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Using Mixture of Sweet Basal and Black Cumin as Feed Additives with Different Levels of Energy in Growing Rabbit Diets

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Abstract: This work aimed to study the effect of two ration energy levels supplemented with mixture of sweet basil and black seeds. A total number of 48 male New Zealand White rabbits aged 5 weeks with an average body weight of 657 ± 33.30 g. Rabbits were classified into four equal groups (G_1-G_4). The 1st and 3rd groups received basal ration with 100 % and 90% of energy requirements and served as first and second control, respectively. The 2nd and the 4th groups received basal ration with 100% and 90% of energy requirements supplemented with mixture of sweet basil and black cumin seeds at the level of 1.5%, respectively. The 90% of energy level treatments (G_3 and G_4) showed an increasing in hemicellulose content, while showed a decreasing in acid detergent fiber (ADF), cellulose and non fibrous carbohydrates (NFC) content compared to the 100% of energy requirements. The neutral detergent fiber (NDF) and acid detergent lignin (ADL) content of experimental rations showed approximately the same trend. Decreasing energy requirements by 10% in rabbit diets significantly increased ($P<0.05$) all nutrient digestibility coefficients (DM, OM, CP, CF, EE and NFE) and nutritive value as digestible crude protein (DCP), while insignificantly increased the total digestible nutrient (TDN). The 90% of energy requirement with 1.5% additives mixture (G_4) recorded the best digestibility coefficients of OM, CP, EE, NFE and nutritive values of TDN and DCP. There were significant ($P<0.05$) interactions between the energy and additives mixture levels on DM, OM, CP, EE and NFE digestibility coefficient and DCP value. The 90% of energy level significantly ($P<0.05$) increased feed intake as DCP and TDN (g/ day), but it significantly decreased DE intake (kcal/h/d) as well as showed insignificant decrease on DM and CP intakes (g/ day). Addition of 1.5% of medicinal plants mixture significantly ($P<0.05$) improved feed conversion (g intake/ g gain) of DM, CP, DCP, TDN and DE (Kcal intake /g gain), respectively compared to control treatment. The 90% of energy with 1.5% additives mixture (G_4) recorded the best values of final body weight and body weight gain. The 90% of energy level (G_3) recorded the highest value of relative economic efficiency (165%) and the lowest value of feed cost/ kg live body weight (5.65 LE) flowed by the 90% of energy level with 1.5% additives mixture (G_4) recorded (156.6%) and (6.14 LE) for feed cost/ kg live body weight relative to the economic efficiency. Dietary treatments had no significant effect on all carcass parameters. Also, there were no interaction between energy and additives mixture levels on all carcass parameters. From these results it can be concluded that using the mixture of sweet basil and black cumin seeds as feed additives improved the utilization of low energy rabbit diet as well as growth performance.

Key words: *Ocimum basilicum* · Black cumin seeds · Rabbits · Growth performance · Digestibility · Carcass characteristics · Economic evaluation

INTRODUCTION

Recently, feed additives of plant origin have received considerable attention as alternatives to the traditional feed additives. Because of the increasing cost of feed ingredients, this effort was carried out to use some medicinal feed additives to participate in facing energy shortage problem and at the same time to decrease feeding costs. The hypothesis fact that pancreas makes amylase (alpha amylase) to hydrolyse dietary starch into di-saccharides and tri-saccharides which are converted by other enzymes to glucose to supply the body with energy. Some plants and bacteria produce amylase as reported by Santa-Maria *et al.* [1] which make the energy extraction is maximized as noticed by de Castro [2]. Sweet basil used is the dried leaves of *Ocimum basilicum* L., belonging to the

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Lamiaceae family. The aroma in sweet basil is a factor affecting the commercial value of the crop [3]. Anethole is the most important constituent in *Ocimum basilicum* L., which gives the aroma and flavor [4]. Linalool is the major constituent of *Ocimum basilicum* L. essential oil, reported to possess antioxidative properties [5]. Sweet basil aqueous extract via antioxidant and possibly alpha glycosidase and alpha amylase inhibiting activities, offered positive benefits to control diabetes [6]. Sweet basil has antioxidant and antiglycant activities and inhibitory potential against enzymes involved in glycemic regulation [7]. Six triterpene acids identified as betulinic, oleanolic, ursolic,3-epimaslinic, alphitolic and euscaphic acids have been isolated from a dichloromethane extract of *Ocimum basilicum* L. [8].Black cumin used is the dried seeds of *Nigella sativa* L. is also known as black seed belonging to the ranunculaceae family. Nigellone is the carbonyl polymer of thymoquinone, isolated from *Nigella sativa* L. seeds, which is in relatively low concentrations, is very effective in inhibiting of oxidative energy metabolism [9]. Thymoquinone prevent the energy decline in kidney tissues [10]. *Nigella sativa* L. increased cardiac work load or energy consumption [11]. *Nigella sativa* L. seed ethanol extract previously reported hypoglycemic and hypolipidemic activity [12]. Thymoquinone is a major active component of *Nigella sativa* L. and has been used to treat disease processes [13]. *Nigella sativa* L. seeds also contain proteins, alkaloids (nigellicines and nigelledine) and saponins (alpha-hederin) in substantial amounts [14]. The phytochemicals in black cumin seeds can positively be used against lifestyle disorders [15].

This work aimed to evaluate the efficacy of the mixture of *Ocimum basilicum* L.and *Nigella sativa* L. as feed additives in improving the utilization of low energy rabbit diet as well as growth performance.

MATERIALS AND METHODS

A total number of 48 male New Zealand White rabbits aged 5 weeks with an average body weight of 657 ± 33.30 g, were divided into four equal groups. The basal experimental diet was formulated and pelleted to cover the nutrient requirements of rabbits as a basal diet according to N.R.C. [16] as shown in Table 1. Additives mixture used in this study are composed of *Ocimum basilicum* L. and *Nigella sativa L.* at ratio of (1:1). The feeding period was extended for 56 days and the experimental groups were classified as follow:

Group 1: Basal diet with 100 % energy requirement and served as control (G_1),

Group 2: Basal diet with 100 % energy requirement + 1.5% additives mixture (G_2),

Group 3: Basal diet with 90 % energy requirement and served as control (G_3) and

Group 4: Basal diet with 90 % energy requirement + 1.5% additives mixture (G_4).

Table 1: Composition of the experimental diets (kg/ton)

	Experimental diets			
	100% Energy requirements		90% Energy requirements	
Item	G_1	G_2	G_3	G_4
Yellow corn	250	250	---	---
Barley grain	50	50	160	160
Wheat bran	250	250	250	250
Soybean meal 44% CP	140	140	140	140
Alfalfa hay	280	265	270	270
Alfalfa straw	--	--	150	135
Di- Ca- Phosphate	10	10	10	10
Lime stone	10	10	10	10
Sodium chloride	5	5	5	5
Vit. & Min. mixture*	3	3	3	3
DL-Methionine	1	1	1	1
Anti fungal agent	1	1	1	1
Plants mixture supplement	--	15	--	15
Price, L.E/Ton	2093	2248	1851	2024

* Vit. & Min. mixture: Each kilogram of Vit. & Min. mixture contains: 2000.000 IU Vit. A, 150.000 IU Vita. D, 8.33 g Vit. E, 0.33 g Vit. K, 0.33 g Vit. B_1, 1.0 g Vit. B_2, 0.33g Vit. B_6, 8.33 g Vit.B_5, 1.7 mg Vit. B_{12}, 3.33 g Pantothenic acid, 33 mg Biotin, 0.83g Folic acid, 200 g Choline chloride, 11.7 g Zn, 12.5 g Fe, 16.6 mg Se, 16.6 mg Co, 66.7 g Mg and 5 g Mn

LE = Egyptian pound equals 0.18 American dollars approximately

Rabbits individually housed in galvanized wire cages (30 x 35 x 40 cm). Stainless steel nipples for drinking and feeders allowing recording individual feed intake for each rabbit were supplied for each cage. Feed and water were offered *ad libitum*. Rabbits of all groups were kept under the same managerial conditions and were individually weighed and feed consumption was individually recorded weekly during the experimental period. At the end of the experimental period, all rabbits were used in digestibility trials over period of 7 days to determine the nutrient digestibility coefficients and nutritive values of the tested diets. Feces were daily collected quantitatively. Feed intake of experimental rations and weight of feces were daily recorded. Representative samples of feces was dried at 60°C for 48 hrs, ground and stored for later chemical analysis.

Six representative rabbits from each treatment were randomly chosen and fasted for 12 hours before slaughtering according to Blasco ***et al.*** [17] to determine the carcass measurements. Edible offal's (Giblets) included liver, heart, kidneys, testes, spleen and lungs were separated and individually weighed. Full and empty weights of digestive tract were recorded and digestive tract contents were calculated by differences between full and empty digestive tract. Hot carcass was weighed and divided into fore, middle and hind parts. The 9, 10 and 11^{th} ribs were frozen in polyethylene bags for later chemical analysis. The best ribs of samples were dried at 60°C for 24 hrs. The air-dried samples were analyzed for DM, EE and ash according to the A.O.A.C. [18] methods, while CP percentage was determined by difference as recommended by O'Mary ***et al.*** [19].

Chemical analysis of experimental rations and feces were analyzed according to A.O.A.C [18] methods. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were also determined in the experimental rations according to Goering and Van Soest [20]. Hemicellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL. Gross energy (kilo calories per kilogram DM) was calculated according to Blaxter [21], where, each g of crude protein (CP) = 5.65 kcal, each g of ether extract (EE) = 9.40 kcal and each g crude fiber (CF) and nitrogen-free extract (NFE) = 4.15 kcal. Digestible energy (DE) was calculated according to Fekete and Gippert [22] using the following equation:

$$\text{DE (kcal/kg DM)} = 4253 - 32.6\ (\text{CF }\%) - 144.4\ (\text{total ash}).$$

Non fibrous carbohydrates (NFC) were calculated according to Calsamiglia ***et al.*** [23] using the following equation:

$$\text{NFC} = 100 - (\text{CP} + \text{EE} + \text{Ash} + \text{NDF}).$$

Diets were offered pelleted and diameter of the pellets was 4 mm. Economical efficiency of experimental diets was 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 %.

Collected data were subjected to statistical analysis as two factors-factorial analysis of variance using the general linear model procedure of SPSS [24]. Duncan's Multiple Range Test [25] was used to separate means when the dietary treatment effect was significant.

RESULTS AND DISCUSSION

Chemical Analysis and Cell Wall Constituents of the Experimental Diets: Chemical analysis and cell wall constituents of the experimental diets are presented in Table 2. Digestible energy for the four tested rations (G_1-G_4) was 2507, 2510, 2252 and 2251 (kcal/ kg DM), respectively. These variations were related to differ in ingredients that used in ration formulations. The 90% of energy level treatments (G_3 and G_4) showed increasing in hemicellulose content, while showed decreasing in (ADF), cellulose and (NFC) values compared with 100% of energy requirements (Table 2). The (NDF) and (ADL) values of experimental rations approximately showed the same trend. These results owing to the using of barley grain which contain 15.6 % dietary fiber as an alternative of yellow corn which contain 2.7 % dietary fiber according to the report of the FAO [26].

Nutrient Digestibility and Nutritive Values of the Experimental Diets: The main effects of energy and supplemented levels on nutrient digestibility coefficients and nutritive values of the experimental diets are presented in (Table 3). Decreasing 10% of the energy requirements in rabbit diets significantly increased ($P<0.05$) all nutrient digestibility coefficients (DM, OM, CP, CF, EE and NFE) and nutritive value (DCP) as well as insignificantly ($P>0.05$) increased the (TDN). These results may be attributed to absence of yellow corn as a

Table 2: Chemical analysis and cell wall constituents of the experimental diets

	Experimental diets			
	100% Energy requirements		90% Energy requirements	
Item	G_1	G_2	G_3	G_4
Dry matter	91.48	91.71	92.25	92.31
Chemical analysis on dry matter basis				
Organic matter (OM)	90.48	90.52	89.05	88.96
Crude protein (CP)	16.01	16.05	16.05	16.09
Crude fiber (CF)	11.38	11.47	12.87	12.51
Ether extract (EE)	4.74	4.68	4.62	4.59
Nitrogen-free extract (NFE)	58.35	58.32	55.51	55.77
Ash	9.52	9.48	10.95	11.04
Gross energy (kcal/ kg DM)[1]	4244.00	4243.00	4179.00	4173.00
Digestible energy (kcal/kg DM)[2]	2507.00	2510.00	2252.00	2251.00
Non fibrous carbohydrates (NFC)[3]	30.21	30.40	28.86	28.53
Cell wall constituents				
Neutral detergent fiber (NDF)	39.52	39.39	39.52	39.75
Acid detergent fiber (ADF)	18.62	18.63	16.46	16.50
Acid detergent lignin (ADL)	6.39	6.34	6.83	6.84
Hemicellulose	20.90	20.76	23.06	23.25
Cellulose	12.23	12.29	9.63	9.66

[1]Gross energy (kilo calories per kilogram DM) was calculated according to Blaxter (1968), where, each g of crude protein (CP) = 5.65 kcal, each g of ether extract (EE) = 9.40 kcal and each g crude fiber (CF) and nitrogen-free extract (NFE) = 4.15 kcal

[2]Digestible energy (DE) was calculated according to Fekete and Gippert [22]using the following equation:

DE (kcal/ kg DM) = 4253 – 32.6 (CF %) – 144.4 (total ash)

[3] Non fibrous carbohydrates (NFC), calculated according to Calsamiglia *et al.* [23] using the following equation:

NFC = 100 – {CP + EE + Ash + NDF}

Table 3: Main effects of energy and supplementation levels on nutrient digestibility coefficients and nutritive values of the experimental diets

	Experimental diets					
	Energy levels			Supplementation		
Item	100%	90%	SEM	0%	1.5%	SEM
Nutrient digestibility coefficients (%)						
Dry matter (DM)	81.94^b	85.95^a	0.79	84.42	83.47	0.79
Organic matter (OM)	70.88^b	75.50^a	1.08	72.12	74.25	1.08
Crude protein (CP)	74.44^b	80.48^a	1.21	75.98	78.94	1.21
Crude fiber (CF)	30.02^b	39.62^a	2.37	34.70	34.94	2.37
Ether extract (EE)	70.69^b	78.83^a	2.02	71.90	77.62	2.02
Nitrogen-free extract (NFE)	77.91^b	81.97^a	0.91	78.98	80.91	0.91
Nutritive values (%)						
Total digestible nutrient (TDN)	68.31	71.74	0.96	68.94	71.11	0.96
Digestible crude protein (DCP)	11.94^b	12.93^a	0.20	12.18	12.69	0.20

a and b: Means in the same row within each treatment having different superscripts differ significantly ($P<0.05$)

SEM, standard error of the mean

form of starch and increasing the dietary fiber in the form of alfalfa straw presence which leads to improve the caecal microbial activity of the rabbit digestion. Similar results obtained in rabbit by Gidenne *et al.* [27], who noticed that, the intestinal digestive maturation and the caecal microbial activity of the rabbit evolved and affected markedly when the NDF: fiber ratio increased. Adding mixture of medicinal plants at 1.5% insignificantly ($P>0.05$) improved the OM, EE and NFE digestibility coefficients and nutritive values (TDN and DCP). The 90% of energy requirement with 1.5% additives mixture (G_4) recorded the best digestibility coefficients of OM, CP, EE, NFE and

Table 4: Effect of interactions between energy and supplementation levels on nutrient digestibility coefficients and nutritive values of the experimental diets

	Experimental diets				
	100% Energy requirements		90% Energy requirements		
Item	G_1	G_2	G_3	G_4	SEM
Nutrient digestibility coefficients (%)					
Dry matter (DM)	82.47^{bc}	81.40^{c}	86.37^{a}	85.53^{ab}	0.79
Organic matter (OM)	70.11^{b}	71.64^{ab}	74.13^{ab}	76.87^{a}	1.08
Crude protein (CP)	73.60^{b}	75.29^{b}	78.36^{ab}	82.59^{a}	1.21
Crude fiber (CF)	28.91	31.13	40.49	38.76	2.37
Ether extract (EE)	69.79^{b}	71.60^{b}	74.02^{b}	83.65^{a}	2.02
Nitrogen-free extract (NFE)	77.22^{b}	78.60^{b}	80.73^{ab}	83.21^{a}	0.91
Nutritive values (%)					
Total digestible nutrient (TDN)	67.59	69.04	70.30	73.19	0.96
Digestible crude protein (DCP)	11.79^{c}	12.08^{bc}	12.58^{ab}	13.29^{a}	0.20

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05)

SEM, standard error of the mean

nutritive values as TDN and DCP (Table 4). These results may be due to the antibacterial activity of sweet basil. Similar results are in agreement with those obtained by Sacchetti *et al.* [28], who observed the antibacterial activity of *Ocimum basilicum* L. essential oil against Gram positive and Gram negative bacterial strains. Also, may be due to some or all of the six triterpene acids in sweet basil as reported by Marzouk [8]. Similar results were obtained by Singh *et al.* [29], who noticed that triterpenoid might be acting by increasing the gastric mucosal resistance and local synthesis of cytoprotective prostaglandins and inhibiting the leukotriene synthesis. On the other hand may be due to the thymoquinone antibacterial activity in *Nigella sativa* L. seeds against bacterial biofilm formation, as reported by Chaieb *et al.* [30].

There were significant (P<0.05) interactions between the energy and additives mixture levels on DM, OM, CP, EE and NFE digestibility coefficients and DCP value, while there were no interactions between the energy and additives mixture levels on CF digestibility coefficient and TDN value (Table 4). These significant interactions may be due to the both positive effects of low dietary starch level and the high dietary fiber level as well as the antibacterial activity of either of *Nigella sativa* L. *Nigella sativa* L. or *Ocimum basilicum L.* on digestion coefficients. Similar result noticed by Hossain *et al.* [31] who reported that *Ocimum basilicum* L. displayed a great potential of antibacterial activity against *Bacillius cereus*, *B. subtilis*, *B. megaterium*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Escherichia coli*, *Shigella boydii*, *S. dysenteriae*, *Vibrio parahaemolyticus*, *V. mimicus* and *Salmonella*. Also, may be due to the spontaneous contractions in rabbit jejunum caused by *Nigella sativa* L. seeds as observed by Gilani *et al.* [32]. On other word, may be attributed to the protective ability of *Nigella sativa* L. of the digestive tract. Similar result explained by Butt and Sultan [14] who noticed that alkaloids and saponins in *Nigella sativa* L. affected on reducing some various maladies.

Growth Performance of the Experimental Groups: The 90% energy level insignificantly improved (P>0.05) the final body weight, total weight gain and average daily gain (g) compared to control (Table 5). The 90% energy level significantly (P<0.05) increased feed intake as DCP and TDN (g/ day), but it significantly decreased DE intake (kcal/h/d) as well as showed insignificant effect on DM and CP intakes (g/ day) (Table 5). The 90% energy level significantly (P<0.05) improved feed conversion (g intake/ g gain) of DM, CP and DE (Kcal intake /g gain), respectively, compared to control diet 100% energy requirements (Table 5). These results suggested that the dietary rabbit with low dietary energy the nutrient and energy extraction is maximized. Similar results were obtained in human by de Castro [2], who noticed that there were significant inverse relations among dietary energy level and body weight, cognitive restraint, positive relations with intake, meal size and meal frequency.

Adding mixture of medicinal plants at 1.5% level showed insignificant improvement in the final body weight, total body weight gain, average daily gain (g) and feed intakes of DM, CP, DCP, TDN and DE compared to

Table 5: Main effects of energy and supplementation levels on growth performance of the experimental groups

	Experimental diets					
	Energy levels			Supplementation		
Item	100%	90%	SEM	0%	1.5%	SEM
Initial weight, g	657.00	656.00	33.30	657.00	657.00	33.30
Final weight, g	2246.00	2919.00	54.48	2279.00	2386.00	54.48
Total body weight gain, g	1589.00	1763.00	59.21	1622.00	1729.00	59.21
Duration period (days)	56.00	56.00	--	56.00	56.00	--
Average daily gain (ADG), g	28.38	31.48	1.06	28.96	30.88	1.06
Feed intake as:						
Dry matter (DM), g/h/d	119.50	121.40	1.62	121.40	119.50	1.62
Crude protein (CP), g/h/d	19.16	19.53	0.26	19.48	19.21	0.26
Digestible crude protein (DCP), g/h/d	14.26^{b}	15.73^{a}	0.29	14.80	15.19	0.29
Total digestible nutrient (TDN), g/h/d	81.61^{b}	87.19^{a}	1.38	83.75	85.05	1.38
Digestible energy (DE), Kcal/h/d	299.9^{a}	273.5^{b}	5.10	289.10	284.30	5.10
Feed conversion (g intake/g gain) of						
Dry matter	4.23^{b}	3.86^{a}	0.09	4.21^{b}	3.87^{a}	0.09
Crude protein	0.68^{b}	0.62^{a}	0.01	0.67^{b}	0.62^{a}	0.01
Digestible crude protein	0.51	0.50	0.01	0.51	0.49	0.01
Total digestible nutrient	2.89	2.77	0.05	2.90^{b}	2.75^{a}	0.05
Digestible energy, (Kcal intake/g gain)	10.59^{b}	8.69^{a}	0.30	10.06^{b}	9.22^{a}	0.30

a and b: Means in the same row within each treatment having different superscripts differ significantly ($P<0.05$)

SEM, standard error of the mean

Table 6: Effect of interactions between energy and supplementation levels on growth performance of the experimental groups

	Experimental diets				
	100% Energy requirements		90% Energy requirements		
Item	G_1	G_2	G_3	G_4	SEM
Initial weight, g	655	660	659	653	33.30
Final weight, g	2173	2319	2385	2453	54.48
Total body weight gain, g	1518	1659	1726	1800	59.21
Duration period (days)	56	56	56	56	--
Average daily gain (ADG), g	27.11	29.63	30.82	32.14	1.06
Feed intake as:					
Dry matter (DM), g/h/d	123	116	120	123	1.62
Crude protein (CP), g/h/d	19.69	18.62	19.26	19.79	0.26
Digestible crude protein (DCP), g/h/d	14.50^{b}	14.01^{b}	15.10^{b}	16.35^{a}	0.29
Total digestible nutrient (TDN), g/h/d	83.14^{ab}	80.09^{b}	84.36^{ab}	90.02^{a}	1.38
Digestible energy (DE), Kcal/h/d	308^{a}	291^{ab}	270^{b}	277^{b}	5.10
Feed conversion (g intake/ g gain) of					
Dry matter	4.54^{b}	3.91^{a}	3.89^{a}	3.83^{a}	0.09
Crude protein	0.73^{b}	0.63^{a}	0.62^{a}	0.62^{a}	0.01
Digestible crude protein	0.53^{b}	0.47^{a}	0.49^{a}	0.51^{ab}	0.01
Total digestible nutrient	3.07^{b}	2.70^{a}	2.74^{a}	2.80^{a}	0.05
Digestible energy, (Kcal intake/ g gain)	11.36^{c}	9.82^{b}	8.76^{a}	8.62^{a}	0.30

a, b and c: Means in the same row having different superscripts differ significantly ($P<0.05$)

SEM, standard error of the mean

the control (Table 5). However, addition of 1.5% of medicinal plants mixture significantly ($P<0.05$) improved feed conversion (g intake /g gain) of DM, CP, DCP, TDN and DE (Kcal intake /g gain), respectively, compared to its control group. These results may be due to the high level of beta-carotene in sweet basil. Similar result showed by Akhtar and Munir [33] who reported that *Ocimum basilicum* L. contained the high levels of beta-carotene and beta-cryptoxanthin which transferred to micelles after digestion. On the other hand, may be due to gastroprotective effect of black seeds. Kanter *et al.* [34] noticed that *Nigella sativa* L. could partly protect gastric mucosa from acute alcohol-induced mucosal injury, due to their antiperoxidative, antioxidant and antihistaminic effects. There were no interactions between energy and additives levels on rabbit performance (Table 6).

Table 7: Main effects of energy and supplementation levels on carcass characteristics of the experimental groups

	Experimental diets					
	Energy levels			Supplementation		
Item	100%	90%	SEM	0%	1.5%	SEM
Slaughter weight (SW), g	2261	2260	59.52	2248	2273	59.52
Inedible offal's*, g	370	316	36.15	353	333	36.15
Head, g	121	126	2.43	127	120	2.43
Digestive tract						
Full, g	381	368	16.75	395	354	16.75
Empty, g	178	173	7.82	185	166	7.82
Contents	202	195	8.93	210	188	8.93
Empty body weight, g (EBW)	2059	2065	52.50	2039	2085	52.50
Edible offal's (Giblets)**						
Liver	86.50	89.00	3.80	90.50	85.00	3.80
Heart	8.50	7.50	0.51	8.50	7.50	0.51
Kidneys	19.00	18.50	0.69	17.50	20.000	0.69
Testes	9.00	9.00	0.37	9.00	9.00	0.37
Spleen	2.00	2.00	---	2.00	2.00	---
Lungs	14.50	15.00	0.54	14.50	15.00	0.54
Total edible offal's	139.5	141.0	4.71	142.0	138.5	4.71
Carcass weight (CW_1), g	1250	1310	40.18	1233	1328	40.18
Carcass weight including giblets (CW_2)	1390	1451	41.46	1375	1466	41.46
Carcass weight including giblets and head (CW_3)	1511	1577	42.17	15.01	1586	42.17
Dressing percentages (DP)%						
DP^1 (CW_1/ SW)	55.26	57.98	1.44	54.82	58.42	1.44
DP^2 (CW_1/ EBW)	60.67	63.46	1.55	60.45	63.68	1.55
DP^3 (CW_2/ EBW)	67.45	70.28	1.50	67.41	70.33	1.50
DP^4 (CW_3/ EBW)	73.33	76.37	1.51	73.61	76.09	1.51
Carcass cuts						
Fore part, g	373	391	11.88	367	396	11.88
Middle part, g	395	414	12.54	390	420	12.54
Hind part, g	382	405	15.77	475	512	15.77
Chemical analysis of the 9,10 and 11th ribs						
Dry matter (DM)	28.47	28.58	0.93	27.97	29.07	0.93
Crude protein (CP)	69.05	61.16	2.67	67.44	62.77	2.67
Ether extract (EE)	26.31	31.19	2.69	26.51	30.99	2.69
Ash	4.64^b	7.65^a	0.68	6.05	6.24	0.68

a and b: Means in the same row within each treatment having different superscripts differ significantly (P<0.05)

SEM, standard error of the mean

* Inedible offal's: included fur, ears, legs and blood

** Edible offal's (Giblets): included liver, heart, kidneys, testes spleen and lungs

Empty body weight (EBW) = slaughter weight – digestive tract contents

The 90% of energy requirements with 1.5% additives mixture (G_4) recorded the best values of final body weight, body weight gain, daily weigh gain and feed conversion.

Carcass Characteristics of the Experimental Group: Both the energy and supplementation levels had no significant (P>0.05) effect on slaughter weight, inedible offal's, digestive tract, empty body weight, edible offal's (giblets), carcass weight, dressing percentages, carcass cuts and chemical analysis of the best 9,10 and 11th ribs (Table 7). There were no significant interaction between energy and additives mixture levels on all carcass parameters (Table 8). These results agreed with those obtained by Durrani *et al.* [35] who noticed that, broiler receiving black seed in the feed had a non significant effect on gizzard, intestine and weight of abdominal fat. These results on one hand may be attributed to the dietary energy under tropical conditions; rabbits seem to store a considerable proportion of absorbed energy in the internal fat depots rather than in the carcass. Similar results in adult Pelibuey ewes observed by Chay-Canul *et al.* [36]. On the other, hand may be attributed to the effective components of black seeds in the regulation of the appetite feed intake, storage patterns of adipose tissue, or development of insulin resistance.

Table 8: Effect of interactions between energy and supplementation levels on carcass characteristics of the experimental groups.

	Experimental diets				
	100% Energy requirements		90% Energy requirements		
Item	G_1	G_2	G_3	G_4	SEM
Slaughter weight (SW), g	2242	2280	2254	2265	59.52
Inedible offal's*, g	410	330	295	336	36.15
Head, g	121	121	132	119	2.43
Digestive tract					
Full, g	406	355	383	352	16.75
Empty, g	190	166	180	165	7.82
Contents	216	189	203	187	8.93
Empty body weight, g (EBW)	2026	2091	2051	2078	52.50
Edible offal's (Giblets)**					
Liver	91.00	82.00	90.00	88.00	3.80
Heart	10.00^{a}	7.00^{b}	7.00^{b}	8.00^{ab}	0.51
Kidneys	18.00	20.00	17.00	20.00	0.69
Testes	9.00	9.00	9.00	9.00	0.37
Spleen	2.00	2.00	2.00	2.00	---
Lungs	15.00	14.00	14.00	16.00	0.54
Total edible offal's	145.0	134.0	139.0	143.0	4.71
Carcass weight (CW_1), g	1160	1340	1305	1315	40.18
Carcass weight including giblets (CW_2)	1305	1474	1444	1458	41.46
Carcass weight including giblets and head (CW_3)	1426	1595	1576	1577	42.17
Dressing percentages (DP)%					
DP^1 (CW_1/ SW)	51.74	58.77	57.90	58.06	1.44
DP^2 (CW_1/ EBW)	57.26	64.08	63.63	63.28	1.55
DP^3 (CW_2/ EBW)	64.41	70.49	70.40	70.16	1.50
DP^4 (CW_3/ EBW)	70.38	76.28	76.84	75.89	1.51
Carcass cuts					
Fore part, g	346	399	389	392	11.88
Middle part, g	367	423	412	416	12.54
Hind part, g	447	518	504	507	15.77
Chemical analysis of the 9,10 and 11th ribs					
Dry matter (DM)	27.54	29.39	28.41	28.75	0.93
Crude protein (CP)	73.34	64.75	61.54	60.78	2.67
Ether extract (EE)	22.71	29.92	30.31	32.07	2.69
Ash	3.95	5.33	8.15	7.15	0.68

a and b: Means in the same row having different superscripts differ significantly ($P<0.05$)

SEM, standard error of the mean

* Inedible offal's: included fur, ears, legs and blood

** Edible offal's (Giblets): included liver, heart, kidneys, testes spleen and lungs

Empty body weight (EBW) = slaughter weight – digestive tract contents

Similar results noticed by Benhaddou-Andaloussi *et al.* [12] who pointed that the potential uses of *Nigella sativa* L. or compounds derived thereof, against obesity and the metabolic syndrome which my be due to the alkaloids and saponins in *Nigella sativa* L. as noticed by Butt and Sultan [14].

Economical Evaluation: The profitability of using additives mixture depends upon the price of tested diets and the growth performance of rabbits (Table 9). The cost of one kg feed, (LE) was decreased by 11.65% and 3.30% in G_3 and G_4, respectively, compared to control diet G_1. These results were due to the decreased energy level by 10% as quantity under this study which considered the effective expensive parameter in the diet. The 90% of energy requirements regardless the feed additives showed the high values of net revenue, economical efficiency and relative economic efficiency as well as the low of feed

Table 9: Economical evaluation of the experimental groups

Item	Experimental diets			
	100% Energy requirements		90% Energy requirements	
	G_1	G_2	G_3	G_4
Marketing weight, Kg	2.173	2.319	2.385	2.453
Feed consumed (as it is) kg/ rabbit	7.560	7.056	7.280	7.448
Costing of one kg feed, (LE)[1]	2.093	2.248	1.851	2.024
Total feed cost, (LE)	15.82	15.86	13.48	15.07
Management/ Rabbit, (LE)[2]	4	4	4	4
Total cost, (LE)[3]	34.82	34.86	32.48	34.07
Total revenue, (LE)[4]	47.81	51.02	52.47	53.97
Net revenue	12.99	16.16	19.99	19.90
Economical efficiency[5]	0.3731	0.4636	0.6155	0.5841
Relative economic efficiency[6]	100	124.3	165.0	156.6
Feed cost / kg LBW (LE)[7]	7.28	6.84	5.65	6.14

[1]Based on prices of year 2011

[2]Include medication, vaccines, sanitation and workers

[3]include the feed cost of experimental rabbit which was LE 15/ rabbit + management

[4]Body weight x price of one kg at selling which was LE 22

[5]net revenue per unit of total cost

[6]Assuming that the relative economic efficiency of control diet equal 100

[7]Feed cost/kg LBW = feed intake * price of kg / Live weight

LE = Egyptian pound equals 0.18 American dollars approximately

cost/ kg live body weight (LE). These high values were due to the additives mixture role in raising the ration value by improving the utilization of low energy diet as our hypothesis via enhancing pancreatic insulin sensitivity that makes amylase (alpha amylase) to hydrolyse dietary starch into di-saccharides and tri-saccharides which are converted by diastase enzyme to glucose to supply the body with energy as reported by Hill and Needham [37]. The 90% of energy level (G_3) diet recorded the highest value of relative economic efficiency (165 %) and the lowest value of feed cost/ kg live body weight (5.65 LE). The second highest value are noticed by the treatment of the 90% energy level with 1.5% additives mixture (G_4) which recorded (156.6%) relative economic efficiency and (6.14 LE) for feed cost/ kg live body weight. These results are in agreement with those recorded by Ibrahim *et al.* [38], who found the same results when rabbits fed two different levels of energy supplemented with herbs mixture of *Artemisia herba-alba, Matricaria recutita* L. *and Chrysanthemum coronarium.*

CONCLUSION

The 90% of energy level requirements with 1.5 % mixture of *Ocimum basilicum* L. and *Nigella sativa* L. as feed additives recorded the best digestibility coefficients of OM, CP, EE, NFE and nutritive values of TDN and DCP. There were significant ($P<0.05$) interactions between the energy and additives mixture levels on DM, OM, CP, EE and NFE digestibility coefficient and DCP value. The 90% energy with 1.5% additives mixture (G_4) recorded the best values of final body weight, body weight gain and feed conversion. Our data suggest that the mixture of *Ocimum basilicum* L. and *Nigella sativa* L. can be considered as growth promoter that is effective for achieve maximum benefit from the low energy diet.

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