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IMPACT OF USING *Moringa oleifera* LEAVES MEAL IN GROWING RABBIT DIETS ON PRODUCTIVE PERFORMANCE, CARCASS TRAITS AND BLOOD BIOCHEMICAL CHANGES UNDER HEAT-STRESS CONDITIONS

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ABSTRACT: *This study examined the effects of giving Moringa oleifera leaves (MOLM) in diets on growing rabbits raised under heat-stress circumstances on growth performance, blood biochemical changes and carcass characteristics. Seventy-two weaned New Zealand White (NZW) rabbits weighing 700 ± 10 g were randomly divided into four treatment groups. The first group (control) was fed a baseline diet. Second, third, and fourth treatments were fed on diets containing 2.5, 5.0, and 7.5% of MOLM. Daily feed and water consumption were provided ad libitum. Body weight, weight gain, and feed intake were tracked as growth performance. after 8 weeks three rabbits from each treatment were randomly chosen, starved for 18 hours, and then slaughtered to evaluate carcass attributes. Blood samples were obtained to measure the biochemical blood changes, cortisol, triiodothyronine, and thyroxine levels. The results showed that the rabbits fed diets containing MOLM had significantly (P≤0.05) better body weight, body weight gain, and feed conversion ratio. Also, MOLM-fed rabbits had higher carcass weight and dressing percentage than the control group. In contrast, meals containing MOLM reduced ALT, AST, total cholesterol, and LDL-cholesterol and increased total protein, albumin, globulin, and HDL-cholesterol. in addition, the control group had the highest cortisone and lowest T3 and T4 levels.*

***Conclusively,** this study showed positive effects on growth performance, carcass characteristics, and biochemical blood indicators were seen when rabbits were fed diets containing 2.5, 5.0, or 7.5% Moringa oleifera. In addition, It may also help the animals' capacity to deal with high temperatures.*

Key-words: *Moringa Oleifera,* growth performance, blood biochemical, carcass traits, heat stress.

INTRODUCTION:

Animal protein intake has dropped in developing countries and Egypt due to the high expense of animal protein sources, while consumption of plant protein sources such as legumes has increased. These legumes lack essential amino acids such as threonine, phenylalanine, lysine, methionine, and vitamin B12 (FAO, 2012). That is why it turns out that there is no substitute for animal protein sources as a source of protein to provide these essential nutrients. Furthermore, the continuous increase in the population, which is reflected in the increased demand for animal protein (Mengesha, 2012), poses a significant threat to global food security as it increases the number of people needed for its food (Seleiman *et al.,* 2020). Consequently, the livestock industry will need to double its current output or may need to expand in order to accommodate the anticipated population growth rate (FAO, 2012). However, because of the high cost of producing animal protein from livestock, it has become necessary to provide cheap animal protein sources.

One source of protein that can help with this is rabbit meats. It is no secret that rabbit is lean fat-free white meat. Also, The protein, essential amino acids, and vitamin B content of rabbit meat are high, while the meat's cholesterol, fat, and calorie content are low. (Dorning and Harris, 2017). Furthermore, rabbits require little space for production; they have a fast rate of growth and a low cost of production (Rao *et al.,* 1977; Oyawoye and Ogunkunle, 1989; Marai *et al.,* 1999). For these reasons, rabbits are getting much attention. So it is clear that rabbits can meet the world’s demands for a low-cost protein source. There is another serious problem facing the development and expansion of rabbit production in terms of climate change and heat stress. Heat stress mainly threatens animal health and growth by exposing it to oxidative stress and inflammation. so, Heat stress is one of the most detrimental environmental pressures to global animal husbandry *(Renaudeau et al.,* 2011; Sejian *et al.,* 2018), and it is equally detrimental to rabbit productivity. Rabbits are particularly sensitive to heat stress due to their lack of functioning sweat glands (Marai *et al*., 2002).

Exposure of rabbits to heat stress "Hyperthermia" may exacerbate behavioural and physiological processes to reduce excessive body temperature (Donnelly, 2004). Dysregulation of thermal balance can arise if these processes cannot decrease the body's temperature (Zeferino *et al.,* 2013). Heat stress can change blood biochemical markers, which has numerous deleterious effects on growth performance, meat quality, and rabbit health. (Pla *et al.,* 1994; Ayyat and Marai, 1997; Marai *et al.,* 2002; Fatehi *et al.,* 2017). Heat stress has been linked to an increase in oxygen-derived free radical generation, damaging cells, dampening immunological responses, and ultimately leading to higher mortality rates (Phuoc and Jamikorn, 2017).

Some research has shown that the medicinal herb *Moringa oleifera* can help prevent and treat heat stress in animals and maintain the health management and safety of animals (Vergara-Jimenez *et al.,* 2017), exacerbated by global warming (Daba, 2016; Mall and Tripathi, 2017). *Moringa oleifera* has been exploited as a source of plant antioxidants. It is abundant in antioxidant vitamins like vitamin C and E and β-carotene (Makkar and Becker, 1996; Kidmose *et al.,* 2006; Konmy *et al.,* 2016). Moreover, the leaves of Moringa oleifera include simple sugar, carotenoids, phenolic acids, rhamnose and flavonoids (Amaglo *et al.,* 2010 and Coppin *et al.,* 2013). Furthermore, it contains vitamins B and A and nutritional elements such as iron and magnesium (Makkar and Becker, 1996; Ferreira *et al.,* 2008; Konmy *et al.,* 2016) and some essential amino acids (Ma *et al.,* 2019), in addition, anti-inflammatory compounds (Yang *et al.,* 200**6).**

Therefore, the present study examined the effects of varying doses of Moringa oleifera leaf (MOLM) in diets on growth performance, carcass characteristics, and blood biochemical parameters in heat-stressed rabbits.

MATERIALS AND METHODS

Experimental design

The study was conducted on a private farm in El Arish, Egypt, in the North Sinai Governorate, throughout the summer. Seventy-two New Zealand White (NZW) rabbits, raised for eight weeks, were utilized in this study. These rabbits were used after weaning at 35 days of age and on average weighed 700 ± 10 g. The rabbits were randomly divided into four groups of equal and given different treatments. The rabbits were housed in a facility with natural ventilation, each in a cage made of galvanized wire that measured 60×55×40 cm. Batteries were accommodated with feeders for pelleted rations and automatic drinkers. Animals were kept under similar management conditions. Throughout the course of the experiment, temperatures and relative humidities were recorded twice daily (at 6:00 am and 2:00 pm), and the mean values were calculated. To calculate an approximation of the temperature-humidity index (THI) we utilized the following formula according to Marai *et al.,* (2001):

$$THI = db°C - [(0.31 - 0.31\ (RH))\ (db°C - 14.4)]$$

Where:

- db°C = Temperature of bulb.
- RH = The percent of relative humidity /100

The resulting THI values were then sorted into the following categories: Without heat stress (< 27.8), mild heat stress (27.8 - < 28.9), severe heat stress (28.9 - <30.0), and very severe heat stress (30.0 and above) (Marai *et al.,* 2001).

Experimental diets

Moringa (Moringa oleifera) was obtained from Agricultural Research Center in Dokki, Egypt, and was used in diets at 0, 2.5, 5 and 7.5 %. *Moringa Oleifera* leaves are composed of 91.48% Dry matter, 26.5% crude protein (CP), 11% crude fibre (CF), 10.1% total ash,6.35% Either Extract (E.E), 3200 Kcal/Kg feed Digestible energy. Clean water, besides feed, was supplied daily *ad libitum*. The daily light and dark cycles remained constant at 14 hours of illumination and 10 hours of darkness. The diets were formulated to provide the nutrients rabbits need as outlined by the NRC (1977). Table (1) displays the ingredients composition of the experimental diets.

Measurements

Productive performance:

Rabbits' weekly feed consumption and live body weights were recorded for 8 weeks. Also, the body weight gain (BWG) was determined as the following equation:

$$BWG = F_W - I_W$$

Where, F_W and I_W represent the final and initial body weight (g), respectively.

The feed conversion ratio (FCR) was calculated by dividing the feed intake (g) by the body weight gained (g). Mortality was recorded during the experiment.

Carcass traits

After 8 weeks of the experiment, three rabbits from each treatment were chosen randomly, starved for 18 hours, and then slaughtered. Live body weights were recorded prior to slaughter. After evisceration, the carcass, head, and giblets (liver, kidney, heart) were weighed separately.

Blood analysis

At the end of the experimental period (8 weeks), blood samples (5ml) were withdrawn in the morning from marginal ear veins for each treatment before feeding. Samples were collected in test tubes without heparin to obtain serum. Before being analyzed, blood samples were centrifuged at 3000 rpm for 15 minutes and were stored until analysis. Automated Cobas e411/601 Immunoassay Analyzer (Cobas 6000, Germany) using electro-

Table (1): Diet composition and chemical characteristics in the current study

Ingredients, %	*Moringa oleifera* Leaves Meal %			
	0	**2.5**	**5**	**7.5**
Yellow corn	18.05	17.36	16.13	15.71
Soybean meal, 44%	11.3	10.14	8.87	7.79
Wheat bran	22.65	22	22	21
Barley	15	15	15	15
Alfalfa hay	30	30	30	30
Limestone	1	1	1	1
Dicalcium Phosphate	1.2	1.2	1.2	1.2
Salt (NaCl)	0.5	0.5	0.5	0.5
Vit. + min. premix*	0.3	0.3	0.3	0.3
MOLM	0	2.5	5	7.5
Total	**100**	**100**	**100**	**100**
Calculated chemical analysis (%)				
Crude protein	16.50	16.50	16.50	16.50
Crude fiber	12.55	12.65	12.70	12.78
Ether extract	2.90	2.95	2.97	3.02
Lysine	0.80	0.78	0.78	0.76
Methionine	0.30	0.30	0.30	0.30
Calcium	1.15	1.26	1.30	1.35
Phosphorus	0.50	0.55	0.55	0.58
Digestible energy (DE)	2709.35	2708.55	2701.15	2703.8
Price/Kg (L.E)	8.30	8.47	8.75	9.00

* Vitamin A (12,000,000 IU), Vitamin D3 (3,000,000 IU), Vitamin E (700 mg), Vitamin K_3 (500 mg), Vitamin B_1 (500 mg), Vitamin B_2 (200 mg), Vitamin B_6 (600 mg) B_{12} vitamin (15 mg) Panathenoic acid (670 mg), Choline chloride (1000 mg), Niacin (3000 mg), biotin (6 mg), Folic acid (10 mg), Sulfate of manganese (80 g), Iron (1.0 g), Zinc (70 g), Copper (0.2 g), Iodine (1.0 g), Cobalt (300 mg), and Selenium (0.3 g) are all included in the vitamin mineral premix's 3 kilogramme serving size.

chemiluminescence immunoassay (ECLIA) technology was used for quantitative assessments of free triiodothyronine (fT3), free thyroxine (fT4), and cortisol hormone in vitro. The sensitivity of the assay was 0.2 ng/ml for fT3, 0.4 ng/dl for fT4, and 18.0 µg/dl for cortisol. Moreover, collected serum samples were subjected to biochemical analysis of each parameter according to the manufacturers' exact steps of its kit. Total protein, albumin and total cholesterol were measured according to the methods described by

Sonnenwirth and Jarett (1980), Doumas (1971) and Stein (1986), respectively.

Economic evaluation

The economic efficiency (EE, in percent) of the experimental diets was caluclated according to the local market price of feed components and the live body weight of rabbits, as shown below.

$$Nr = Tr - Tc$$

$$EE\ (\%) = (Nr / Tc) \times 100.$$

Where, Nr, Tr and Tc represent net and total revenue and total cost, respectively.

The relative economic efficiency (REE) is the result of dividing the EE by the EE of the control diet, assuming that the REE of the control diet is 100%.

Statistical analysis

Analysis of Variance (ANOVA) was used to statistically evaluate the collected data according to Snedecor and Cochran (1982) by following the General Linear Model (GLM) Procedure outlined in the SAS User's Guide (SAS, 2004**).** Duncan's multiple range test was used to examine significance levels for mean differences at ($P<0.05$) (Duncan, 1955).

RESULTS AND DISCUSSION

Temperature-humidity index (THI)

Table (2) displays the THI values over the course of the experiment, demonstrating the rabbits' exposure to extreme heat stress.

Productive performance

The results in Table (3) indicated the influence of dietary *Moringa oleifera* leaves meal (MOLM) on live body weight, body weight gain, feed intake and feed conversion ratio for growing rabbits. The results demonstrated a rise in live body weight, weight gain, and feed conversion ratio when *Moringa* was included in the diet at a 7.5% ratio.

The final live body weight and body weight gain of MOLM-fed animals were both significantly ($P\leq0.05$) higher than those of control-fed animals. In contrast, the feed conversion ratio was significantly ($P\leq0.05$) lower. However, there were no statistically significant variations in feed intake between treatments. These results agree with El-Badawi *et al.* (2014)

Table (2): The range value (Max and Min) with Mean for temperature (°C), relative humidity (RH%) and temperature–humidity index (THI) throughout the course of the experiment

Period (week)	Average temp. (0C)			Average RH (%)			Average (THI)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1st	25.3	35.9	30.6	26	68	47	25.07	35.25	30.16
2nd	26.3	38.9	32.6	25	67	46	24.46	34.10	29.28
3rd	26.6	39.8	33.2	26	68	47	25.17	36.40	30.79
4th	26.4	39.2	32.8	27	69	48	25.66	36.36	31.01
5th	26.2	38.6	32.4	28	68	48	24.21	35.10	29.66
6th	26.8	40.2	33.5	27	67	47	24.82	35.74	30.28
7th	26.4	39.0	32.7	29	67	48	25.03	35.94	30.48
8th	25.9	37.7	31.8	28	68	48	23.46	33.66	28.56
Average	26.24 ±0.24	38.66 ±0.52	32.5 ±0.44	27 ±1.18	68 ±1.45	47 ±1.23	24.74 ±0.33	35.32 ±0.47	30.03 ±0.41

and El-Wardany *et al.* (2015) found that rabbits fed 0.15% and 0.30% Moringa-supplemented rations had better body weight gain, average daily gain, and feed conversion ratio than the control group. Helal *et al.* (2017) saw a similar pattern when they included 0.5% Moringa oleifera in rabbits' diets. Similar improvements were seen in body weight, weight increase, and feed conversion ratio when MOLM was used at 3% and 6%, as reported by El-Desoky *et al.* (2018). Hashem *et al.* (2019) employed Moringa oleifera extracts in rabbits and discovered an increase in productive performance except for feed intake compared to the control group. in the same trend, Abubakar et al., (2015) and Mankga *et al.,* (2022) found the rabbits fed Moringa oleifera meal increased their body weight and feed conversion ratio. Moringa's success may be due to bioactive chemicals, minerals including calcium, magnesium, phosphorus, amino acids (lysine and methionine), and some vitamins. Several studies have linked these chemicals to a boost in animal growth (Ahmed, 2017; Briones *et al.,* 2017; El-Desoky *et al.,* 2018; Mahfuz and Piao, 2019; Sebola *et al.*, 2017). In addition, El-Badawi *et al.* (2017) reported that Moringa oleifera increased the number of helpful gut microbes in a rabbit, leading to better productive performance.

Table 3: Effect of using *Moringa oleifera* leaves in growing rabbits' diets on productive performance parameters under heat stress conditions (Mean ±S.E)

Items	Control	*Moringa oleifera* leaves, %			Sig.
		2.5	5.0	7.5	
Initial weight (g)	702 ±0.00	705 ±0.00	703 ±0.00	700 ±0.00	NS
Final weight (g)	1935[d] ±50.6	2055[c] ±51.2	2120[b] ±55.7	2205[a] ±53.4	*
Body weight gain (g)	1233[d] ±25.4	1350[c] ±27.5	1417[b] ±20.73	1505[a] ±23.1	*
Average daily gain (g)	22.0[c] ±1.23	24.1[b] ±1.17	25.3[ab] ±1.82	26.9[a] ±1.67	*
Feed intake (g)	4530 ±64.7	4615 ±67.2	4565 ±54.4	4490 ±60.8	NS
Average daily feed intake (g)	80.9 ±3.38	82.4 ±3.11	81.5 ±3.52	80.2 ±2.98	NS
Feed conversions ratio	3.67[a] ±0.65	3.42[b] ±0.57	3.22[b] ±0.37	2.98[c] ±0.43	*

[a,b,c] Means are bearing different letters in the same row, differ significantly ($P \leq 0.05$)
NS= Not significant, * (P<0.5), ** ((P<0.1).

Hashem *et al.* (2017) and Soltan *et al.,* (2018) state that Moringa leaves contain organosulfur compounds and amides/alkaloids. These compounds have a strong effect on pathogenic bacteria, such as E. coli (Makkar *et al., 2007).* In addition to anti-inflammatory and immunomodulatory properties (Khatab *et al.,* 2016 and Hashem *et el.,* 2017). These chemicals may improve the intestinal microbial ecosystem, enhancing rabbits' digestive efficiency and immune condition. This improves the digestibility of crude protein and fibre and increases body weight, which explains the increased FCR. Similar results were reported by several researchers (Omara *et al,.* 2018; Sun *et al.,* 2018; Jiwuba and Ogbuewu, 2019).

In addition, the high content of *Moringa* leaves from vitamins C and A (Ferreira *et al.,* 2008; Konmy *et al.,* 2016 and USDA, 2016) and flavonoids act as powerful antioxidants and have the ability to eliminate the adverse effects of excess free radicals resulting from heat stress. In comparison, the absence of significant differences in feed consumption may be due to the existence of tannins and saponins in MOLM diets that could influence taste and palatability.

So, the improvement of productive performance in rabbits fed *Moringa* leaves in the present study might be due to *Moring oleifera* containing an exceptional supply of nutrients such as crude protein, minerals, organosulfur substances, amides/alkaloids, phenolic compounds and antioxidants.

Therefore, the MOLM is an excellent nutritional source for enhancing growth performance.

Carcass characteristics

Table (4) shows the effect of *Moringa oleifera* in growing rabbit diets on carcass characteristics. The results showed improved carcass weight and dressing percentage in animal groups fed a diet containing MOLM compared with control. At the same time, the results showed an insignificant difference between the control group and other treatments on internal organs like the heart and spleen. Moreover, dietary quantities of MOLM did not affect the liver and kidney size involved in detoxification.

These results may represent the beneficial effect of *Moringa oleifera* leaves meals in diets on the rabbits' metabolism and immune. This observation concurs with Ologhobo *et al.* (2014) who showed that birds fed diets containing *Moringa oleifera* leaf had greater slaughter weights. Alternatively, the reason may relate to a change in weight and length in the digestive tract of rabbits fed *Moringa*, which leads to a change in the intestinal absorptive area, as indicated by El-Badawi *et al.* (2014 & 2017) when the authors noticed that the use of *Moringa* leaves led to improve hot and cold carcass weight and dressing percentage.

On the same trend, *Nuhu*, (2010) and Dougnon *et al.* (2012) mentioned that rabbits fed *Moringa* leaf meal had better slaughter weight and dressed weight compared to fed control diet, and the values were increased with increasing *Moringa* level in diets. In contrast, *Abubakar et al. (2015)* found that *Moringa* leaves can be used in rabbit diets at up to 45% without any adverse side effects on carcass and organs. Also, El-Desoky *et al.* (2018) reported that using *Moringa* leaves at rates of 3, 6, and 9% did not affect carcass weight and Internal organs, except the dressing percentage, have improved with using *Moringa* in the rabbit diet.

Table 4: Effect of using *Moringa oleifera* leaves in growing rabbits' diets on carcass traits parameters under heat stress conditions (Mean ±S.E)

Items		Control	*Moringa oleifera* leaves, %			Sig.
			2.5	5.0	7.5	
Presluaghter weight (g)		1890	1995	2055	2140	
Empty body weight, g		1135^{c}±25.5	1240^{b}±27.8	1280^{ab}±23.7	1335^{a}±27.4	*
Carcass	**(%)**	60.05^{b}±3.27	62.16^{a}±3.44	62.29^{a}±3.18	62.38^{a}±3.52	
Head	**weight, g**	121.3^{d}±4.51	133.8^{c}±5.17	137.8^{b}±5.28	144.9^{a}±4.87	*
	(%)	6.42^{b}±0.73	6.71^{a}±0.77	6.71^{a}±0.62	6.77^{a}±0.54	
Heart	**weight, g**	5.28±0.78	5.85±0.84	6.22±1.02	6.43±0.93	NS
	(%)	0.28±0.03	0.29±0.02	0.30±0.02	0.30±0.01	
Liver	**weight, g**	51.35±2.56	55.23±2.31	58.04±2.48	59.92±2.87	NS
	(%)	2.72±0.47	2.77±0.53	2.82±0.36	2.80±0.29	
Kidney	**weight, g**	10.66±1.07	11.58±0.89	11.43±1.12	11.61±1.26	NS
	(%)	0.56±0.03	0.58±0.04	0.56±0.03	0.54±0.06	
Spleen,	**weight, g**	1.31±0.27	1.27±0.18	1.16±0.30	1.29±0.25	NS
	(%)	0.07±0.02	0.06±0.01	0.06±0.01	0.06±0.02	
Giblets	**weight, g**	189.9^{d}±5.27	207.73^{c}±4.18	214.65^{b}±3.72	224.15^{a}±4.36	*
	(%)	10.05±1.05	10.41±1.17	10.45±0.96	10.47±1.24	NS
Dressing	**weight, g**	1202.29±3.18	1312.66±4.11	1355.69±4.27	1412.96±3.76	*
	(%)	63.61±1.23	65.80±1.35	65.97±1.12	66.03±1.62	

[a,b,c] Means are bearing different letters in the same row, differ significantly ($P \leq 0.05$).
NS= Not significant, * ($P<0.5$).
Giblets weight = Weight of each of Heart + Liver + Kidney, Dressing weight = Empty body weight as carcass + Giblets weight

Biochemical parameters of blood

Table (5) shows the influence of using Moringa oleifera leaves (MOLM) in diets on some biochemical changes in the blood of grower rabbits. The obtained results showed that increasing Moringa in the diet to 7.5% improved blood biochemical parameters. Moringa oleifera in the rabbits' diet increased total protein, albumin, globulin and HDL-cholesterol in the blood while decreasing total cholesterol and LDL-cholesterol compared with the control group. These results agree with those reported by

Table 5: Effect of using *Moringa oleifera* leaves in growing rabbits' diets on blood biochemical parameters under heat stress conditions (Mean ±S.E)

Items	Control	*Moringa oleifera* leaves, %			Sig.
		2.5	5.0	7.5	
T. protein (g/dl)	5.18[d] ±0.39	5.97[c] ±0.43	6.42[b] ±0.57	6.65[a] ±0.36	*
Albumin (A) (g/dl)	3.27[c] ±0.33	3.72[b] ±0.37	3.98[a] ±0.24	4.11[a] ±0.28	*
Globulin (G) (g/dl)	1.91[c] ±0.18	2.25[b] ±0.20	2.44[a] ±0.17	2.54[a] ±0.11	*
Total cholesterol (mg/dl)	122.7[a] ±4.28	105.5[b] ±3.47	98.6[bc] ±3.52	96.2[c] ±4.13	*
HDL- cholesterol (mg/dl)	50.5[c] ±1.74	55.7[b] ±1.42	58.3[ab] ±1.67	60.2[a] ±1.53	*
LDL- cholesterol (mg/dl)	71.06[a] ±2.06	48.75[b] ±1.89	39.17[c] ±1.32	34.98[d] ±1.45	*
Glucose (mg/dl)	140.6[a] ±4.17	127.3[b] ±4.25	123.8[c] ±4.38	121.4[c] ±4.67	*
Creatinine (mg/dl)	1.53[a] ±0.15	1.22[b] ±0.17	1.1[c] ±0.17	1.05[c] ±0.18	*
ALT (U/L)	72.5[a] ±2.68	69.4[b] ±2.42	66.7[c] ±2.21	64.3[d] ±2.44	*
AST (U/L)	83.5[a] ±3.11	78.6[b] ±2.97	76.8[bc] ±3.08	74.7[c] ±2.85	*
Cortisol (µg/dl)	1.95[a] ±0.19	1.38[b] ±0.14	1.24[c] ±0.09	1.11[c] ±0.11	*
Triiodothyronine (ng/dl)	82.8[c] ±6.72	88.4[b] ±6.18	90.7[ab] ±5.93	92.3[a] ±6.34	*
Thyroxine (µg/dl)	2.3[c] ±0.27	2.9[b] ±0.25	3.2[ab] ±0.21	3.4[a] ±0.28	*

[a,b,c] Means are bearing different letters in the same row, differ significantly (P≤0.05)
NS= Not significant, * (P<0.5), ** ((P<0.1).
ALT=Alanine aminotransferase, AST=Aspartate aminotransferase

El-Wardany *et al.* (2015) and El-kashef (2022), who found an increase in total protein, albumin and HDL cholesterol and a decrease in total cholesterol and LDL-cholesterol when used Moringa leaves in feeding adult females rabbits. On the same side, Samar *et al.* (2016) found a significant diminishing in total and LDL- cholesterol. While, Mehta *et al.* (2003) showed increased total cholesterol and LDL-cholesterol and an increase in the HDL-cholesterol in the control group compared to other groups fed a diet containing moringa fruit. Also, El-Speiy *et al.* (2021) got the same results when they used extracts of Moringa in feeding adult rabbits. On another side, Voemesse *et al.* (2018) showed a significant increase in total protein and albumin levels when they used moringa leaf in feeding chickens. On the contrary, Yakubu *et al.* (2013) and Abdul-Azeem *et al.* (2022) found no significant differences between groups fed a diet with or without Moringa in serum total protein, albumin, total cholesterol and total lipids.

Also, the results showed that the highest value of ALT and AST were recorded for the control group compared to other groups, where a decrease in those enzymes in animal groups fed diets containing Moringa leaves, in addition, to the increase of total protein and albumin which reflects the ability of this plant to enhance protein metabolism and stimulate the regeneration of hepatic tissue which increases protein synthesis in the liver and improvement of the functional status in the liver cells Which explains its role in preserving the health and safety of liver tissues in those groups compared to the control group. Results showed that the ALT and AST values were within a normal range of 45–80 and 35–130 U/l, respectively, according to Melillo, (2007), which means that rabbits were able to afford the anti-nutritional factors existing in Moringa leaves which lead to possible toxic effects when intake in large quantities. These results agree with El-kashef (2022) who showed a decrease in ALT and AST values when they used *Moringa* leaves in feeding buck rabbits under heat-stress conditions.

Also, Abdel-Latif *et al.* (2018) showed the same results by using *Moringa oleifera* extract in feeding rabbits under heat-stress conditions.

On another side, using MOLM in diets improves the ability of animals to confrontation the heat stress by affecting the amount of cortisol, Triiodothyronine and Thyroxine hormones in blood where the group of animals fed a diet containing Moringa leaves achieved the lowest rate of cortisol hormone and the highest rate of T3 and T4 in blood compared to the control group. These results agree with Abdel-Latif et al. (2018), who reported that using Moringa oleifera improved the ability of animals to confront heat stress by decreasing levels of cortisol compared to other treatments. Also, Khaled *et al.* (2020) found the same results when they used *Moringa oleifera* leaf powder in feeding rabbits at a rate of 200 mg/kg body weight under heat stress conditions.

Cortisol is one of the stress hormones, and it was found that there is a direct relationship between it and heat stress, as the rate of this hormone in the blood increases when the animal is exposed to heat stress (Mazlomi *et al.,* 2017). It has also been found that heat stress can increase the body's inflammatory response (Yun *et al.,* 2012). In addition increases the level of adipokines in the blood (Al-Daood, 2017). Changing the level of cortisol in the blood is the way the body responds to heat stress and adaptability to higher temperatures (Nakyinsige *et al.,* 2013; Ranabir and Reetu, 2011). Higher cortisol levels and T_3 indicate better adaptation to chronic heat stress, reduced glucose oxidation rate, and increased metabolic heat production (Kumari and Nath, 2017). Therefore, the low cortisol level in the treated groups that used MOLM indicates the animal’s ability to heat resistance. On the contrary, the increase in cortisol percentage is considered helpful in dealing with long-term high temperatures in the control group. From the preceding, it is clear that the previous effects and mechanisms of action may be due to the content of moringa leaves high levels of antioxidant vitamins such as vitamin C, vitamin E and β-carotene (Kidmose *et al.,* 2006) and polyphenols. These components increase their antioxidant activity more than traditional antioxidants like ascorbic acid (Yang *et al.,* 2006). In addition, Moringa Oleifera leaves contain simple sugar, vitamin A, iron, vitamin B1 and B2 (Ferreira et al., 2008; Konmy *et al.,* 2016) and anti-inflammatory compounds (Yang, *et al.,* 2006). These compounds help the body to perform its functions and maintain the integrity and health of its tissues.

Economic efficiency:

An economic evaluation of feeding growing rabbits on diets containing *Moringa oleifera* leaves is shown in Table (6). The best economic efficiency was recorded for rabbits fed a diet containing 7.5% of *Moringa oleifera* leaves (1.43), followed by 5% (1.36), then 2.5% (1.33), while the control group archived the lowest value (1.27). The relative economic efficiency calculated relative was 100%, 104.67%, 106.87% and 112.33% for groups fed diets containing 0, 2.5, 5 and 7.5% of MOLM, respectively. The increase in the ratio of *Moringa oleifera* leaves in the diets led to increased feed cost because of the high price of *Moringa oleifera* leaves. However, feed cost/kg weight gain was decreased with increasing the level of *Moringa oleifera* leaves in rabbit diets. It was 19.43, 19.02,

Table 6: Effect of using *Moringa oleifera* leaves in growing rabbits diets on economic efficiency under heat stress conditions

Items	Control	*Moringa oleifera* leaves, %		
		2.5	**5.0**	**7.5**
Live body weight (kg)	1.935	2.055	2.120	2.205
Total feed consumed for each rabbit (kg)	4.530	4.615	4.565	4.490
Costing of one kg feed (LE)	8.30	8.47	8.75	9.00
Total feed cost (LE)	37.60	39.09	39.94	40.41
Managerial cost / Rabbit (LE)	5.00	5.00	5.00	5.00
Total cost (LE)	42.60	44.09	44.94	45.41
Price/kg live body weight (L.E)	50.00	50.00	50.00	50.00
Total revenue (LE)	96.75	102.75	106	110.25
Net revenue	54.15	58.66	61.06	64.84
Economic efficiency	1.27	1.33	1.36	1.43
Relative economic efficiency	100.00	104.67	106.87	112.33
Feed cost / kg LBW (LE)	19.43	19.02	18.84	18.33

Managerial cost / Rabbit = Include management, labors and veterinary care.
Total cost = Feed cost of rabbit + Managerial cost / Rabbit
Total revenue = Body weight x Price of one kg at selling
Feed cost/kg LBW = (Feed intake × Price of kg feed) / live body weight.

18.84 and 18.33 L.E for groups fed a diet containing 0, 2.5, 5 and 7.5% MOLM, respectively.

Conclusively, according to the findings of this research project, including 7.5% *Moringa oleifera* in the meals of rabbits appears to have a beneficial impact on the animals' growth performance, as well as their carcass traits and blood biochemical contents. In addition to this, it assists in enhancing the rabbits' resistance to the adverse effects of heat stress.

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آثر استخدام أوراق المورينجا بالعلائق على انتاجية الارانب ، وصفات الذبيحة والتغيرات البيوكيميائية في الدم تحت ظروف الإجهاد الحراري

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أجري هذا البحث لدراسة تأثير استخدام أوراق المورينجا بالعلائق على الأداء الإنتاجي والتغيرات البيوكيميائية في الدم وخصائص الذبيحة فى الأرانب النامية تحت ظروف الإجهاد الحراري. تم تقسيم ٧٢ من الأرانب النيوزيلندية البيضاء النامية التي تم فطامها في عمر ٣٥ يومًا بمتوسط وزن جسم ٧٠٠ ± ١٠ جم بشكل عشوائي إلى أربع مجموعات. المجموعة الأولى (الكنترول) تغذت على عليقة لاتحتوي على اوراق المورينجا. تم تغذية المجموعه الثانية والثالثة والرابعة على علائق تحتوي على اوراق المورينجا بمستويات ٢.٥ و ٥ و ٧.٥٪ على التوالي. استمرت التجربة لمدة ٨ اسابيع

تم تقديم الأعلاف اليومية والمياه يومياً للارانب. تم تسجيل متغيرات الأداء الإنتاجية بما في ذلك وزن الجسم ومعدل الزيادة في الوزن واستهلاك العلف وتم حساب معدل التحويل الغذائي. بعد ٨ أسابيع تم ذبح ٣ أرانب مأخوذة عشوائياً من كل معاملة لتقدير صفات الذبيحة وذلك بعد التصويم لمدة ١٢ ساعة. كما تم أخذ عينات الدم لتحديد التغيرات البيوكيميائية في الدم ومستويات هرمونات الكورتيزول و ثلاثي يودوثيرونين و الثيروكسين.

أظهرت النتائج وجود تحسن معنوي في الصفات الإنتاجية مثل وزن الجسم ومعدل الزيادة في وزن الجسم ونسبة التحويل الغذائي في مجموعات الأرانب التي تغذت على علائق تحتوي على اوراق المورينجا مقارنة بمجموعة الكنترول. وفي نفس الاتجاه فإن تلك المجموعات سجلت أعلى قيمة لوزن الذبيحة مقارنة بمجموعه الكنترول. كما أظهرت النتائج أن هناك انخفاضًا معنويًا في إنزيم ALT و AST والكوليسترول الكلي وكوليسترول البروتين الدهني منخفض الكثافة وزيادة معنوية في إجمالي البروتين والألبومين والجلوبيولين وكوليسترول البروتين الدهني عالي الكثافة للمجموعات التي تغذت على العلائق التي تحتوي على اوراق المورينجا مقارنة مع مجموعة الكنترول. بالإضافة إلى ذلك فأن تلك المجموعات حققت تحسن ملحوظ في مستويات كل من هرمون الكورتيزون و ثلاثي يودوثيرونين و الثيروكسين مقارنة مجموعه الكنترول.

التوصية: من خلال هذه الدراسة يمكن التوصية باستخدام المورينجا أوليفيرا بمستوى ٥،٧٪ في النظام الغذائي للأرانب يبدو أن له تأثير إيجابي على أداء النمو ، وصفات الذبيحة والكيمياء الحيوية في الدم ، بالإضافة إلى أنه ساعد في تحسين قدرة الحيوانات على مقاومة الإجهاد الحراري.

الكلمات المرشدة: المورينجا ، الاداء الانتاجي ، مكونات الدم ، صفات الذبيحة ، الاجهاد الحراري.