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EFFECT OF SAGE AND NEEM AQUEOUS LEAF EXTRACTS ON GROWTH, CARCASS AND HEMATOLOGICAL PARAMETERS OF GROWING APRI RABBITS UNDER SUMMER AND WINTER CONDITIONS

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ABSTRACT:

The objective of this study was to determine the effects of daily oral administration of aqueous leaves extracts of Salvia officinalis L.(sage) and Azadirachta indica L. (neem) on growth performance, carcass characteristics and hematological parameters of growing rabbit under summer and winter conditions. Rabbits were classified into four equal groups 10/each, in two trails of growth, 40 rabbit's /each trail. The first group was served as a control, the second received 200 mg/kg of body weight of aqueous leaves extract of sage (SAE), the third received 50 mg/kg of body weight of aqueous leaves extract of neem (NAE) and the fourth group were received the same dose of both extracts (SNAE). Daily oral treatment of both extracts was continued for consecutive 8 weeks.

***Results indicated that** most of the productive, hematological and carcass traits were better performed during winter than summer season. Measured environmental data indicated that rabbits during summer exposed to long-term severe heat stress, where the mean air temperature was ranged between 32 - 35 ˚C and temperature humidity index ranged between 31– 33 degree, indicating long-term exposure of rabbits to very severe heat stress that caused a physiological and biological impairment due to negative impacts by summer heat stress. Results showed that aqueous leaves extract of Sage and Neem plants and their combination improved significantly the final body weight (FBW), daily body weight gain (DBWG), feed conversion ratio (FCR) and significantly decreased the feed intake (FI), water intake (WI) and rectal temperature (RT) compared to the control group. In addition, treatment with SAE, NAE and SNAE increased significantly carcass, liver, heart, testes and spleen weights, and no significant difference in weight of kidney compared to the control group. Aqueous extract of Sage and Neem and their mixture exhibited significantly increase in Hb, RBC, PCV, WBC and MCHC values and significant decrease in MCH and MCV values compared to control*

group. It can be concluded that there were significant interactions between season and treatments on the growth performance, carcass traits and hematological parameters except the FI and RT parameters. ***Conclusively,*** *the present study suggests that the dietary leaf extract has performed a good nutritional supplement by enhancing growth performance and health guidelines of APRI growing rabbits against stressful conditions especially during summer season.*

Keywords: *Growing rabbit; Salvia officinalis L.; Azadirachta indica L.; growth performance; carcass traits, hematological parameters.*

INTRODUCTION:

Raising rabbits for meat has gone a long way toward addressing the worldwide meat crisis, and it is the third-largest meat production business in terms of importance, behind beef and chicken. Rabbit meat is also of high quality, high in protein, and low in fat and calories (Trocino, 2019). Egypt was the world's fourth largest producer of rabbit meat in 2017, according to the Food and Agriculture Organization. In that year, its production was predicted to be 62,262 tons counting 3.8 % of global production (FAO, 2019). The temperature of earth has risen (warmed) in the last century by almost 0.74°C, according to an IPCC (2019) assessment, with the 1990s and 2000s being the warmest on record. High ambient temperature combined with high air humidity has been shown to produce pain and increase stress levels in animals, resulting in a decrease in physiological and metabolic activity (Ganaie *et al*., 2013; Younis *et al*., 2018).

Because rabbits have few functional sweat glands, prolonged exposure to high ambient temperatures can cause chronic heat stress (Ondruska *et al*., 2011), which is linked to slowed growth. As a result, the rabbit industry suffers huge financial losses (Cui *et al*., 2016). Kumar *et al*. (2011) revealed that prolonged rabbits to temperature stress cause an oxidative stress by increasing free radicals. Also, according to Akbarian *et al*., (2016), heat-induced stress is linked to oxidative stress, in which the free radicals produced result in considerable amounts of their metabolites. Heat stress, being a major environmental stressor that is unfavorable to animal husbandry worldwide (Sejian *et al*., 2018) is also disadvantageous to rabbit production. Rabbits are particularly sensitive to heat stress owing to their lack of functional sweat glands (Marai *et al*., 2002). Various natural feed additives have been used to mitigate the negative effects of heat stress on rabbit growth, immunity, redox state, and inflammation for safe, practical, long-term, and low-cost ways (Wang *et al*., 2017; Abdelnour *et al*., 2019).

Currently, research is concentrating on managerial and dietary solutions to help animals better endure heat stress and preserve their health and production (Sheiha *et al*., 2020). Chauhan *et al*., (2014) reported that sup-

plementation of natural antioxidant rich feed additives can mitigate the negative effects of heat stress in sheep by the successful reduction in expression of inflammatory genes in muscles along with reduced rectal temperature, respiration rate as well as maintenance of feed intake under heat stress. *Salvia officinalis* L. (sage) is an important antioxidant, anti-diabetic, anti-inflammatory, and anti-microbial agent, according to Grdiša *et al*., (2015) and Jakovljević *et al*. (2019) and portions of the plant, such as leaves and branches, are high in phenolic components (caffeic, vanillic, ferulic, and rosmarinic acids), flavonoids (luteolin, apigenin, and quercetin) and volatile chemicals (Shan *et al*., 2005). Simonová *et al*. (2020) found that the first 10–15 days after weaning are the most critical for rabbits, and that using natural compounds like sage extract to prevent post-weaning alimentary disturbances, maintain rabbit health, and stabilize the breeding economy is one possible way to improve rabbit husbandry and productivity. According to Szabóová *et al*., (2008), the *Salvia officinalis* extract had an antimicrobial and anticoccidial effect on bacteria in rabbit's intestinal tracts. Sage administration had a positive effect in rabbits by increasing consumption and weight gain as phagocytic activity. Salla *et al*. (2020) studied the administration of aqueous extract of sage and marjoram plants on chronic kidney patients and found an increase in Hb, RBCs, WBCs and Plts near the normal values compared to the control. Patients who consumed the mix of aqueous extract of herbs recorded the best increase in WBCs and RBCs values.

Azadirachta indica A. Juss, known as neem in vernacular, belongs to the family meliaceae and is widely distributed in Asia, Africa and other tropical parts of the world (Sombatsiri *et al*., 1995). Because of its many benefits and ability to treat a variety of diseases, neem is also known as "a tree for solving world problems" (Kumar and Navaratnam, 2013). The presence of considerable quantities of alkaloids, phenolic chemicals, flavonoids, terpenoids, steroids, and carotenoids in all portions of the neem plant gives the neem plant important antioxidant, antibacterial, and anti-inflammatory properties (Dash *et al*., 2017). Flavonoids in neem leaves, inclusive of nimbin, are considered effective antioxidants that minimizing the production of reactive oxygen species (Naik *et al*., 2014). In addition to endoperoxides and enzymes such as protein kinase and phosphodiesterase, all of which are involved in inflammation (Batista *et al*., 2018). Paul *et al.*, (2020) showed that supplemented broiler chickens with neem leaf extract as alternative to antibiotic growth promoter improved growth performance and reduced production cost. The beneficial influences of neem leaves on growth performance and hematological parameters (Nodu *et al*., 2016) and carcass characteristics were also reported in chickens (Landy *et al*., 2011).

Therefore, this current study was undertaken to investigate the ameliorating effects of oral administration of Sage and Neem water extracts, single or combined, on reducing the impacts of heat stress on growth performance, Caracas traits and hematological indices of APRI growing rabbits in summer season versus winter with different conditions.

MATERIALS AND METHODS:

The experimental work of the present study was carried out at El-Sabahia Poultry Research Station (Alexandria), Animal Production Re-Search Institute, Agricultural Research Center, Ministry of Agriculture, Egypt during summer and winter seasons.

A total number of 80 APRI growing rabbits were used during 35-84 days of age in two trails of growth (40 rabbit's/each). These trials were run during summer 2017 (July - August) and winter 2018 (January - February). A total number of 40 APRI rabbits at 5 weeks age and average weight 580-620 g were randomly allotted into four equal experimental groups (n = 10). The first group was used as a control; the second group received daily 200 mg /kg body weight of aqueous extract of Sage (SAE) dried leaves by oral administration. Third group received daily 50 mg/kg body weight of aqueous extract of Neem (NAE) dried leaves. The fourth group received daily mixture (SNAE) of both above extracts in the same dose for consecutive 8 weeks. Rectal temperature (RT) is an indicator of thermal balance and can be used to assess severity of thermal environment (Rejeb *et al*., 2016). Rabbits were housed in one galvanized wire cages (50×45×40 cm). Pelleted form of feed and water were offered *ad libitum* throughout the experimental period during. Diets were formulated as shown in Table (1) according to NRC, (1977).

The study building was open air with electric exhaust fans on the side walls. Indoor climatic conditions, changes in ambient temperature (AT, ^{o}C) and relative humidity (RH, %) were daily recorded at 8:00 am and 2:00 pm inside the rabbit's room using electronic digital thermo-hygrometer. Maximum and minimum temperature (°C) and relative humidity (RH %) and temperature-humidity index (THI) and weekly condition changes, during the experimental periods, for both seasons are shown in Table (2) and Figure (1).

The relationship between ambient temperature and relative humidity was termed temperature-humidity index (THI) were calculated according to Marai *et al*. (2001):

Table (1): Ingredients and chemical composition of the experimental diets fed to growing APRI rabbits (35-84 day of age).

Ingredients	%	Determined and Calculated Composition	
Berseem hay	40.0	Dry matter (DM)[2], %	89.67
Yellow corn	10.0	Crude protein (CP)[2], %	17.18
Barley	13.0	Crude fiber (CF)[2], %	13.05
Wheat bran	15.0	Ether extract (EE)[2], %	3.41
Soybean meal	17.5	Nitrogen free extract (NFE)[3], %	56.03
Molasses	3.0	Ash[2], %	10.33
Di-calcium phosphate	0.8	Digestible energy (DE)[3] Kcal/Kg	2519
Sodium chloride	0.3	Calcium[3], %	0.83
Vit+ Min Premix[1]	0.3	Available phosphorus[3], %	0.31
DL-Methionine	0.1	Methionine[3], %	0.36
		Total sulphur amino acid [3], %	0.68
Total	100	Lysine[3], %	0.98

[1]**Vit+Min mixture provides per kilogram contains:** Vit A 6000 IU; Vit D3 450 IU; Vit E 40 mg; Vit K3 1 mg; Vit B1 1 mg; Vit B2 3 mg; Vit B_3 180 mg; Vit B_6 39 mg; Vit B_{12} 2.5 mg; Pantothenic acid 10 mg; biotin 10 mg; folic acid 2.5 mg; choline chloride 1200 mg; Manganese 15 mg; Zinc 35 mg; Iron 38 mg; Copper 5 mg; Selenium 0.1 mg; Iodine 0.2 mg; Selenium 0.05 mg.

[2]Analyzed values according to **AOAC (1995)**.

[3]Calculated values according to **NRC (1977)**.

DE calculated according to **Cheeke (1987)**.

DE=4.36-0.0491*NDF%, NDF%=28.92+0.657*CF%.

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

Where, db ^{o}C = dry bulb temperature in centigrade and RH = relative humidity %. The THI values classified as follow:

>27.8= absence of heat stress, 27.8 - >28.9 moderate heat stress, 28.9 - >30.0= server heat stress and 30.0 and more = very sever heat stress.

Preparation of Crude Herbal Extracts:

Aqueous leaf extract of Neem:

The leaves of Neem (*Azadirachta indica*) were cleaned and dried using hot air oven at 55 ^{o}C for 6 h and then they were crushed into powder used for preparation of aqueous crude extract according to the procedure previously described by Sithisarn, *et al*. (2006) with some modification. Briefly, the dried powder of Neem leaves were boiled with distilled water (plant: water = 1 : 20, w/v) for 6 h and then filtered. The filtrate was evaporated to dryness in a vacuum evaporator to yield the aqueous crude extract of Neem leaf.

Aqueous leaf extract of Sage:

Leaves of sage *(Salvia officinalis*) were taken and washed by distilled water and cut into small pieces and grinded. Fifty grams of grinded sage then mixed with 250 ml of double distilled water in Erlenmeyer flask and the mixture was boiled for 5 minutes. Then the aqueous sage extract was cooled and filtrated with filter papers to obtain clear extracts (Barbinta-Patrascu *et al.,* 2013).

Data Collection:

Rabbits used in this study were reared under the same environmental and management conditions during experimental period. Changes in live body weight (BW), feed intake (FI) and water intake (WI) were recorded. Daily weight gain (DBWG) and feed conversion ratio (FCR) were calculated. The RT was measured according to the method described by Hassan *et al*. (2011) for rabbits.

During experimentation, blood samples were weekly withdrawn from the ear vein of rabbits in heparinized tubes. Blood constituents, hemoglobin concentration (Hb) was determined by Tietz (1982), red blood cells (RBC's) and white blood cells (WBC's) were counted according to the method of Helper (1966), and Hawkeye and Dennett (1989), packed cell volume (PCV, %) was recorded directly according to Wintrobe (1965). The mean cell volume (MCV), the mean cell Hemoglobin (MCH), and the mean cell Hemoglobin concentration (MCHC) were referred as absolute value:

MCV (μ^3 /RBC) = Hematocrite (%) × 10 / Number of RBC's.

MCH (µg) = Hemoglobin concentration (g/dl) × 10 / Number of RBC's

MCHC (%) = (Hemoglobin (g/dl) / Hematocrite %) × 100.

At the end of the experiment, four rabbits / each group were randomly chosen for slaughter. Rabbits were fasted for 12 hours before slaughtering, and then they were weighed individually as pre-slaughter weight. Rabbits were slaughtered by cutting the jugular vein. After complete bleeding, they were weighed, skinned and eviscerated. Carcass, liver, kidneys, heart, testes and spleen were immediately weighed.

Statistical analysis:

Collected data were expressed as means $\pm$ SD and statistical analysis of obtained data was performed by ANOVA (SAS, 2002). Data of growing rabbits were analyzed by a two-way model studying the main effect of treatment and season and their possible interaction. Student Newman Kelus test was used to detect significant differences among the group means.

Data were presented based on main effects and when the interaction was significant.

RESULTS AND DISCUSSION

Temperature humidity index (THI) values:

Data presented in Table (2) and Fig. (1) demonstrated that the calculated THI values were ranged between 31 and 33 during summer (2017) conditions in Egypt, revealing very sever heat stress conditions according to Marai *et al*. (2002). The thermo-neutral zone (TNZ) for rabbits is around 18 to 21^{o}C (Marai *et al*. 2001). The upper critical temperature for rabbit at rest is 27 to 28 ^{o}C. The overall mean of THI values during this study indicated that growing rabbits were exposed to very severe heat stress conditions during this period of season.

The summer months of Egypt, particularly in July and August, provide warm subtropical environmental conditions. The average of ambient temperature (AT) and THI values reported in Table (2) indicated that the rabbit under summer condition was exposed to long-term of very severe heat stress. Exposure of rabbits for long-term to such stress condition can cause physiological and biological harm (Imbabi *et al*., 2021) due to negative impacts by summer heat stress. Continuous exposure of rabbits to extremes of heat leads to disruptions in homeostatic mechanisms, thereby causing damages to various organs and their functions (Farghly *et al*., 2021).

Table 2. Average ambient temperature (AT,°C), relative humidity (RH, %) and temperature-humidity index (THI) during the experimental period.

Items	Summer 2017		Winter 2018	
	July	August	January	February
AT (^{o}C)	35	32	20	21
RH (%)	75	76	81	83
THI	33	31	22	21

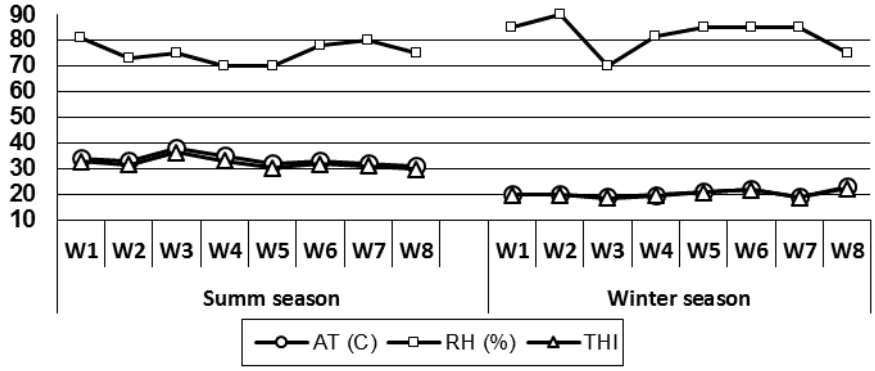

Fig.1. Calculated temperature-humidity index (THI) throughout the experimental period in summer (July 2017-August 2017) and winter (January 2018-Febrary 2018) seasons.

Growth performance and rectal temperature of growing APRI rabbits:

The effect of aqueous extract of Sage (SAE) and Neem (NAE) extracts and their combinations (SNAE) on APRI growing rabbits during summer and winter seasons and the interaction between treatment and season on the growth performance were illustrated in Table (3). Regardless of treatment effect, growing rabbits had better performance in growth during winter than summer season. The data showed significant increase in IBW, FBW, DBWG and FI and significant decrease in WI and RT values during winter compared to summer season. Moreover, the FCR values showed that a growing rabbit had significantly better performance during winter than summer season. Regardless of season effect, treatment with SAE, NAE and SNAE significantly improved the growth performance of growing rabbits.

Table (3): Effect of season, treatment with SAE and NEA aqueous extracts and their mixture (SNAE) on growing rabbit's initial body weight (IBW), final body weight (FBW), feed intake (FI), daily body weight gain (DBWG), feed conversion ratio (FCR) water intake (WI) and rectal temperature (RT) under summer and winter conditions.

Items	IBW (g)	FBW (g)	DBWG (g/r/d)	FCR (g/g)	FI (g/ kg/d)	WI (ml /kg/d)	RT (°C)
Effect of season (S)							
Summer	598.4^{b}	1750.2^{b}	23.24^{b}	4.10^{a}	86.81^{b}	62.09^{a}	39.24^{a}
Winter	628.9^{a}	1949.7^{a}	26.86^{a}	3.81^{b}	94.85^{a}	52.78^{b}	38.12^{b}
Effect of treatment (T)							
Control	602.5	1685.8^{c}	22.14^{c}	5.14^{a}	99.60^{a}	60.02^{a}	39.12^{a}
SAE	611.0	1904.1^{a}	26.01^{a}	3.47^{c}	85.16^{c}	56.49^{bc}	38.68^{b}
NEA	612.0	1843.2^{b}	24.85^{b}	4.04^{b}	93.03^{b}	58.13^{ab}	38.56^{bc}
SNAE	629.1	1908.4^{a}	26.13^{a}	3.57^{c}	87.26^{c}	55.09^{c}	38.37^{c}
SEM	63.2	76.93	1.143	0.308	5.21	3.011	0.259
***P* values**							
(S)	0.0344	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
(T)	0.6024	0.0001	0.0001	0.0001	0.0001	0.0059	0.0001
S×T	0.8148	0.7292	0.3409	0.4734	0.0455	0.8660	0.0199

Symbols a, b, c declare that means of data within the same column with common letter(s) are not significantly different ($P<0.05$).

No significant difference was found for IBW as a result of treatment effects (Table 3). Administration of growing rabbit with SAE and NAE and their combination caused significant increase in the final body weight (FBW) and daily body weight gains (DBWG) and significantly decrease in feed efficiency, feed intake (FI), water intake (WI) and rectal temperature (RT) compared to control group. Feed intake and feed efficiency did not differ significantly between SAE and SNAE groups (Table 3). No signifi-

cant differences were shown between season and treatment interaction for all growth performance traits in this study except the FI and RT parameters (Table 3).

Simonová *et al*., (2020) revealed that the first 10–15 days during the weaning period are the most critical period for rabbits and to achieve better production in rabbit husbandries, one possible way is the use of natural compounds, such as sage extract for preventing post-weaning alimentary disturbances, maintaining the rabbit's health, and stabilizing the economy of breeding. Our results were in agreement with Szabóová *et al.*, (2008) who concluded that the *Salvia officinalis* (sage) extract had an antimicrobial effect on bacteria in the intestinal tract of rabbits and anticoccidial effect. They added that sage administration had a positive effect in rabbits by increasing the consumption and weight gain as phagocytic activity. Also, Paul *et al*., (2020) reported that dietary supplementation of neem (NLE) leaf extracts improved growth performance and reduced production cost in broiler chickens. They added that the body weight gain in NLE fed chickens could be possibly due to the diversified effect of NLE on intestinal microflora, and the presence of macro- and micro-minerals in *A. indica* leaves (Ansari *et al*., 2012). Imbabi *et al*., (2021) showed that daily whole-pomegranate extract (WPE) supplementation counteracted the negative effect of heat stress on control rabbit performance and improved final rabbit weight gain and FCR. Moreover, it has been demonstrated that supplementing diets with Moringa dry leaves or mixture of Moringa leaves and rosemary leaves can improve growth performance, nutrient digestibility and antioxidant status of rabbits under heat stress conditions (Helal *et al*., 2017).

Carcass traits of growing APRI rabbits:

The treatment effects of APRI growing rabbits with aqueous extracts of sage (SAE) and neem (NAE) plants and their combinations (SNAE) during summer and winter seasons and the interaction between treatment and season on carcass traits are presented in Table (4).

The data showed a highly significant increase of carcass, liver, heart, kidney and testes weights and a significant decrease of spleen weight during winter season compared to summer one. Regardless season effects, a highly significant increase in rabbit body weight, carcass, liver and testes and a significant increase in heart and spleen weights were observed as a result of treatment of growing rabbits with SAE, NAE and SNAE, and no significant different change in the weight of kidney compared to untreated group (Table 4). There were significant interactions between season and treatment only on liver, heart and testes weights.

Table (4): Effect of season, treatment with SAE and NEA aqueous extracts and their mixture (SNAE) on growing rabbit's body weight (BW), carcass, liver, heart, kidney, testes and spleen weights during summer and winter seasons

Items	BW (g)	Carcass (g)	Liver (g)	Heart (g)	Kidney (g)	Testes (g)	Spleen (g)
Effect of season (S)							
Summer	1791.3^{b}	958.2^{b}	56.83^{b}	6.20^{b}	10.94^{b}	7.01^{b}	1.82^{a}
Winter	2068.1^{a}	1159.9^{a}	96.92^{a}	6.86^{a}	13.56^{a}	8.69^{a}	1.61^{b}
Effect of treatment (T)							
Control	1786.3^{b}	937.6^{c}	60.06^{c}	5.94^{b}	11.38	5.90^{d}	1.55^{b}
SAE	1991.9^{a}	1110.9^{a}	82.13^{ab}	6.90^{a}	12.68	8.73^{b}	1.78^{a}
NEA	1928.3^{a}	1046.4^{b}	75.65^{b}	6.41^{ab}	12.63	7.58^{c}	1.74^{ab}
SNAE	2012.5^{a}	1141.3^{a}	89.65^{a}	6.88^{a}	12.32	9.21^{a}	1.75^{ab}
SEM	95.4	61.4	8.17	0.559	1.58	0.340	0.221
P values							
(S)	0.0001	0.0001	0.0001	0.0029	0.0001	0.0001	0.0122
(T)	0.0003	0.0001	0.0001	0.0061	0.3461	0.0001	0.0450
S×T	0.9999	0.9485	0.0008	0.0269	0.4082	0.0006	0.7369

Symbols a, b, c declare that means of data within the same column with common letter(s) are not significantly different (P<0.05).

The present results are in agreement with Paul *et al.* (2020) who reported that dietary supplementation of neem (*Azadirachta indica*) leaf extracts improved growth performance and had beneficial influences on carcass characteristics (Landy *et al*., 2011) in broiler chickens. Also, Ansari *et al.* (2012) found better dressing percentages in birds fed with herbal plant diets than control. In contrast, Elangovan *et al.* (2000) found no effects of neem extracts on carcass characteristics.

Hematological parameters*:*

Data in Table (5) revealed the effect of treated APRI rabbits with aqueous extract of sage (SAE) and neem (NAE) plants and their mixture (SNAE) on the hematological parameters during summer and winter seasons. Highly significant differences were detected for all hematological parameters under study as a result of season exchange and treated growing rabbits with SAE, NAE and their mixture except the MCV, which insignificantly deferent by season. Regards to season, the treatment with SAE, NAE and their mixture caused highly significant increase in Hb, RBC, PCV, WBC and MCHC values and highly significant decrease in MCH and MCV values compared to control group. Treated growing rabbits with SNAE caused the highest significant improvement in the hematological parameters

Table (5): Aqueous extract effects of sage and neem and their mixture on growing rabbit's hemoglobin (Hb), red blood cells (RBC), packed cell volume (PCV), white blood cells (WBC), mean cell Hemoglobin (MCH), mean cell volume (MCV) and mean cell Hemoglobin concentration (MCHC) during under summer and winter conditions

Items	**Hb (mg/100m**	**RBC ($\times10^6$)**	**PCV (%)**	**WBC ($\times10^3$)**	**MCH (%)**	**MCV (%)**	**MCHC (%)**
Effect of season (S)							
Summer	11.44^b	4.18^b	32.8^b	7.93^a	30.21^a	80.16	34.84^a
Winter	12.42^a	4.77^a	38.6^a	7.05^b	26.28^b	81.80	32.19^b
Effect of treatment (T)							
Control	10.97^c	4.00^d	34.6^d	6.50^c	29.52^a	86.88^a	31.82^b
SAE	12.28^a	4.66^b	36.2^b	7.92^a	27.65^b	78.42^c	34.07^a
NEA	11.93^b	4.30^c	35.2^c	7.36^b	29.26^a	82.60^b	34.04^a
SNAE	12.52^a	4.93^a	36.8^a	8.18^a	26.55^b	76.02^c	34.14^a
SEM	0.79	0.523	1.22	0.95	2.840	8.96	2.06
***P* values**							
(S)	0.0001	0.0001	0.0001	0.0001	0.0001	0.2067	0.0001
(T)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
S×T	0.1118	0.7589	0.6943	0.3468	0.9961	0.7276	0.0353

Symbols a, b, c declare that means of data within the same column with common letter(s) are not significantly different ($P<0.05$).

followed by SAE then NAE treatment (Table 5). The interaction between season and treatment had no significant effects on the hematological parameters under studied (Table 5).

According to Peters *et al.* (2011), the packed cell volume, hemoglobin and mean corpuscular hemoglobin are major indices for evaluating circulatory erythrocytes, and are significant in the diagnosis of anemia and also serve as useful indices of the bone marrow capacity to produce red blood cells as in mammals (Awodi *et al.*, 2005; Chineke *et al.*, 2006). Our results are in agreement with Paul *et al.* (2020) who reported that dietary supplementation with neem (*Azadirachta indica*) leaf extract in broiler chickens caused a beneficial influences on hematological parameters, similar results were also found by Nodu *et al*. (2016) and Nayaka *et al*. (2013).

A good physiological status of poultry can be evaluated based on hematological parameters and their values are varied due to variation of dietary supplements (Khan and Zafar, 2015). Various studies found that Neem leaf extract feeding can significantly change the hematology of poultry (Nayaka *et al*., 2013). On the other hand, Nodu *et al*. (2016) did not observe any significant difference in hematological parameters between control and neem treated groups. They suggested that no affect stress for neem on blood

cell formation, constituents, and their function. However, Sarker *et al.* (2014) found a significantly increase only on WBC parameter in broilers treated with 1% neem leaves at day 42.

Salla *et al.* (2020) investigated the effect of aqueous extract of sage (*Salvia Officinal*) and marjoram (*Origanum Majoranum*) on advanced chronic kidney patients. They found that the treated groups had an increase in Hb, RBCs, WBCs and Plts near to the normal values of the control. The best increase in Hb was in patients consumed sage (5 g) aqueous extract, followed by patients which consumed sage (10 g) aqueous extract. Patients who consumed the mix of aqueous extract of herbs recorded the best increase in WBCs and RBCs values. Regarding hematological data, we can deliver an interpretation that both sage and neem extracts have a stimulatory effect on hematopoiesis in the bone marrow; reduce hemolysis in circulation or both effects.

Conclusively, the present study suggests that the dietary leaf extract has performed a good nutritional supplement by enhancing growth performance and health guidelines of APRI growing rabbits against stressful conditions especially during summer season.

REFERENCES

Abdelnour, S.A.; Abd El-Hack, M.E.; Khafaga, A.F.; Arif, M.; Taha, A.E. and Noreldin, A.E. (2019). Stress biomarkers and proteomics alteration to thermal stress in ruminants: a review. *J. Therm. Biol.*, 79: 120‑134.

Akbarian, A.; Michiels, J.; Degroote, J.; Majdeddin, M.; Golian, A. and De Smet, S. (2016). Association between heat stress and oxidative stress in poultry; mitochondrial dysfunction and dietary interventions with phytochemicals. *J. Anim. Sci. Biotechnol*. 7: 37-50.

Ansari, J.; Khan, S.H.; Haq, A.U. and Yousaf, M. (2012). Effect of the levels of *Azadirachta indica* dried leaf meal as phytogenic feed additive on the growth performance and haemato-biochemical parameters in broiler chicks. *J. Appl. Anim. Res.*, 40 (4): 336-345.

AOAC, (1995). *Official Methods Of Analysis* (13th Ed). Association of Official Analytical Chemists Washington, DC. USA.

Awodi, S.; Ayo, J. O.; Atodo, A. D. and Dzende, T. (2005). Some haematological parameters and the erythrocyte osomotic fragility in the laughing dove (*Streptopella senegalensis*) and the village weaner bird (*Ploceus cucullatus*) (p.384-387). *Proceedings of the 10th Annual Conference of Animal Science Association of Nigeria.*

Barbinta-Patrascu, M. E.; Bunghez, I. R.; Iordache, S. M.; Badea, N.; Fierascu, R. C., and Ion, R.M. (2013). Antioxidant properties of bi-ohybrids based on liposomes and sage silver nanoparticles. *Journal of Nanoscience And Nanotechnology*, 13(3), 2051-2060.

Batista, F.L.A.; Lima, L.M.; Abrante, I.A.; de Araújo, J.I.F.; Batista, F.L.A.; Abrante, I.A.; Magalhães, E.A.; de Lima, D.R.; Maria da Conceição, L.L. and do Prado, B.S. (2018). Antinociceptive activity of ethanolic extract of *Azadirachta indica* A. Juss (*Neem, Meliaceae*) fruit through opioid, glutamatergic and acid-sensitive ion pathways in adult zebrafish (*Danio rerio*). Biomed. *Pharmacother.,* 108: 408–416.

Chauhan, S.S.; Celi, P.; Fahri, F.T.; Celi, P. and Dunshea, F.R., (2014). Dietary antioxidants at supranutritional doses modulate skeletal muscle heat shock protein and inflammatory gene expression in sheep exposed to heat stress. *J. Anim. Sci.,* 92: 4897–4908.

Cheeke, P. (1987). *Rabbits Feeding And Nutrition*. Academic press. Orlando, Florida, USA.

Chineke, C.A.; Ologun, A.G.; and Ikeobi, C.O.N. (2006). Haematological parameters in rabbit breeds and crosses in humid tropics. *Pakistan Journal of Biological Sciences*, 9 (11): 2102-2106.

Cui, Y., Hao, Y.; Li, J.; Bao, W.; Li, G.; Gao, Y. and Gu, X., (2016). Chronic heat stress induces immune response, oxidative stress response, and apoptosis of finishing pig liver: a proteomic approach. *Int. J. Mol. Sci*., 17: 393- 416.

Dash, S.P.; Dixit, S. and Sahoo, S. (2017). Phytochemical and Biochemical Characterizations from Leaf Extracts from *Azadirachta indica* : An Important Medicinal Plant *Biochem Anal Biochem*.; 6 (2): 2–5.

Elangovan, A.V.; Verma, S.V.S.; Sastry, V.R.B. and Singh, S.D. (2000). Effect of feeding neem (*Azadirachta indica*) kernel meal on growth, nutrient utilization and physiology of Japanese quails (*Coturnix coturnix japonica*). *Asian Australas. J. Anim. Sci.,* 13(9): 1272-1277.

FAO. (2019). Food and Agriculture Organization of the United Nations. FAO Database. *Available online: http://www.faostat.fao.org*.

Farghly, M.F.A.; Mahrose, K.M.; Peris, S.I.; Abou-Kassem, D.E.; Metwally, K.A.; Abougabal, M.S. and Abd El-Aziz, A. (2021). Effects of lighting source as an environmental strategy for heat stress amelioration in growing Californian rabbits during summer season. *Anim Biotechnol. https:// doi. org/ 10. 1080/ 10495 398. 2021. 18951 86*

Ganaie, A.H.; Ghasura, R.S.; Mir, N.A.; Bumla, N.A.; Sankar, G. and Wani S.A. (2013). Biochemical and Physiological Changes during Thermal Stress in Bovines. *Iranian Journal of Applied Animal Science*, 3: 423 - 430.

Grdiša, M.; Jug-Dujaković, M.; Lončarić, M.; Carović-Stanko, K.; Ninčević, T.; Radosavljević, I. and Šatović, Z. (2015). Dalmatian Sage (*Salvia officinalis L.*): A review of biochemical contents, medical properties and genetic diversity. *Agric. Conspec Sci*., 80: 69-78.

Hassan, R.A.; Ebeid, T.A.; Abd El-Lateif, A.I. and Ismail, N.B. (2011). Effect of dietary betaine supplementation on growth, carcass and immunity of New Zealand White rabbits under high ambient temperature. *Livest. Sci.,* 135: 103–109.

Hawkey, C. and T. Dennett (1989). *A color Atlas Of Comparative Veterinary Hematology Wolf.* Publishing limited, London, England.

Helal, F.I.S.; El-Badawi, A.Y.; El-Wardany, I.; Ali, N.G.M. and Aboelazab, O.M., (2017). Effect of dietary moringa (*Moringa oleifera*) and rosemary (*Rosmarinus officinalis*) leaves or their mixture on productive performance, carcass characteristics and antioxidant enzymes of rabbits reared under heat stress conditions. *Agric. Eng. Int. CIGR J.,* 184–192.

Helper, O. (1966). *Manual Of Clinical Laboratory Methods*. Thomos Spring Field. Illinois.

Imbabi, T.A.; Ahmed-Farid, O.; Selim, Dina A. and Sabeq, I.I. (2021). Antioxidant and anti-apoptotic potential of whole-pomegranate extract promoted growth performance, physiological homeostasis, and meat quality of V-line rabbits under hot summer conditions. *Animal Feed Science and Technology*, 276: 114911-

IPCC (2019). *Intergovernmental Panel on Climate Change***.** Refinement to the 2006 IPCC 535 guidelines for national greenhouse gas inventories, 15.

Jakovljević, M.; Jokić, S.; Molnar, M.; Jašić, M.; Babić, J.; Jukić, H. and Banjari, I. (2019). Bioactive profile of various *Salvia officinalis* L. preparations. *Plants*, 8: 55.

Khan, T.A. and Zafar, F. (2015) Haematological study in response to varying doses of estrogen in broiler chicken. *Int. J. Poult. Sci.,* 4(10): 748-751.

Kumar, S.B.V.; Kumar, A. and Kataria, M. (2011). Effects of heat stress in tropical livestock and 554 different strategies for its amelioration. *J. Stress Physio. And Bioch.*,7 (1): 4554.

Kumar, V.S. and Navaratnam, V. (2013). Neem (*Azadirachta indica*) prehistory to contemporary medicinal uses to human kind Asian Pacific. *Journal Tropical Biomedicine*, 3 (7): 505-514.

Landy, N.; Ghalamkari, G.H. and Toghyani, M. (2011). Performance, carcass characteristics, and immunity in broiler chickens fed dietary neem (*Azadirachta indica*) as alternative for an antibiotic growth promoter. *Livest. Sci.*, 142 (1-3): 305-309.

Marai, I.F.; Habeeb, A.A. and Gad, A.E. (2002). Rabbits productive, reproductive and physiological performance traits as affected by heat stress. *Livestock Production Science*, 78(22): 71-90.

Marai, I.F.M.; Ayyat, M.S. and Abd El-Monem, U.M. (2001). Growth performance and reproductive traits at first parity of New Zealand White female rabbits as affected by heat stress and its alleviation under Egyptian conditions. *Trop Anim Health Prod* ., 33:1–12.

Naik, M.R.; Bhattacharya, A.; Behera, R.; Agrawal, D.; Dehury, S. and Kumar, S. (2014). Study of anti-inflammatory effect of neem seed oil (*Azadirachta indica*) on infected albino rats. *J. Health Res. Rev.*, 1: 66-69.

Nayaka, H.B.S.; Umakantha, B.; Ruban, S.W.; Murthy, H.N.N. and Narayanaswamy, H.D. (2013). Performance and hematological parameters of broilers fed neem, turmeric, Vitamin E and their combinations. *Emir. J. Food Agric*., 25(6): 483-488.

Nodu, M.B.; Okpeku, M.; Akpoveta, Z.A. and Iroegbu, D.O. (2016). Evaluation of *Azadirachta indica* leave extract on hematology and biochemical profiles, organs weight and growth parameters of broiler chickens. *J. New Sci*., 32 (5): 1879-1884.

NRC (1977). *National Research Council Nutrient Requirements Of Domestic Animals*. Nutrients requirement of rabbits. USA. National Academy of Sci, Washington, D.C.

Ondruska, L.; Rafay, J.; Okab, A.; Ayoub, M.; Al-Haidary, A.; Samara, E.; Parkanyi, V.; Chrastinova, L.; Jurcik, R. and Massanyi, P. (2011). Influence of elevated ambient temperature upon some physiological measurements of New Zealand White rabbits. *Vet. Med. (Praha)* 56:180–186.

Paul, T.K.; Hasan, M.M.; Haque, M.A.; Talukder, S.; Sarker, Y.A.; Sikder, M.H.; Khan, M.A.N.A.; Sakib, M.N. and Kumar, A. (2020). Dietary supplementation of Neem (*Azadirachta indica*) leaf extracts improved growth performance and reduced production cost in broilers, *Veterinary World*, 13(6): 1050-1055.

Peters, S.O.; Gunn, H. H.; Imumorin, I.G.; Agaviezor, B.O. and Ikeobi, C.O.N. (2011). Hematological studies on frizzled and naked neck genotypes of Nigerian native chickens. *Trop Anim. Health Prod.*, 43: 631–638.

Rejeb, M.; Sadraoui, R.; Najar, T.; and M'rad, M. Ben (2016). A complex interrelationship between rectal temperature and dairy cows' performance under heat stress conditions. *Open J. Anim. Sci.,* 24–30. https://doi.org/10.4236/ojas.2016.61004,

Salla, N.S.; Haggag, M.H.; Rabeh, N.M. and Ahmed, O.M. (2020). Effect of Antioxidants of Sage tea and Marjoram tea on Advanced Renal Disease. *Egypt. J. of Nutrition and Health*, 15(2): 41-52.

Sarker, S.K.; Mostofa, M.; Akter, F.; Rahman, M.M. and Sultana, M.R. (2014). Effects of aqueous extract of Neem (*Azadirachta indica*) leaves as growth promoter and anti-colibacillosis in broilers. *Bangladesh J. Anim. Sci*., 43(2): 138-141.

SAS, Institute, (2002). *SAS/ STAT User's Guide Sstatistics*. SAS Institute INC. Cary, NC, USA.

Sejian, V.; Bhatta, R.; Gaughan, J.B.; Dunshea, F.R. and Lacetera, N. (2018). Review: adaptation of animals to heat stress. *Animals,* 12, S431–S444.

Shan, B.; Cai, Y.Z.; Sun, M. and Corke, H. (2005). Antioxidant capacity of 26 spice extracts and characterization of their phenolic constituents. *J. Agric. Food Chem.*, 53: 7749-7759.

Sheiha, A.M.; Abdelnour, S.A.; Abd El-Hack, M.E.; Khafaga, A.F.; Metwally, K.A.; Ajarem, J.S.; Maodaa, S.N.; Allam, A.A. and El-Saadony, M.T. (2020). Effects of dietary biological or chemical-synthesized nano-selenium supplementation on growing rabbits exposed to thermal stress. *Animals*, 10: 430.

Simonová, M.P.; Chrastinová, Ľ.; Kandričáková1, A.; Kubašová1, I.; Formelová, Z.; Chrenková, M.; Miltko, R.; Belzecki, G.; Strompfová, V. and Lauková1, A. (2020). Enterocin M and Sage Supplementation in Post-weaning Rabbits: Effects on Growth Performance, Caecal Microbiota, Fermentation and Enzymatic Activity. *Probiotics and Antimicrobial Proteins*, 12: 732-739.

Sithisarn, P.; Supabphol, R. and Gritsanapan, W. (2006). Comparison of free radical scavenging activity of Siamese neem tree (*Azadirachta indica* A. Juss var. siamensis Valeton) leaf extracts prepared by different methods of extraction. *Medical Principles and Practice*, 15(3): 219–222.

Sombatsiri, K.; Ermel, K. and Schmutterer, H. (1995). Other Meliaceous plants containing ingredients for integrated pest management and further purpose. In H. Schmutter (Ed.), The Neem tree Azadirachta indica A. Juss and other meliaceous plants. Germany: VCH pp. 585-597.

Szabóová, R.; Lauková, A.; Chrastinová, Ľ.; Simonová, M.; Strompfová, V.; Haviarová, M.; Plachá, I.; Faix, Š.; Vasilková, Z.; Chrenková, M. and Rafay J. (2008). Experimental Application of Sage in Rabbit Husbandry. *ACTA VET. BRNO* 2008, 77: 581-588.

Tietz, N.W. (1982). *Fundamental Of Clinical Chemistry*. Edition by Norbert Sounder Company, Philadelphia, USA.

Trocino, A.; Cotozzolo, E.; Zomeño, C.; Petracci, M.; Xiccato, G. and Castellini, C. (2019). Rabbit production and science: The world and Italian scenarios from 1998 to 2018. *Ital. J. Anim. Sci*., 18: 1361-1371.

Wang, S.; Zhang, L.; Li, J.; Cong, J.; Gao, F. and Zhou, G. (2017). Effects of dietary marigold extract supplementation on growth performance, pigmentation, antioxidant capacity and meat quality in broiler chickens. *Asian-Australas J. Anim. Sci*., 30: 71–77.

Wintrobe, M.M. (1965). *Clinical Hematology*, Lead and Fibiger Philadelphia, USA.

Younis, F. E.; Basyony, M. A.; Abou-Elezz, S. S.; El-Bolkiny; Y. E. and S. T. El-Shehry (2018). Comparative Study of Heat Stress Effect on Thermoregulatory and Physiological Responses of Baladi and Shami Goats in Egypt. *J. Animal and Poultry Prod., Mansoura Univ*., 9 (6): 271 – 275.

تأثير المستخلص المائي لاوراق المرمارية والنيم علي صفات النمو والذبيحة والصفات الهيماتولوجية لارانب الابري النامية تحت ظروف موسمي الصيف والشتاء

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الهدف من هذه الدراسة هو دراسة تأثير تناول المستخلص المائي لاوراق نباتي المرمارية والنيم على الاداء الانتاجي وخصائص الذبيحة وبعض المعايير الهيماتولوجية للارانب النامية تحت ظروف موسمي الصيف والشتاء. تم اجراء تجربتيين احدهما في فصل الصيف والاخري في فصل الشتاء

حيث تم تقسيم كل تجربة بعدد ٤٠ من الارانب النامية الي اربع مجاميع كل مجموعة تحتوي علي ١٠ من الارانب النامية من نوع الابري. المجموعة الاولي هي المجموعة المقارنة بينما المجموعة الثانية والثالثة تناولت يوميا ٢٠٠ ملجم و٥٠ ملجم من المستخلص المائي لكل من اوراق المرمارية والنميم لكل كيلوجرام وزن جسم علي التوالي بينما المجموعة الرابعة تناولت الخليط من كلا المستخلصين بنفس الجرعات. استمرت المعاملة لمدة ٨ اسابيع خلال كل من فصل الصيف والشتاء.

اظهرت النتائج ان اداء الارانب النامية في كل من الصفات الانتاجية والهيماتولوجية وصفات الذبيحة كان افضل اثناء فصل الشتاء مقارنا بفصل الصيف. اظهرت مقاييس الحرارة والرطوبة ودليل الحرارة و الرطوبة الي تعرض الارانب النامية تحت الدراسة الي اجهاد حراري شديد حيث تراوحت درجة الحرارة ما بين ٣٢ الي ٣٥°م وان دليل الحرارة و الرطوبة تراوح ما بين ٣١-٣٣درجة مما اشار الي تعرض الارانب النامية الي اجهاد الحراري عالي الشدة اثناء فصل الصيف مما يسبب اضرار فسيولوجية وبيولوجية علي الارانب النامية. اظهرت النتائج ان المعاملة بالمستخلص المائي لاوراق المرمارية والنيم وخليطهما بالجرعات الموصي بها تحسن في وزن الجسم النهائي ووزن الجسم اليومي المكتسب ومعدل التحويل الغذائي وانخفاض في وزن العلف المأكول والماء المتناول ودرجة حرارة الجسم وكذلك اظهر تحسن في صفات الذبيحة والصفات الهيماتولوجية مقارنا بالمجموعة المقارنة.

التوصية: تلخص النتائج ان استخدام المستخلص المائي لاوراق المرمارية والنيم وخليطهما بالجرعات الموصي خاصا اثناء فصل الصيف حيث تعرضت الارانب النامية لاجهاد حراري شديد قد حسن بدرجة ملحوظة من الاداء الانتاجي والفسيولوجي للارانب النامية.