E /h/d)	100	139.18	172.29	71.80

Means bearing different letter superscripts (a,b,c,d) within the same row are significantly ($P \leq 0.05$) different.
Calculation based on the following price in Egyptian pound (L.E.) per ton at 2016: CFM = 2900 L.E. / ton. chicory = 100 L.E. / ton. The price of one kg of live body weight was 24 L.E.

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CONCLUSION

The results of this study can asserts that the addition dried chicory leaves into the diet of rabbits at 1% of their live body weight could be improved the growth performance, digestion coefficients, feeding values and carcass traits. Furthermore, the physiological parameters of blood and caecum microflora had the highest acceptability among groups and all of these beneficial effects also decreased the mortality rate.

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تأثير إضافة أوراق الشيكوريا الجافة للعلائق علي أداء الأرانب النامية

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تم إستخدام فى هذه الدراسة 48 أرنب نيوزيلندى أبيض متوسط أوزانهم الى 578 جم عند عمر 5 أسابيع فى تجربة تغذية بإستعمال التصميم كامل العشوائية وقسمت عشوائيا إلى 4 مجموعات متماثلة (12 أرنب/مجموعة)0 غذيت الأرانب على عليقة الأرانب الأساسية بدون إضافة (مجموعة المقارنة، ج1) أو مع إضافة 0,5 % (ج2)، 1% (ج3)، 2% (ج4) أوراق الشيكوريا الجافة0 وذلك لدراسة تأثيرتلك الإضافات المقدمة لهذه الأرانب على النمو ومعاملات الهضم و القيمة الغذائية وعلى صفات الذبيحة و معدل النفوق وكذلك تأثير ذلك على مكونات الدم الأيضية. توضح النتائج أن الأرانب فى المجموعة الثالثة أظهرت معنويا (P<0.05) عند مستوى 1% من أوراق الشيكوريا الجافة أعلى وزن للجسم وأيضا أعلى فى متوسط معدلات الزيادة اليومية فى الوزن وذلك فى مراحل العمر المختلفة تلتها المجموعة الثانية عند مستوى 0.5%، بينما كانت أقل الأوزان فى المجموعة الأولى والرابعة. سجلت النتائج أنه لم يكن هناك إختلافات (P>0.05) معنوية للمأكول اليومي بين مجموعات الأرانب المغذاة على المستويات المختلفة من أوراق الشيكوريا الجافة أثناء فترة التجربة و مجموعة الكنترول. أظهرت النتائج تحسن فى معدل الكفاءة التحويلية فى المجموعات المغذاة على المجموعتين الثانية و الثالثة مقارنة بالمجموعتين الاخرتين. وكذلك قيم معاملات هضم العناصر الغذائية و المركبات الغذائية المهضومة والبروتين الخام المهضوم كانت الأعلى معنويا أيضا مع المجموعة الثالثة (1% شيكوريا فى الغذاء). أيضا وزن الأرانب قبل الذبح ووزن الذبيحة ونسب التصافى كانت الأعلى معنويا مع المعاملة الثالثة. كذلك أوزان كل من الكبد والقلب والكلى أخذت نفس الإتجاه السابق (كانت الأعلى مع المعاملة الثالثة). وكذلك الكفاءة الإقتصادية كانت الأعلى معنويا مع المعاملة الثالثة (1% شيكوريا بالغذاء). من هذه النتائج نستخلص أن الأرانب المغذاة على العليقة المضاف اليها 1٪ أوراق الشيكوريا الجافة، أظهرت أفضل النتائج بخصوص أداء النمو، ومعاملات الهضم و القيمة الغذائية ، مكونات الدم، وكذلك أفضل النتائج بخصوص صفات الذبيحة، معدل النفوق وأيضا النشاط الميكروبى والكفاءة الإقتصادية.

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