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EFFECT OF USING ONION SEEDAND MORINGA SEED OIL ON PRODUCTIVEAND PHYSIOLOGICAL PERFORMANCE OF GROWINGRABBITS UNDER HOT CLIMATE CONDITIONS.

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A completely random experiment was conducted to evaluate onion and moringa seed oils or their mixture under climate summer conditions on growth performance, carcass traits, rectal temperature, respiration rate, blood biochemistry, digestibility coefficients, and economic efficiency of growing rabbits, from June, to August, 2015.A total of 108 Bauscat rabbits, weaned at 5 weeks of age with an average initial body weight of 528.80 ± 1.49,g were randomly distributed into four experimental treatments (27 rabbits/ each) and each treatment was sub-divided four 3 replicates of nine rabbits each. Rabbits were fed the basal diet either un supplemented or supplemented with 1g onion seed oil/Kg diet, or 1gmoringaseed oil/Kg diet and their combination 0.5 g onion seed oil + 0.5 g moringa oil/Kg diet throughout the whole experimental period which lasted for 3 months. The experimental basal diet was isonitrogenous (CP=17.0 %) and isocaloric (2536 Kcal/Kg DE).

Results obtained showed that*the percentages of total saturated fatty acids (TSFA) in moringa oil (23.88%) were higher than in onion oil (8.71%). Moringa oil contains a high level of monounsaturated fatty acids (MUSFAs) especially oleic acid (71.43%) than onion oil (8.71%). Total unsaturated fatty acids (TUSFAs), especially PUSFAs (linoleic) in onion oil were higher than that in moringa oil .Under the high ambient temperatures final body weight, daily gain and total gain of growing rabbits were significantly ($P \leq 0.05$) increased and feed conversion values were improved with dietary supplementation with either moringa oil or onion oil and their mixture compared with those of the control group from 5-17 weeks of age. However, feed intake and viability rate were not significantly influenced by experimental dietary*

supplementations during the experimental periods. Hot carcass weight and dressing % were significantly (P≤0.05) higher for growing rabbits fed diets supplemented with onion oil as compared with those fed the control diet. Dietary either onion or moringa oil and their mixture ameliorated some of the adverse effects of heat stress on rectal temperature and respiration rate. Serum total protein (TP) and globulin (Glb), digestibility coefficients of CP and EE were significantly increased (P ≤ 0.05) while, serum total lipids, cholesterol and glucose concentrations were significantly decreased (P ≤ 0.05) due to dietary onion oil only or with moringa oil as compared with the control group. Onion oil plus moringa oil fed group recorded the highest (P ≤ 0.05) net return and best economical efficiency followed by those fed onion oil treatments as compared with the control group.

***In conclusion**, results of the experiment concluded that addition of 1g/Kg diet mixture of onion and moringa seed enhanced growth performance carcass weight and digestibility coefficient of CP, EE and reduced rectal temperature and respiration rate when growing rabbits were subjected to heat stress.*

Keywords: Onion seed oil, moringa seed oils growth, thermo-respiratory reaction, serum constituents, digestibility, and rabbits.

Climate change, especially the expected global rise in surface temperature, has constituted a serious hazard for livestock production (Dangi *et al.*, 2016). High ambient temperatures are a major stress factor for rabbits due to their dense fur and few functional sweat glands, which greatly hinder heat loss (Marai *et al.,* 2002). Heat load also causes increased oxygen-derived free radicals, which create a condition of oxidative stress (Sahin&Kucuk, 2003). Heat stress can evoke multiple biological and physiological responses that can become fatal if not appropriately controlled (Ducray *et al.,* 2016). High environmental temperature induces physiological stress in rabbits leading to production losses (Marai *et al.,* 2001). Also because of poor thermoregulation ability of rabbits, some consequences of heat stress affect digestive system functions, with impaired appetite, growth and feed conversion, with increased disease incidence (Bani*et al.*, 2010).

Medicinal plant oils such as onion and moringa oils are rich in factors interest in disease prevention and health promotion. These beneficial factors include monounsaturated and polyunsaturated fatty acids, tocopherols, carotenoids and antioxidative phenolic compounds. Also, these plant oils were found to contain natural substances that promote health and ameliorate the body

condition against the stress (Shehata *et al.,* 2011 and Ezzat and Saher, 2012). Previous researches had found that onions and onion oil possess several biological properties, such as antimicrobial (Benkeblia, 2004), antidiabetic (Wu and Xu 2014),antioxidant activities (Ye *et al.,* 2013) and antimutagenic (Singh *et al.,*2009). And the most medicinally significant components of onion oil are the organ sulfur-containing compounds (Kyung, 2012), which are reactive, volatile, odor producing and lachrymatory(Block *et al.,* 1992). Onion oil containing sulphur compounds such as dialkyl disulfides and their oxidized thiols compounds has been reported to have an antioxidative effect against the oxidative damage caused by nicotine in experimental animals (Helen *et al.,* 2000). Moringa seeds contain a high percentage of sweet oil (30–40% of the seed weight) and contain around 76% polyunsaturated fatty acids which can control cholesterol. Seeds of moringa oleifera are a source of protein, iron, calcium, ascorbic acid vitamin A and antioxidant compounds such as carotenoids, flavonoids, vitamin E and phenolics(Sultana, and Anwar 2008). The presence of vitamins and minerals benefit in improving the immune system and cure a myriad of diseases (Gopalakrishnan *et al.,* 2016). Various amino acids, such as Arg, His, Lys, Trp, Phe, Thr, Leu, Met, Ile, Val are present in moringa oleifera leaves (Gopalakrishnan *et al.,* 2016). Moringa seeds oil contains all the fatty acids as in olive oil, except linoleic acid (Morton, 1991). Moringa seeds oil is known for its Anti-bacterial, anti-inflammatory, antihypertensive, antiepileptic, antioxidant, antifungal, antipyretic and anticancer medicinal properties(Sultana *et al.,* 2014).

Therefore, the present study was carried out to determine the effect of adding 1.0 g/Kg diet of either onion or moringa seeds oils or combination of both oils to commercial rabbits ration on growth performance, carcass characteristics, thermo-respiratory reaction, immune response, serum constituents, nutrients digestibility of growing rabbits, under Egyptian summer conditions.

MATERIALS AND METHODS

The present study was carried out in Inshas Poultry Research Station, Animal Production Research Institute, Ministry of Agriculture, Egypt, during the period from June, to August, 2015, (the hottest months in Egypt).

A total of 108Bauscatrabbits, weaned at 5 weeks of age with an average initial body weight of 528.80 ± 1.49,g were randomly distributed into four experimental treatments (27 rabbits/ each) and each treatment was sub-divided four 3 replicates of nine rabbits each. The basal experimental diet was

formulated to be *isonitrogenous* (17.07% CP) and *isocaloric* (2536Kcal DE / Kg diet), and to satisfy the nutrient requirements of growing rabbits according to the Agriculture Ministry Decree recommendations (1996). The feed ingredients and chemical composition of the experimental basal diet are presented in Table (1). Rabbits were fed the basal diet either unsupplemented (control) or supplemented with 1g onion seed oil/Kg diet, or 1g/Kg diet moringa seed oil and their combination 0.5 g onion seed oil + 0.5 g moringa oil/Kg diet throughout the whole experimental period which lasted for 3 months. Rabbits were housed (three rabbits together) in stainless steel cages (60 x 50 x 40 cm) provided with feeders and automatic nipple drinkers. The building used for carrying the experiments was open-air, naturally ventilated and provided with sided electric fans. All rabbits were kept under the same managerial, hygienic and environmental conditions. Diets were offered to rabbits *ad libitum* and fresh water was available all the time. All the experimental rabbits were healthy and clinically free from internal and external parasites. The rabbits were individually weighed at the beginning of the experiment and then at weekly intervals. Weighing was carried out before offering the morning meal (once a week) at 8.00 h and the live body gain weight was calculated weekly. Feed consumption and feed conversion values were recorded.

Samples of the different oils were taken to determine the fatty acids composition by using the gas-liquid chromatography (Model: variant 3300; column ov. 101; temperatures of the column, injector and detector were 200, 280 and 240 °C, respectively). Fatty acids were identified by composition of retention times with standers and expressed as percentages of fatty acid methyl ester distribution. Percentages of identified fatty acids were determined by using of digital "Ushikataplani meter (Model DIGI PLAN 220P). The analysis of fatty acids was performed in the Laboratory of Department of Natural Products Chemistry, National Research Center, Dokki, Cairo, Egypt (Table 2).

The average minimum and maximum ambient temperatures during summer season ranged between 24.51 and 35.21 ^{0}C, relative humidity ranged from 19.85 to 81.19 % and temperature-humidity index (THI) ranged from 22.00 to 34.00 % under Inshas, Sharkia Province, Egypt as shown in Table 3. THI was estimated according to the formula by Marai *et al.* (2000) as follows:

$$THI = db\ ^{o}C - \{(0.31 - 0.31\ RH)\ (db\ ^{o}C - 14.4)\},$$

Where db ^{o}C = bulb temperature in Celsius and RH= RH%/100. The values obtained indicate the following: <22.2 = absence of heat stress; 22.2 to <23.3 = moderate heat stress: 23.3 to <25.6 = severe heat stress and 25.6 and more = extreme severe heat stress.

Table 1. Feed ingredients and chemical composition of the experimental basal diet.

Ingredients	**%**	**Calculated analysis[2] (DM, %)**	**%**
Clover hay (12.%CP)	27.80	**Crude protein (CP)**	17.07
Barley grain	21.40	**Ether extract (EE)**	2.47
Wheat bran	21.00	**Digestible energy (Kcal/Kg)[3]**	2536
Soybean meal (44%CP)	16.00	**Crude fiber (CF)**	13.08
Molasses	3.00	**Calcium**	0.9
Corn	8.50	**Total phosphorus**	0.65
Dicalcium phosphate	1.05	**Methionine**	0.43
Limestone	0.43	**Lysine**	0.72
DL-Methionine	0.22	**Meth+Cys**	0.67
Vit. and Min. Premix[1]	0.40	**Available P**	0.36
NaCl	0.20		
Total	**100.00**		

(1) **Each 3 kg vitamin and mineral premix provides**: Vit. A 12000000 IU, Vit. D_3 750000 IU, Vit. E 10000 mg, Vit. K 2000 mg, Biotine 50 mg, Folic acid 1000 mg, Choline choloride 500 mg, Selenium 100 mg, Manganese 25 g, Zinc 50 mg, Fe 60 mg, Cu 2.5 mg, Co 6 mg, Iodine 1 g and carrier $CaCo^3$ to 3000 gm.

(2) According to Feed Composition Tables for Animal Poultry Feedstuffs Used in Egypt (2001).

(3) Calculated according to De Blas and Mateos (1998).

Table 2. Fatty acids composition of moringa and onion oils

Type of fatty acids *:*	**Carbon atoms**	**Onion oil**	**Moringa oil**
Myrstic	14:00	0.11	0.14
Palmatic	16:00	6.12	7.71
Stearic	18:00	1.98	6.42
Arachdic	20:00	0.31	3.23
Behenic	22:00	0.19	6.38
Total saturated fatty acids (TSFA), %:		8.71	23.88
Palmitoleic	16:01	0.25	1.57
Oleic	18:01	24.4	71.43
Eicosaenoic	20:01	0.38	2.18
Brassidic acid	22:01	0.06	0.13
Monounsaturated fatty acids (MUSFAs), %		25.09	75.31
Linoleic	18:02	66.04	0.63
Linolenic	18:03	0.16	0.18
Polyunsaturated fatty acids (PUSFAs), %		66.2	0.81
Total unsaturated fatty acids (TUSFAs), %		91.29	76.12
Total fatty acids (TFAs), %		**100**	**100**

Table (3). Means of air temperature, relative humidity (RH) and temperature-humidity index (THI) during summer season according to Egyptian Meteorological Authority.

Summer months	Air temperature (^{o}C)		Relative humidity (%)		Temperature-humidity index (THI)	
	Min*	Max**	Min*	Max**	Min*	Max**
June	22.4±0.26	33.17±0.54	18.97±1.05	77.4±1.1	20.39	31.85
July	24.13±0.25	35.36±0.4	19.33±1.2	85.23±1.81	21.70	34.40
August	27±0.3	37.1±0.42	21.26±1.6	80.94±1.56	23.92	35.76
Averages	**24.51±0.27**	**35.21±0.45**	**19.85±1.28**	**81.19±1.49**	**22.00**	**34.00**

Respiration rate and rectal temperature were recorded once a week at 9.00- 11.00 h for each animal. The respiration rate was recorded by counting the flank movements per minute by using a hand counter. The rectal temperature was measured by using a clinical thermometer inserted into the rectum for two minutes at depth of 4 cm.

At the end of the experimental period, four rabbits from each treatment were randomly chosen, individually weighed and slaughtered. After complete bleeding, pelt and viscera were removed and then carcass and giblets (liver, heart, and kidneys) were weighed. Dressing percentage included relative weights of carcass, giblets and head were estimated according to Steven *et al.*, (1981).

At the last week of the experiment, digestibility trial was conducted using five rabbits from each treatment group, housed individually in metabolism cages that allow feces and urine separation. The preliminary period continued for 7 days and the collection period extended for 5 days. Feed and feces were daily recorded quantitatively and chemically analyzed according to AOAC (2000).

Blood samples were collected at slaughter from each rabbit to determine blood components. Serum was separated by centrifugation at 5900g for 10 min and frozen at -20 ^{0}C. until analysis. Blood serum total proteins (TP), albumin (ALB), total lipids (TL), total cholesterol (TCH) and glucose (GLG) were calorimetrically determined using commercial kits purchased from Bio-Diagnostic, Egypt, following the same steps as described by the manufactures. However, globulin (GLB) was calculated by the difference between total proteins and albumin. Serum was also analyzed for triodothyronine (T3) and thyroxine (T4) hormone levels, Radioimmunoassay (RIA) kits (diagnostic products corporation, Los Angeles, USA) were used for the assays.

The economic efficiency (EEf) of the experimental diets was estimated depending on feeding cost and price of meat. Performance index (PI) was calculated according to North (1981) as follows:

PI = [Live body weight (Kg) / Feed conversion ratio] × 100.

The data were subjected to one- way statistical analysis applying SAS program (SAS, 2003) using the General Liner Model Program (GLMP). Significant differences among treatment means were separated by Duncan's new multiple-range test (Duncan, 1955).

RESULTS AND DISCUSSION

1. ***Fatty acids composition of onion and Moringa oils:***

Results presented in Table (2) showed that the percentages of TSFA in moringa oil (23.88%) were higher than in onion oil (8.71%). Moringa oil contains a high level of monounsaturated fatty acids especially oleic acid (71.43%) than Onion oil (8.71%).TUSFA, especially PUSFAs (linoleic) in onion oil were higher than that in moringa oil. The biome chemical functions of PUSFAs are currently under extensive research including their influence/impact on cellular signaling and membrane structure, gene expression and prostaglandin biosynthesis and nervous, endocrine and immune system mediations. These results may indicate that either onion oil or moringa oil are good sources for the essential fatty acids in rabbit diets. Also, the experimental diets containing onion and moringa oils gave the satisfied contents of MUSFAs and PUSFAs.

2. ***Growth performance:***

Results of Table (4) indicated that dietary supplementation with either onion oil or moringa oil and their mixture had a positive effect on growth performance of growing rabbits during the period of high ambient temperatures. Under the high ambient temperatures final body weight, daily body gain and growing rabbits were significantly ($P \leq 0.05$) increased and feed conversion values were improved with dietary supplementation with either moringa oil or onion oil and their mixture compared with those of the control group. However, feed intake and viability rate were not significantly influenced by experimental dietary supplementations during the experimental periods. It is noticed that the best values of final body weight, daily gain, total gain and feed conversion of growing rabbits were recorded with dietary supplementation with onion plus moringa oils compared with the other treatments. These improving in growth performance may be attributed to the properties of these materials that act as antibacterial, antiprotozoal, antifungal and as antioxidant these results are in agreement with those of El-Hindawy *et*

Table 4. Effect of dietary onion oil or moringa oil and their mixtureon growth performance of growing rabbits

Items	Control	Onion oil	Moringa oil	Onion oil +Moringa oil	Sig.
Initial weight, g	526.67 ±2.86	527.97 ±3.62	529.82 ±2.85	530.75 ±2.91	NS
Final weight, g	1981.96 ±30.47^{b}	2048.96 ±30.48^{ab}	2092.71 ±29.5^{a}	2100.40 ±27.43^{a}	*
Daily feed intake, g	86.43 ±0.96	85.43 ±0.99	85.33 ±0.85	84.94 ±0.94	NS
Daily gain, g	16.14 ±0.34^{b}	16.94 ±0.34^{ab}	17.38 ±0.33^{a}	17.46 ±0.31^{a}	*
Total gain, g	1452.4 ±30.4^{b}	1523.96 ±29.94^{ab}	1564.17 ±29.23^{a}	1570.8 ±27.30^{a}	*
Feed conversion	5.42 ±0.14^{a}	5.11 ±0.14^{ab}	4.97 ±0.14^{b}	4.92 ±0.13^{b}	*
Viability % (5 to18 wks)	81.48	85.19	85.19	88.89	NS

Means having different letters within the same row are significantly (P≤0.05) different.
NS= Not significant. *=P≤0.05

Table 5. Effect of dietary onion oil or moringa oil and their mixtureon carcass traits.

Items	Control	Onion oil	Moringa oil	Onion oil + Moringa oil	Sig.
Hot carcass weight (%)	52.25 ±0.85^{b}	56.15 ±0.67^{a}	53.86 ±0.95^{ab}	54.79 ±0.91^{ab}	*
Liver (%)	3.54 ±0.09	3.34 ±0.16	3.30 ±0.23	3.15 ±0.13	NS
Kidney (%)	0.74 ±0.04	0.77 ±0.02	0.75 ±0.03	0.76 ±0.04	NS
Heart (%)	0.36 ±0.03	0.39 ±0.02	0.38 ±0.02	0.38 ±0.02	NS
Giblets (%)	4.63 ±0.08	4.49 ±0.18	4.42 ±0.23	4.29 ±0.12	NS
Total non-carcass fat (%)	1.75 ±0.15	1.99 ±0.09	1.88 ±0.13	1.97 ±0.12	NS
Dressing (%)	56.88 ±0.81^{b}	60.64 ±0.69^{a}	58.28 ±0.87^{ab}	59.07 ±0.82^{ab}	*

Means having different letters within the same row are significantly (P≤0.05) different.
NS= Not significant. *=P≤0.05

al.(2003) who found a significant (P≤0.05) improvement in growth performance parameters of rabbits fed onion seed. Also, Abou El-Wafa *et al*. (2002) reported that live body weight; daily weight gain and feed conversion values were significantly improved by adding onion oil to rabbits diet. On the

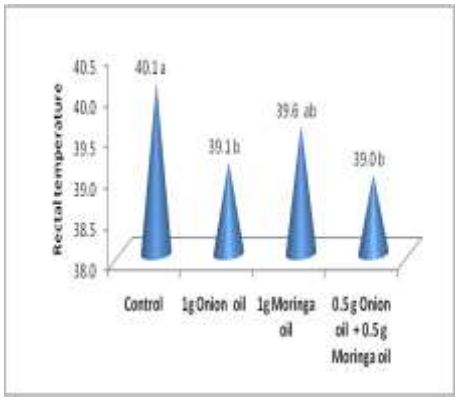
other hand, Makkar and Becker (1996) reported that the increase in body weight and weight gain of the rabbits fed moringa oil may be due to that linoleic acid is a precursor of prostaglandins which plays an important role in promoting hypothalamic release of growth hormone releasing factor. El-Kholy *et al.* (2018a) revealed that moringa leaves extract at its highest levels (90 mL aqueous moringa oleifera leaf extracts/L drinking water) significantly ($P \leq 0.05$) increased the final body weight, daily weight gain and improved feed conversion. El-Badawi *et al.* (2014) suggested that moringadry leaves at level (0.15 or 0.30%) could use as a natural growth promoter. In the same time, certain adverse effect could be due to the high content of some phytochemical compounds (phenols, coumarins, alkaloids and tannins), or might be due to the fact that moringa oleifera is rich in amino acids, vitamins and minerals particularly iron (Faye *et al.,* 2011).

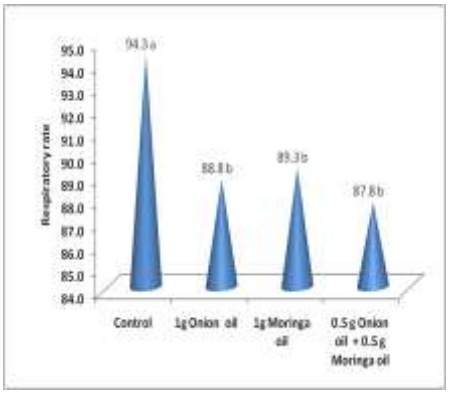
3. *Carcass traits:*

Results in Table (5) showed that hot carcass weight and dressing percentage were significantly ($P \leq 0.05$) higher for rabbits fed diets supplemented with onion oil as compared with those fed the control diet. Conversed, dietary supplementation had no significant effects on percentages of liver, kidneys, heart, giblets and total non-carcass fat. These results are in corresponding with the previous reports of El-Hindawy *et al.* (2003) who found that the dressing percentage of warm carcass (hind limb, trunk, liver and heart) were significantly ($P \leq 0.05$) improved for rabbits fed 4, 8, 12 and 16 % onion seed. Also, Abou El-Wafa *et al.* (2002) observed significant effect on carcass characteristics due to onion supplementation. El-Badawi *et al.* (2014) reported that inclusion of moringa leaves by levels of 0.15 or 0.30% in the diets of broilers and rabbits, respectively, improved hot and cold carcass weight, dressing percentage and lean meat yield. Also, Helal *et al.*(2017) revealed that slaughter weight, empty body weight, dressing percentage, total edible parts, non-edible offals, trimmings and protein or fat contents of meat were not affected significantly ($P > 0.05$)for rabbits fed 1% moringa leaves and control groups experimental diets.

4. *Some physiological parameters:*

Results in Figures (1 and 2) showed that rectal temperature and respiration rate were significantly ($P \leq 0.05$) decreased for growing rabbits fed diets supplemented with onion oil plus moringa oil as compared with those fed the control diet. Interestingly, dietary supplementation ameliorated some of the adverse effects of heat stress on rectal temperature and respiration rate. In hot period, rabbits have difficulty in eliminating body heat due to their unfunctional sweat glands (Marai *et al.*, 1996). Different physical and physiological methods have been used to alleviate the heat load in heat stressed animals. It is well





Figures (1 and 2): Effect of dietary onion oil or moringa oil and their mixture on rectal temperature (Fig 1) and respiratory rate (Fig 2) of growing rabbits.

known that body temperature and respiration rate are increased following exposure to high (>30°C) environmental temperatures (Habeeb *et al*., 1997; Marai *et al* 2001, 2002). In this respect, due to its ability in reducing body temperature and consequently respiration rate, onion oil or *moringa* oil and their mixture might be supplemented to the growing rabbit diets during hypothermic stress in order to alleviate some of the adverse effects of heat stress. From another point of view, the increase in body temperature due to the exposure to ambient temperatures above the thermal comfort zone has a negative impact on animal performance via decreasing feed intake, body weight gain and the resistance to disease and increasing the feed conversion ratio (Habeeb *et al*., 1997and Marai *et al*. 2001). Since onion oil or moringa oil and their mixture had a significant effect in reducing body temperature which consequently participated in enhancing feed intake and body weights as well as carcass yield (Tables 4 and 5).Ezzat and Saher (2012) found that dietary either rocket or onion oil and their mixture of growing rabbits ameliorated some of the adverse effects of heat stress on immune response, rectal temperature and respiration rate. It could be assumed that dietary onion oil or moringa oil and their mixture supplementation might help to overcome the negative effects of heat stress on growth performance and carcass yield.

5. *Biochemical constituents of blood serum*:

Growing rabbits at the end of the experimental period received dietary moringa oil only or plus onion oil recorded significantly ($P \leq 0.05$) higher serum total protein (TP) and globulin (Glb) compared with values of rabbits fed the control diet (Table 6).The increase of Glb concentration may be an indicator to increase of immunity in rabbits since the liver will be able to synthesize enough

Table 6. Effect of dietary onion oil or moringa oil and their mixtureon blood serum constituents of growing rabbits at the end of experimental period.

Items	Control	Onion oil	Moringa oil	Onion oil +Moringa oil	Sig.
Total Protein (g/dl)	4.41±0.17[b]	4.93±0.19[a]	5.13±0.15[a]	5.19±0.12[a]	*
Albumen (g/dl)	2.62±0.14	2.71±0.1	2.55±0.08	2.85±0.19	NS
Globulin (g/dl)	1.79±0.06[b]	2.22±0.16[ab]	2.58±0.18[a]	2.34±0.17[a]	*
Total lipids (mg/dl)	384.94±16.27[a]	304.01±31.12[b]	330.8±14.9[ab]	290.81±18.5[b]	*
Cholesterol (mg/dl)	92.98±1.42[a]	88.2±1.24[b]	88.48±0.85[b]	85.94±1.61[b]	*
Glucose(mg/dl)	139.58±8.01[a]	114.43±7.17[b]	120.31±4.00[ab]	109.14±5.80[b]	*
Tri-iodothyronine (T3) (ng/ml)	1.43±0.09	1.48±0.15	1.58±0.07	1.62±0.09	NS
Thyroxine (T4) (ng/ml)	38.73±2.97	39.19±2.55	43.99±2.42	46.06±2.92	NS

Means having different letters within the same row are significantly (P≤0.05) different.
NS= Not significant. *=P≤0.05

Glb for immunologic action as mentioned by Sunmonu and Oloyede (2007). However, Glb level has been used as an indication of increased immunity and source of antibody production. The results are in agreement with those of Hussein *et al*. (2007) who found that garlic and onion oils improved serum total protein and albumin. Ezzat *et al.* (2014) illustrated that values of serum total protein and albumin were improved significantly ($P \leq 0.05$) when NZW rabbit does received mixture of moringa plus rocket oils diet followed by moringa oil and rocket oil. In the current study, the significant increase in serum total protein and albumin observed in rabbits fed dietary onion oil and moringa oil indicate the ability of these oils to stimulate the regeneration of hepatic tissue which increase protein synthesis in liver and improved the functional status of the liver cells. El-Kholy *et al.* (2018b) found that growing rabbits from the groups receiving *Moringa oleifera* leaves extract no significant differences among the experimental groups in activity of serum transaminases (AST and ALT) as compared with those from the control group. Data of Table (6) clearly indicate that total lipids, cholesterol and glucose were significantly ($P \leq 0.05$) decreased for rabbits fed diet onion oil, moringa oil or their mixture as compared with control group. Bordia *et al.* (1977) suggested that the essential oils of onion and garlic protect against experimental atherosclerosis by preventing the fall in the alpha lipoprotein fraction and by enhancing fibrinolytic activity, as well as by lowering the serum cholesterol and triglyceride levels. Mehta *et al.* (2003) showed that administration of rabbits for 120 days of moringa fruit, lowered the levels of serum cholesterol, phospholipids, triglyceride, very low density lipoprotein (VLDL), low density lipoprotein (LDL), cholesterol ratio and atherogenic index, and was

able to increased the high density lipoprotein (HDL) ratio as compared to the control group. One proposed mechanism of action is that moringa promotes gastrointestinal excretion of cholesterol. NazninAra *et al.* (2008) found lowering serum triglyceride($P \leq 0.05$) and cholesterol levels in rats fed leaves extract of moringa. El-Kholy *et al.* (2018a) found that growing rabbits received *Moringa oleifera* leaves extract had lower total lipids, triglycerides and total cholesterol as compared with those from the control group. Flavonoids and polyphenolic compounds found in moringa (Okwari *et al.*, 2013) may be caused to impulse of immune function, reduced level of cholesterol; so may be play a role in the prevention of a number of chronic diseases such as cardiovascular disease and cancer in rabbits (Yousef, 2004).

6. *Digestibility coefficients and nutritive values:*

The effects of dietary supplementation with either onion or moringa oils or mixture of them on digestibility coefficients of nutrients are presented in Table 7. The digestibility coefficient of CP and EE were affected significantly ($P \leq 0.05$) by dietary addition, being the highest for onion plus moringa oil, followed by onion oil diet.

However, digestibility of DM, OM, CF and NFE was not affected significantly by dietary addition. Also, inclusion of onion oil or combination with moringa oil in the diets of rabbits significantly ($P \leq 0.05$) improved the nutritive value expressed as DCP compared with the other treatments and control diet. These results are in agreement with those of Belewu *et al.*, (2014) who found that moringa oil in the diet of West African Dwarf Goat improved feed intake and digestibility coefficient of the animal. Also, Bassuny (1999) noticed significant ($P \leq 0.05$) increase in EE and NFE, nutritive values (TDN and DCP) with the increase of digestibility energy (DE) and CP contents in the diet. El-Badawi *et al.* (2014) reported that OM and CP digestibility's in rabbits were significantly higher in animals fed moringa supplemented rations, but the same study showed that moringa dry leaves had positive effects on digestible nitrogen and nitrogen balance.

7. *Economic efficiency:*

Data in Table (8) showed that onion oil plus moringa oil fed group recorded the highest ($P \leq 0.05$) net return and best economic efficiency followed by those fed onion oil treatments as compared with the control. These results are attributed to the high ($P \leq 0.05$) total weight gain of this treatment and better ($P \leq 0.05$) performance index.

Table 7. Digestibility coefficients of nutrients and nutritive values of experimental diets as affected by dietary supplementation of onion oil or Moringa oil and their mixture.

Items	Control	Onion oil	Moringa oil	Onion oil +Moringa oil	Sig.
Digestion coefficients (%):					
DM	65.06 ±1.10	67.45 ±1.21	67.36 ±1.08	68.26 ±1.20	NS
OM	67.33 ±0.80	69.37 ±0.79	68.40 ±0.72	69.11 ±0.79	NS
CP	66.92 ±0.45^{b}	69.34 ±0.54^{a}	68.29 ±0.64^{ab}	70.13 ±0.75^{a}	**
CF	34.15 ±1.47	32.39 ±1.39	33.68 ±1.26	33.37 ±1.53	NS
EE	77.23 ±0.98^{b}	81.83 ±1.08^{a}	80.41 ±0.72^{ab}	82.73 ±1.67^{a}	*
NFE	72.55 ±0.90	73.26 ±0.71	73.86 ±0.94	74.31 ±1.10	NS
Nutritive values (%):					
TDN	62.24 ±0.69	63.10 ±0.32	63.36 ±0.65	64.03 ±0.85	NS
DCP	11.20 ±0.08^{b}	11.61 ±0.09^{a}	11.44 ±0.11^{ab}	11.74 ±0.13^{a}	**
DEE	2756.9 ±30.48	2795.48 ±14.03	2806.72 ±28.63	2836.42 ±37.81	NS

Means having different letters within the same row are significantly (P≤0.05) different.
NS= Not significant. *=P≤0.05 **=P≤0.01.

Table 8. Effect of dietary of dietary onion oil or moringaoil and their mixture on economic efficiency of growing rabbits at the end of experimental period.

Items	Control	Onion oil	*Moringa* oil	Onion oil+ *moringa* oil	Sig.
Total feed intake (Kg)	7.78	7.68	7.69	7.64	
Price of Kg diet	2.500	2.514	2.510	2.512	
Total feed cost /rabbit (LE)	19.45	19.31	19.30	19.20	
Total weight gain (Kg)	1.45	1.56	1.52	1.57	
Price/kg live body weight (LE)	20.00	20.00	20.00	20.00	
Selling price of Kg gain rabbit **	29.05	31.28	30.48	31.42	
Net return/ rabbit (L.E)	9.60^{b}	11.98^{a}	11.18^{ab}	12.21^{a}	*
Economic efficiency(EE)	49.38^{b}	62.03^{a}	57.94^{ab}	63.62^{a}	*
Relative EE%	100.00	125.62	117.33	128.82	

$^{a, b}$ Means having different letters within the same row are significantly (P≤0.05) different .
NS= Not significant. *=P≤0.05 **=P≤0.01
¤ Economic efficiency= net return/total feed cost*100. Whereas net revenue= total return - total feed cost.
Assuming that the relative economic efficiency of the control diet equals 100.

The results of economic efficiency support those obtained by Shehata *et al*., (2011) who showed that the best economic efficiency value was recorded for rabbits fed diets supplemented with onion seed oil at the level of 1.0g/Kg diet than the other treatment groups.

In conclusion, results of the experiment concluded that addition of 1g/Kg diet mixture of onion and moringa seed enhanced growth performance carcass weight and digestibility coefficient of CP, EE and reduced rectal temperature and respiration rate when growing rabbits were subjected to heat stress.

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تأثير استخدام زيت بذور البصل وزيت بذور المورينجا على الكفاءة الإنتاجية والفسيولوجية للأرانب النامية تحت ظروف المناخ الحار

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أجريت تجربة عشوائية تامة لتقييم زيت بذور البصل والمورينجا أو خليط هذه الزيوت في ظل ظروف مناخ الصيف الحار على النمو ، وصفات الذبيحة، ودرجة حرارة المستقيم ، ومعدل التنفس، والاستجابة المناعية، وبعض مكونات الدم، ومعاملات الهضم والكفاءة الاقتصادية للأرانب النامية بداية من شهر يونيه- أغسطس ٢٠١٥.استخدم عدد ١٠٨ أرنب بوسكات

مفطومة عند عمر ٥ أسابيع متساوية تقريبا في متوسط وزن الجسم (٥٢٨.٨٠ ±١.٤٩ جم) قسمت عشوائيا إلي أربع مجموعات (٢٧ أرنب لكل منها) وكل منها يحتوى ٣ مكررات(٩ أرنب لكل مكررة) تم تغذيتها علي عليقه المقارنة (المجموعة الأولي) ، عليقه مقارنة مضاف إليها ١ جرام زيت بذور البصل/كجم عليقه (المجموعة الثانية) ، عليقه مقارنة مضاف إليها ١ جرام زيت بذور المورينجا/كجم عليقه (المجموعة الثالثة)، خليط من هذه الزيوت بمعدل ٠.٥ جرام زيت بذور البصل + ٠.٥ جرام زيت بذور المورينجا /كجم عليقة (المجموعة الرابعة) لمدة ثلاثة أشهر. وتحتوي عليقه التجارب علي ١٧.٠٧% بروتين خام ، ٢٥٣٦ كيلو كالوري/ كجم عليقة طاقة مهضومة.

أظهرت النتائج أن النسب المئوية للأحماض الدهنية المشبعة (TSFA) في زيت المورينجا (٢٣.٨٨٪) كانت أعلى من زيت البصل (٨.٧١٪). يحتوي زيت المورينجا على نسبة عالية من الأحماض الدهنية الأحادية (MUSFAs) خاصة حمض الأوليك (٧١.٤٣%) أعلي من زيت البصل (٨.٧١٪). وكان مجموع الأحماض الدهنية غير المشبعة (TUSFAs) ، وخاصة PUSFAs (لينوليك) في زيت البصل أعلى من ذلك في زيت المورينجا. ووجد أنة تحت ظروف الحرارة المحيطة العالية زاد وزن الجسم النهائي والزيادة اليومية للجسم معنويا (عندمستوي٠.٠٥) للأرانب النامية كما تحسنت الكفاءة التحويلية للغذاء لكل من مجموعه البصل والمورينجا أو هما معا بالمقارنة بمجموعه المقارنة من ٥ إلى ١٧ أسبوعًا من العمر. ومع ذلك ، لم يوجد تأثير معنوي للعلف المستهلك وحيوية الأرانب للإضافات الغذائية التجريبية خلال الفترات التجريبية.

زاد وزن الذبيحة ونسبة التصافي معنويا(عندمستوي٠.٠٥)بالنسبة للأرانب النامية التي تغذت على عليقة مضاف إليها زيت البصل مقارنه مع عليقة المقارنة. ومن الواضح أن زيت البصل أو زيت المورينجا أو الخليط بينهما تخفف التأثيرات الضارة للإجهاد الحراري علي درجة حرارة المستقيم ومعدل التنفس.ووجد أيضا أن إضافة زيت البصل فقط أو مع زيت المورينجا للعلف يزيد معنويا قيم سيرم البروتين الكلي والجلوبيولين ومعاملات هضم البروتين الخام ومستخلص الأثير(عندمستوي٠.٠٥) بينما انخفض معنويا تركيز كل من الليبيدات الكلية والكلسترول والجلوكوز بالمقارنة بمجموعه المقارنة.سجلت مجموعه زيت البصل والمورينجا معنوية اعلي عائد وأفضل كفاءة اقتصادية تتبعها مجموعه زيت البصل بالمقارنة بمجموعه المقارنة.

التوصية: توصي الدراسة بإضافة ٠.٥ جم من خليط زيت بذور البصل والمورينجا / كجم عليقه حسن أداء الصفات الإنتاجية ووزن الذبيحة ومعاملات هضم البروتين الخام ومستخلص الأثير وخفض درجة حرارة المستقيم ومعدل التنفس للأرانب النامية المراباة تحت العبء الحراري.