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Impact of Using Aqueous Rosemary Extract on Hematological Parameters, Carcass Traits, Meat Chemical Composition and Economical Efficiency of Rabbits Under New Valley Conditions

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Abstract

This work investigated the impacts of aqueous rosemary extract (ARE) on hematological parameters, carcass traits, and meat chemical composition of rabbits. Forty eight healthy growing rabbits at 30 d of age were randomly split into 4 groups with 4 replicates (3 rabbits each) per group. All rabbits were randomly assigned to treatment groups. The 1st group was treated as control. The 2nd to 4th groups were received daily water supplements with ARE at doses of 5, 7.5, and 10 ml/L, respectively. The whole experiment lasted 60 days. Results showed that there were no changes in hematological parameters among treatments. Additionally, significant increase was observed for carcass performance, including the weight of the hot carcass, carcass yield, organs weights, and carcass parts. No significant differences among treatments in the composition of meat were observed. The highest value ($P<0.05$) of economic efficiency, net revenue and relative economic efficiency was recorded in rabbits treated with ARE. The presented results concluded that ARE supplementation improves carcass performance, meat chemical composition and economic efficiency in growing rabbits under New Valley conditions.

Keywords: Aqueous rosemary extract; Growth performance; Carcass traits; Rabbits

Introduction

Developing nations experience a deficiency in the supply of animal protein. Ruminants, including cattle, goats, and sheep, has struggled to bridge the gap due to extended generation intervals, shortages of feed and fodder, and disease prevalence **(FAO, 2017).** Recently, there has been growing interest in the benefits of rabbit production in developing countries as a strategy to alleviate shortages of animal protein (**Wongnaa et al., 2023**). The benefits of rabbits mostly stem from their elevated reproductive rate, swift maturation, rapid development, efficient feed and land use, less competition for human food, and high-quality nutritious meat (**Badawi et al., 2016**).

Rabbits (Oryctolagus cuniculus) are a small, domesticated mammal popularly known for its high reproduction and the quality of their meat (**Kitavi et al., 2015; Mokoro et al., 2015**). Rabbits are prolific animals that produce large amounts of meat for human consumption. **FAO (2010)** states that rabbits are also considered herbivores that effectively turn grass into feed. Because they convert food to meat more efficiently than other animals, rabbits develop quickly (**Kitavi et al., 2015**). Production of rabbits necessitates a minimal initial investment, limited space, rapid reproduction, and the capacity to consume fibrous feeds unsuitable for human use (**Mokoro et al., 2015**).

Today, great attention has been paid to the use of herbs and medicinal plants, as feed additives in rabbits (**Mohamed et al., 2025: Soliman et al., 2025**) because of their beneficial effects on feed consumption, immune stimulation and digestive secretions. They also act as antibacterial, antiviral, coccidiostatical, and Anti-inflammatory substances (**Al-Dabbas et al., 2010**). These similarities make the use of medicinal plants a promising way to increase production performance of rabbits instead of using industrial growth promoter.

Rosemary (*Rosmarinus officinalis* L.) is a medicinal herb from the Lamiaceae family, with extracts typically obtained from its leaves and flowers using distillation, hydro-distillation, and maceration **(Andrade et al., 2018).** The main phytochemicals in rosemary extract (RE) are phenolic compounds, terpenes, including caffeic acid, camphor, carnosic acid, carnosol, ursolic acid, and rosmarinic acid **(Catherine et al., 2010).** RE exerted various pharmacological and biological activities such as antioxidant, anti-inflammatory, and antibacterial effects **(Yao et al., 2023)**. Dietary rosemary could alleviate the oxidative damage in animals and decrease the lipid peroxidation, showing an anti-oxidative effect **(Yang et al., 2021).**

Rabbit production under the environmental conditions of the New Valley represents a promising strategy for enhancing sustainable livestock development in arid regions. The New Valley, located in western Egypt, is characterized by extreme temperatures, low humidity, and limited water availability (**Kassab et al., 2021: Soliman *et al.,* 2024**) factors that pose significant constraints to conventional livestock farming. Rabbits demonstrated a high degree of adaptability to such harsh conditions due to their low maintenance requirements, minimal competition with humans for food, and efficient feed conversion rates. Moreover, their rapid reproductive cycles and high prolificacy enable continuous meat production throughout the year (**Kitavi et al., 2015**). When supported by appropriate housing, ventilation, and thermal stress management practices, rabbit farming can contribute meaningfully to improving animal protein supply and supporting rural livelihoods in arid and semi-arid environments such as the New Valley. Therefore, this trail was designed to found the impact of ARE on hematological parameters, carcass traits, meat chemical composition and economic efficiency of rabbits, aiming to provide evidences for the use of rosemary as rabbits feed additive.

Materials and methods

This work was conducted in a private farm located in Elkharga city, New Valley governorate, Egypt; located at 25°27'36.0"N 30°32'49.8"E, during the period from January to February 2024.

Animals feeding system and experimental design

A total 48 growing New Zealand white (NZW) rabbits aged 30 days (average IBW 446.3±6.91 g) were used in this trail. Rabbits were divided randomly into 4 groups (n = 12, 4 replicates, 3 rabbits in each replicate). The 1st group treated as control. The 2nd to 4th groups were received daily drinking water supplements with ARE at doses of 5, 7.5 and 10 ml/L, respectively. Every 3 rabbits were kept in a galvanized wire crate (60 cm × 40 cm × 30 cm) that had an automated nipple drinker and a fee der. The average ambient temperature was 18–26 ◦C and the daily photoperiod was a 16:8 h light-dark cycle with a semi-continuous lighting program. All rabbits were accommodated to the experimental conditions for 7 days before the beginning of the experiment and fed on the control diet. The basal diet was formulated and pelleted according to **NRC (1977)**. The ingredients of the basal diet and the composition of the basal diet are shown in Table 1.

Table (1): Feed ingredients and chemical determined composition of the basal diet

Ingredients	kg/ton	Chemical composition	% of DM basis
Yellow corn	120.0	Crude protein	17.2
Barley	140.0	Crude fiber	13.6
Molasses	30.0	Ether extract	2.8
Alfalfa hay	350.0	Nitrogen-free extract	56.8
Wheat bran	150.0	Ash	9.6
Soybean meal 44%	190.0		
Dicalcium phosphate	6.0		
Limestone	7.0		
Sodiumchloride	4.0		
Vitamin and minerals premix	3.0		

Blood Sampling

For hematological analysis, on the 90st day of feeding, five rabbits per group were chosen at random to have blood samples taken from the ear vein in an anticoagulant tube containing EDTA. Anti-coagulated blood was analyzed for white blood cell (WBC) count, red blood cell (RBC) count, hemoglobin (HGB), hematocrit (HCT), and platelet (PLT) concentrations were calculated by *(Dirui Bcc-3600).*

Slaughter traits

Twenty male rabbits, five in each group, were randomly selected for slaughter following the feeding experiment. They were fasting for twelve hours. The next day, rabbits were weighed (PSW) and slaughtered within two hours at the farm's butcher. The skin, distal portion of the legs, bladder, digestive tract, and genitalia were removed following full bleeding. The hot carcass (HC) and internal organs (liver, spleen, kidneys, heart, and lungs) were weighed. Carcass parts (legs, loin, thorax, shoulders, and head) were weighed.

The carcass yield was calculated as follows:

$$\text{Carcass yield} = \frac{\text{HC}}{\text{PSW}} \times 100\ (\textbf{Farag et al., 2024})$$

Meat quality

Chemical analysis of hind leg meat (protein, fat and ash) were analyzed according to **A. O. A. C (2012).**

Economic efficiency

The prices of the ingredients and medicinal plants used in the experiment were estimated according to the market price during the study period (January and February 2024) for the economic evaluation of the feed.

The economic efficiency was estimated by

$$Feed\ cost = number\ of\ kg\ feed\ per\ rabbit\ x\ price\ of\ kg\ feed.$$

$$Selling\ revenue = BWG\ per\ rabbit\ X\ price\ of\ kg\ for\ BW$$

$$Net\ revenue = selling\ revenue - feed\ cost.$$

$$E.FE = \left(\frac{net\ revenue}{feed\ cost}\right) x\ 100.$$

$$R.E.E, \quad assuming\ control\ treatment = 100\%$$

Statistical analysis:

Data were statistically analyzed by one- way ANOVA using software (**SAS, 2004**). The following statistical model was used:

$$Y_{ij}=\mu+R_i+e_{ij}$$

Where: μ is the overall mean of Y_{ij}; R_i is the effect of treatment; e_{ij} is the experimental error

Duncan's new multiple range test **(Duncan, 1955)** was used to calculate differences between means.

Results and Discussion

Hematological parameters

As shown in Table (2) adding ARE to drinking water of rabbits reduced the WBCs in comparison to the control group. While, no significant differences were shown among treatments. Similar results were found by, **Attia et al. (2017)** who noted that rosemary leaves had no influence on the majority of WBC parameters and adding them at a rate of 0.5 to 1% was safe for male rabbits. Furthermore, HCT, HGB and RBC counts all increased with ARE treatments, indicating that rosemary promoted HGB and RBCs synthesis. At the same time, **Shokrollahi et al. (2015)** who stated that RBCs and HGB were raised in treated rabbits with rosemary extract. All hematological parameters were within the normal ranges for rabbits according to **Hewitt *et al.* (1989**).

Table (2): Hematological parameters of growing NZW rabbits as affected by ARE

Parameter	Experimental rations				±SEM	P-values
	Control	T1	T2	T3		
WBCs(x10^3/µl)	14.27	13.20	13.87	12.57	0.587	0.8233
RBC's (x10^6/µl)	5.61	5.85	5.76	5.87	0.117	0.9044
Hemoglobin (g/dl)	10.83	12.20	11.67	12.83	0.312	0.1559
Hematocrit (%)	40.10	41.70	39.40	38.40	1.014	0.7880
Platelets (x10^3/µl)	164.00	168.33	169.67	179.33	12.04	0.9846

RBC, red blood cell ; WBC, White blood cell

Carcass characteristics:

Carcass characteristics of growing NZW rabbits as affected by addition ARE summarized in Table (3). It was noted that rabbits that received ARE significantly higher (P<0.05) PSW, HC, heart, head thorax and loin weights compared to control. While, the differences of carcass yield, kidneys, lungs, spleen, shoulders, and legs are not significant. The present results summarized that rabbits received ARE showed higher carcass yield.

In consistent with the current findings, the rabbits fed diets enriched with either oregano extract, RE, or both showed a larger carcass yield (%) than the control rabbits (**Cardinali et al., 2015**). Additionally, adding thyme essential oil to the rabbit's diet improved carcass criteria and decreased perirenal and scapular fat without compromising internal organs (**El-Adawy et al., 2020**). However, **El-Gogary et al. (2018)** noted that RE supplementation had no effect on carcass traits of rabbits. At the same time, the majority of rabbit carcass characteristics were not substantially impacted by feeding diets enhanced with peppermint essential oil, basil essential oil, or both **(Zweil et al., 2019).**

Table (3): Carcass traits of growing NZW rabbits as affected by ARE

Parameter	Experimental rations				±SEM	P-values
	Control	T1	T2	T3		
Initial body weight (g)	460.63	439.38	445.00	440.00	6.914	0.7042
Pre-slaughter weight (g)	1826.67[b]	1991.67[a]	1993.33[a]	1836.67[b]	25.94	0.0034
Hot carcass weight (g)	937.40[c]	1094.99[a]	1046.72[ab]	996.52[bc]	19.17	0.0055
Carcass yield (%)	51.34	54.97	52.52	54.27	0.638	0.2060
Organs weight (g)						
Liver	67.17	72.74	69.72	74.07	2.466	0.8413
Heart	4.32[b]	5.01[ab]	5.57[a]	5.56[a]	0.181	0.0271
Kidneys	12.87	13.31	12.45	13.35	0.269	0.7057
Lungs	11.75	12.64	11.26	12.36	0.717	0.9393
Spleen	1.35	1.46	1.46	2.06	19.76	0.2358
Carcass parts (g)						
Head	101.22[b]	109.15[a]	105.10[ab]	106.82[a]	1.054	0.0394
Shoulders	175.49[b]	210.93[a]	196.65[ab]	182.73[ab]	5.202	0.0693
Legs	314.51[b]	368.01[a]	346.24[ab]	331.33[ab]	5.932	0.0830
Thorax	149.81[b]	175.41[a]	178.19[a]	180.99[a]	3.888	0.0010
Loin	196.37[b]	231.48[a]	220.55[ab]	194.64[b]	7.682	0.0587

[a,b] *Means in the same row lacking a common superscript differ (P<0.05)*

Meat chemical composition

Results presented in Tables (4) showed that the chemical composition of meat was not affected by ARE. These results are in line with **Elazab et al. (2022)** who found that rosemary essential oils supplementation (0.25-0.5%) had no significant effects on meat composition traits of NZW rabbits. Also, **Cardinali et al. (2012)** indicated that rosemary (0.2% rosemary aqueous extract) aqueous extract had no effect on the moisture, crude protein, lipid, cholesterol and ash contents of Longissimus dorsi meat in rabbits.

Table (4): Chemical analysis of hind leg meat of growing NZW rabbits as effected by ARE

Parameter	Experimental rations				±SEM	P-values
	Control	T1	T2	T3		
Protein	21.58	21.77	22.04	21.23	0.157	0.4014
Fat	2.95	2.89	2.83	2.98	0.057	0.8615
Ash	2.47	2.54	2.41	2.60	0.055	0.7334

Economic efficiency

Economic efficiency results of rabbits treated with ARE were summarized in Table (5). The highest value (P<0.05) of economic efficiency, net revenue and REE was recorded in rabbits treated with ARE.

Recent studies have demonstrated the positive effects of rosemary and other medicinal plants on the growth and economic efficiency of rabbits. Supplementing rabbit diets with rosemary leaves at 0.5% significantly improved feed conversion ratio, body weight gain, and nutrient digestibility compared to control groups (**Elwardany et al., 2022**). The economic efficiency of rabbit production was also improved with rosemary supplementation (**Elwardany et al., 2022; Bakr et al., 2017).** Some studies consistently show that rosemary, along with other herbs like thyme, black cumin, and fenugreek, can positively impact rabbit performance, digestibility, and carcass traits, leading to better economic outcomes in rabbit farming **(Mousa et al., 2021; Elwardany et al., 2022).**

Table (5): Economic efficiency of the experimental diets

Parameter	Experimental rations			
	Control	T1	T2	T3
Total number of rabbits	12	12	12	12
Average CFM intake (kg/d)	4.577	4.588	4.584	4.586
Costing of one kg feed, (LE)	16.5	16.75	16.8	16.85
Feed cost * (L.E/50 days)	75.52	76.85	77.01	77.27
Average body weight gain (kg)	1.319	1.548	1.583	1.353
Price /kg live body (LE)	125	125	125	125
Selling revenue ** (L.E)	164.88	193.5	197.88	169.13
Net revenue (L.E)	89.35	116.65	120.86	91.85
E.EF (%)	118.32	151.79	156.94	118.86
R.E.E (%)	100	128.29	132.64	100.46

Both the improved feed conversation ratio and the increased final BW of these diets with feed additives may be responsible for the increase in economic efficiency. According to the study's results, adding herbal plants to rabbits' diets is important. Results found positive effects of ARE on hematological parameters, carcass treats and economical efficiency. The aforementioned findings indicated that the rabbits' diets should include additional herbal and medicinal plants.

Conclusion

In conclusion, supplementation of drinking water with aqueous rosemary extract in New Zealand White rabbits significantly improved carcass performance, meat chemical composition, and economic efficiency under New Valley conditions.

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Conflicts of Interest/ Competing interest

The authors declare that they have no competing interests.

Ethical statement

This experiment was performed in accordance with the internationally accepted standard ethical guidelines for animal use and care.

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