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A systematic review on phytogenic feed supplements on the nutritive effects, physiological responses and reproductive parameters in rabbits

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ABSTRACT

The tropics, particularly Nigeria, have been plagued by reduced meat production, antibiotic resistance, lipid peroxidation of meat and meat products, and subpar animal performance. The health and agricultural sectors have been severely impacted by the food crisis, the risk of farmers and animal producers not adhering to antibiotic withdrawal periods, and the high temperatures experienced in the tropics. Over time, antibiotic resistance causes cancer in the end users. On the other hand, meat degradation or spoiling has been linked to lipid peroxidation, which is brought on by high temperatures that create oxidative stress conditions. This paper looks at the basic issues that rabbit farmers face as well as the beneficial solutions that may be implemented through the administration of essential oils and phytogenic feed supplements, as well as the effects these treatments have on various physiological, reproductive, and nutritional parameters. The study used a qualitative analysis approach and drew on secondary sources, including internet publications, textbooks, and journals. Phytogenic supplementation has been found to promptly enhance consumer health and increase animal output by improving production indices and providing a suitable remedy to the challenges associated with antibiotic resistance and lipid peroxidation brought on by climate change.

Tavşanlarda fitojenik yem takviyelerinin besleyici etkileri, fizyolojik tepkileri ve üreme parametreleri üzerine sistematik bir inceleme

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ÖZET

Tropikal bölgeler, özellikle Nijerya, azalan et üretimi, antibiyotik direnci, et ve et ürünlerinde lipid peroksidasyonu ve düşük hayvan performansı gibi sorunlarla karşı karşıyadır. Gıda krizi, çiftçilerin ve hayvan üreticilerinin antibiyotik çekilme sürelerine uymama riski ve tropik bölgelerdeki yüksek sıcaklıklar, sağlık ve tarım sektörlerini ciddi şekilde etkilemektedir. Zamanla, antibiyotik direnci nihai tüketicilerde kansere yol açabilir. Öte yandan, yüksek sıcaklıkların oksidatif stres koşulları yaratması nedeniyle ortaya çıkan lipid peroksidasyonu, etin bozulmasıyla ilişkilendirilmiştir. Bu makale, tavşan yetiştiricilerinin karşılaştığı temel sorunları ve bu sorunlara esansiyel yağlar ile fitojenik yem takviyeleri yoluyla uygulanabilecek faydalı çözümleri ele almakta ve bu uygulamaların çeşitli fizyolojik, üreme ve beslenme parametreleri üzerindeki etkilerini incelemektedir. Çalışma, nitel analiz yaklaşımı kullanılarak gerçekleştirilmiş olup, internet yayınları, ders kitapları ve akademik dergiler gibi ikincil kaynaklardan yararlanılmıştır. Fitojenik takviyelerin, üretim parametrelerini iyileştirerek hayvan verimliliğini artırdığı, antibiyotik direnci ve iklim değişikliğinin neden olduğu lipid peroksidasyonuna karşı etkili bir çözüm sunduğu ve böylece tüketici sağlığını hızla iyileştirdiği bulunmuştur.

1. Introduction

The demand for animal protein is steadily increasing as a result of the world's population expansion, rising incomes, and shifting consumer tastes (Anaso 2023a; FAO, 2009). The severe meat shortage in Nigeria brought on by farmer-herder conflicts, the global pandemic, and unfavorable economic policies has forced livestock farmers to enhance the use of feed resources, the health of their animals, and the amount of meat that they produce (Emmanuel and Alhassan, 2025; Anaso et al., 2024b; Anaso et al., 2021). The cultivation of extremely productive monogastrates with brief production cycles, such as rabbits, can helps fill this gap (Anaso et al., 2024b). Because of their high fertility and quick growth rates, rabbits are a great source of animal-based meat and protein (Anaso, 2024; Dalle and Zotte, 2002). High-quality rabbit meat is distinguished by its low calorie content, sufficient animal protein, and polyunsaturated fatty acids (El-gogary et al., 2018). One of the main climatic factors that always affects rabbit farming and productivity is the tropical climate, which is characterized by high temperatures. Rabbits have a restricted ability to adapt to hot temperatures since they rely heavily on respiratory evaporation to regulate their body temperature (Mailafia et al., 2010). Oxidative stress causes lipid peroxidation, a significant issue in rabbit production that degrades the final product (meat) (El-gogary et al., 2018). Furthermore, because it produces malondialdehyde and other harmful chemicals, lipid oxidation has a negative effect on the quality of meat (Anaso, 2023b). According to reports, the latter has a detrimental effect on people's health (Koné et al., 2016; Cardinali et al., 2015). Other than antibiotics and ionophores, feed additives have recently been employed to improve rabbit productivity and reproductive performance as well as feed utilization (Ismail et al., 2019; Tufarelli et al., 2017; Dhama et al., 2015;). To increase feed efficiency and animal health, feed additives have been used in ruminant diets (Kholif et al., 2017, 2020; Morsy et al., 2018) and more recently in monogastric diets for horses (Elghandour et al., 2016; Elghandour et al., 2014) and rabbits (Abo Hafsa et al., 2016; Gado et al., 2016; Cervantes Valencia et al., 2015). In animal feed, feed additives like essential oils (EOs), spices, and herbs have been effectively used to reduce Pseudomonas species, Enterobacteriaceae, and total mesophilic aerobes (Tufarelli et al., 2017; Koné et al., 2016; Soultos et al., 2009). The threat of antibiotic-resistant bacteria and the recent prohibition of antibiotic growth promoters by several nations have forced the search for alternatives to increase animal productivity while reducing negative effects on human consumers. The use of phytogenics as alternative feed additives in animal nutrition has been the subject of much research as a result of this ban. Essential oils and other phytogenic materials are widely utilized in the food and feed industries and are usually thought to be safe. As a phytogenic feed ingredient, EOs' effects on livestock's intestinal health, antioxidant status, and antibacterial activity are thought to be crucial for biological processes (Ahmed & Abdallah, 2020). According to Miguel (2010), essential oils, also known as volatile oils, are mostly aromatic, oily liquids that are extracted through distillation from various plant components, including flowers, buds, seeds, leaves, twigs, bark, wood, fruits, and roots. These extracts are steam-volatile or, more accurately, organic solvents that have been employed for ages in a variety of cultures around the world. They are mostly recognized for their flavorful and fragrant qualities, as well as their ability to preserve food (Anaso, 2023b). Terpenes, alcohols, acetones, phenols, acids, aldehydes, and esters are among the many distinct chemicals that are typically included in EOs (Negi, 2012). These compounds can defend against attacks by bacteria, fungi, or insects. Numerous beneficial impacts on feed utilization, animal health, and rabbit live performance have been documented by studies on EOs (Celia et al., 2016).

According to Anaso (2023a) and Anaso (2023b), using essential oils and phytogenics as supplements or administrations can help Nigeria address the issues of antibiotic resistance and lipid peroxidation, which causes meat to spoil. Essential oils and phytogenic supplements can be used in conjunction with antibiotics to provide improved results and reduce the risk of noncompliance with withdrawal periods (Anaso, 2023a). The administration of essential oils and phytogenics as supplements to livestock diets has been shown to increase productivity without compromising health in numerous empirical studies (Ceraulo et al., 2022; Ilyas & Sapuan, 2020).

2. Literature Review

The following are the factors of essential oil supplementation to be considered:

I. Effect of phytogenic supplements and essential oil on voluntary feed intake, digestibility and body weight gain
II. Effect of phytogenic supplements and essential oil on apparent digestibility and nutrient utilization
III. Effect of phytogenic supplements and essential oil on Blood profile and oxidative stress indices
IV. Effect of phytogenic supplements and essential oils on semen characteristics
V. Effect of phytogenic supplements and essential oils on body thermoregulatory parameters
VI. Effect of phytogenic supplements and essential oil on carcass characteristics and meat quality
VII. Effect of phytogenic supplements and essential oils on caecal microbial and fermentation profile

2.1. Effects of Phytogenic Supplements on Voluntary Feed Intake, Digestibility and Body Weight Gain

Anaso et al. (2025b) in an experiment using forty-five clinically healthy weaned male Dutch rabbits of about five weeks of age were used in a 12-week experiment. The rabbits were randomly divided into three treatment groups, with fifteen rabbits per group, and balanced for their body weight such that rabbits in each group had similar average initial body weight (BW) of 262.89 ± 22.36 g in a completely randomised design. Treatment 1 was a basal control diet without *Piliostigma thonningii* essential oil (PEO) supplementation (T1). In treatments 2 and 3, the basal control diet was supplemented with 2 ml PEO/kg diet (T2) and 4 ml PEO/kg diet (T3), respectively. Anaso et al. (2025b) reported that supplementation with PEO significantly improved feed and nutrient intake in rabbits. In their study, which examined the effects of PEO on nutrient intake, serum biochemical parameters, and immune/oxidative stress responses, a progressive increase was observed across treatment groups in the intake of dry matter (DM: 28.32–40.80 g/day), crude protein (CP: 4.68–6.74 g/day), ether extract (EE: 0.64–0.92 g/day), crude fibre (3.77–5.42 g/day), neutral detergent fibre (NDF: 9.07–13.08 g/day), acid detergent fibre (ADF: 5.30–7.63 g/day), ash (2.67–3.85 g/day), organic matter (OM: 25.64–36.95 g/day), and nitrogen-free extract (NFE: 16.56–23.85 g/day). These parameters showed statistically significant differences ($P < 0.05$), with the highest values recorded in the T3 group and the lowest in the T1 group. The authors attributed these improvements to the organoleptic properties of PEO, which is a monoterpene hydrocarbon containing bioactive compounds such as β-myrcene and limonene. These compounds are believed to enhance feed palatability, particularly at higher inclusion levels, thereby promoting increased feed consumption in the T3 group.

According to El-Nomeary et al. (2020), a number of essential oils, including juniper, cinnamon, and garlic, were added to the basic diet as feed additives at a rate of 0.5 milliliters per kilogram of rabbits' food. This supplementation did not negatively impact the rabbit's overall performance, however it positively impacted on its growth and digestion indicated by improved the feed conversion ratio (FCR) in experimental rabbits. About 72 post weaned male New Zealand White rabbits were used in the experiment. The results highlighted garlic essential oil increased the total body weight gain and average daily weight gain by approximately 12.4% compared to the control group.

Similarly, Ahmed et al. (2019) found that rabbits administered dietary supplements of phytogenics and Eos' such thyme oil (THY) and betaine (BET) had considerably higher digestible energy and dry matter digestibility.

Ahmed et al. (2019) conducted an eight-week experiment with 72 growing New Zealand white (NZW) male rabbits divided into 9 experimental groups. While the other groups were given the same basal diet supplemented with 1500 mg BET (T2), 750 mg BET (T3), 1000 mg THY (T4), 500 mg THY (T5), 1500 mg BET and 1000 mg THY (T6), 1500 mg BET and 500 mg THY (T7), 750 mg BET and 1000 mg THY (T8), and 750 mg BET and 500 mg THY (T9), the control group was given a basal diet without supplementation (T1). The findings also demonstrated that rabbits fed T2, T3, T4, T6, and T9 diets had significantly higher digestible energy and feed dry matter digestibility. Unlike El-Nomeary et al. (2020), they found that rabbits fed the T4, T5, T7, T8, and T9 diets had significantly lower levels of ammonia nitrogen and total volatile fatty acids in their cecum content when compared to those fed the control diet (T1). It was determined that to increase the feed utilization, growth performance parameters, and overall health of NZW rabbits, dietary supplementation with 1500 mg of betaine or 1000 mg of thyme oil/kg diet, or a combination of the two, at the same levels, is advised.

By examining the effects of supplemental dietary extra virgin olive oil (EVOO), gallic acid (GA), or lemongrass essential oil (LGEO) on growth performance and nutrient digestibility, Al-Sagheer et al. (2017) came to the conclusion that adding these oils to a growing rabbit's diet could be an effective way to mitigate the negative effects of heat stress load on performance, nutrient digestibility, and nutrient digestibility. According to Ahmed et al. (2018), adding up to 100 mg of thyme essential oil (EO) to a rabbit's ration together with 1.50 g of olive oil can be a useful feed addition for young or growing rabbits to enhance their performance in hot and stressful environments.

2.2. Effects of Phytogenic Supplements on Apparent Digestibility and Nutrient Utilization

The bioactive substances in EOs have not yet described their mode of action (MOA) well. However, the MOA of EOs on the digestion of nutrients has been explained by several different mechanisms. According to several writers, using EOs might increase the activity of digestive enzymes including trypsin and amylase (Jang et al., 2004). Other authors have suggested that EOs can also increase the production and secretion of bile acids (Platel and Srinivasan, 2004). Dry matter (DM) digestion was unaffected by the addition of varying experimental amounts of EOs to the laying hen's diet, according to Ding et al. (2017).

In comparison to the control group, Anaso et al. (2025d) found that rabbits supplemented with PEO (T2 and T3) had similar and higher ($P < 0.05$) digestibility in terms of dry matter digestibility (60.10 – 70.98%), crude protein digestibility (68.72 – 76.50%), crude fiber digestibility (34.69 – 46.03%), NDF digestibility (38.09 – 54.26%), and organic matter digestibility (58.35 – 66.39%). Compared to T1 and T2, which exhibited comparable digestibility ($P > 0.05$), T3's ether extract digestibility (53.92 – 73.26%) was higher ($P < 0.05$). T3 had the highest ADF digestibility (29.22–45.37%), whereas T1 had the lowest ($P < 0.05$). However, T1 and T2 and T2 and T3 were equal ($P > 0.05$). PEO supplementation was found to improve growth performance, feed utilization efficiency, nutrient digestibility, and the caecal fermentation characteristics of rabbits.

According to Radwan Nadia et al. (2008), the digestibility of organic matter (OM) was unaffected by the addition of 0.5% to 1.0% of essential oils (EOs) from thyme, oregano, rosemary, or curcuma to the diet of laying hens. According to Yu et al. (2018), laying hens' ability to digest OM was enhanced by the addition of varying amounts of anise oil (200, 400, and 600 mg/kg). However, other studies have found that adding EOs to laying hens boosted their crude protein (CP) digestibility (Ding et al., 2017 and Yu et al., 2018). However, no effect was discovered in another study (Radwan et al., 2008). In contrast to the control, Arslan et al. (2022) found that the addition of EOs at 100 or 200 mg/kg improved the digestion of dry matter, organic matter, and crude protein.

2.3. Effects of Phytogenic Supplements on Blood Profile and Oxidative Stress Indices

The hematological parameters of the rabbits fed a diet supplemented with PEO are shown by Anaso et al. (2024c). According to the research, across treatment groups, Packed call volume (PCV) ranged from 38.00 to 49.95%, Hemoglobin (Hb) from 13.13 to 18.50 g/dL, Red blood cell volume (RBC) from 11.87 to 17.52 x10^6/L, White blood cell volume (WBC) from 5.60 to 8.77 x10^9/L, Mean corpuscular hemoglobin concentration (MCHC) from 29.80 to 35.91%, and neutrophil from 22.45 to 32.78% for T3 > T2 > T1 ($P < 0.05$). T1 had lower values ($P < 0.05$) than T2 and T3, which had similar values (P >

0.05). The Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH), lymphocytes, monocytes, and platelets were 58.02, 64.02, and 65.12 fl; 17.46, 22.45, and 23.67 pg, 49.80, 70.40, and 73.07%; 1.28, 2.40, and 2.72% and 340.16, 530.74, and 580.11 x10^3/uL for T1, T2, and T3, respectively. Eosinophil levels in T3 were greater ($P < 0.05$) than in T1 and T2, which were comparable ($P > 0.05$), and ranged from 1.36 to 2.22%. The neutrophil/lymphocyte ratio (0.41 - 0.45) was similar ($P > 0.05$) between T1 and T2, as well as between T2 and T3; however, it was greater ($P < 0.05$) in T3 than in T1. Likewise, the serum biochemical characteristics of rabbits given PEO are displayed by Anaso et al. (2025). With T1 having the lower value ($P < 0.05$) than T2 and T3, which had similar ($P > 0.05$) values, the trends for serum total protein (4.12 – 7.61 g/dL), serum albumin (2.40 – 4.77 g/dL), globulin (1.72 – 2.84 g/dL), glucose (104.05 – 148.58 mg/dL), and high-density lipoprotein (19.07 – 26.11 mg/dL) were similar. Serum cholesterol was lower in T2 and T3 ($P < 0.05$) than in T1, with a range of 24.18 mg/dL in T3 to 52.50 mg/dL in T1. Compared to T2 and T3, which were not substantially impacted ($P > 0.05$), T1 had increased levels of low-density lipoprotein (42.37 – 71.91 mg/dL), triglycerides (64.74 – 120.70 mg/dL), AST (35.16 – 60.16 u/L), ALT (46.17 – 61.29 u/L), and ALP (6.44 – 11.27 u/L) ($P < 0.05$). Total bilirubin and direct bilirubin were 4.43, 4.73, and 4.88 µmol/L for T2, T3, and T1, and 0.66, 0.73, and 0.78 µmol/L for T3, T1, and T2, respectively. In contrast, the mean values for uric acid, creatinine, and albumin:globulin ratio were 3.43, 3.47, and 3.64 mg/dL, 2.14, 2.25, and 2.30 mg/dL, and 0.96, 1.13, and 1.22 g/dL for T1, T2, and T3, respectively. There was no difference between the treatments ($P > 0.05$). According to Anaso et al. (2025), supplementing the rabbits with *P. thonningii* essential oil improved their immunological response, oxidative status, and serum blood profile.

According to Elghalid et al. (2020), administering lower (LA) and higher (HA) doses of a recently created blend of herbal plants and spices enhanced with unique extracts and essential oils reduced blood cholesterol, triglycerides, and low-density lipoproteins. In contrast, the LA treatment raised total antioxidant capacity and high-density lipoproteins while lowering malondialdehyde in comparison to the control treatment. Three groups of thirty rabbits each were randomly assigned to a basal diet without additives (Control rabbits) or supplemented with 0.5 mL (LA) or 1 mL (HA) of the additives mixture per litre of drinking water. The experiment was carried out using precisely 90 weaned unsexed V-Line rabbits, weighing 668.7±8.2g and aged 30±1days. The effectiveness of rosemary essential oil (REO) as a feed addition on the growth and blood components of growing NZW rabbits was also described by El-Gogary et al. (2018). Four groups of specifically thirty-six NZW were created: three treated groups and one control group. Groups 2, 3, and 4 received feeds supplemented with 0.25, 0.50, and 0.75 g/kg REO, respectively, whereas the control was given the basal diet. Therefore, it was determined that REO at 0.5 g/kg of diet has a positive effect on rabbits' antioxidant state and immunity. A total of seventy NZW male rabbits at approximately five weeks of age with similar or equal body weight were randomly assigned into seven treatment groups (10 rabbits in each group), and Bassiony et al. (2015) similarly reported a significant improvement in some blood hematology WBC, RBC, Hb, and lymphocytes when compared to the control. As a control, group one was given the basic diet without any supplements. Groups two, three, and four were given the basic diet plus 50, 100, and 200 mg of cinnamon aldehyde per kilogram of food, respectively. 50, 100, and 200 mg of thyme/kg food were added to the basic diet for groups five, six, and seven, respectively. Similar findings were reached by Abdelnour et al. (2018), who used 140 male New Zealand white rabbits that were growing weaned and found that dietary red pepper oil (RPO) or black pepper oil (BPO) supplementation greatly enhanced rabbit growth, improved immunity parameters, and enhanced antioxidant activity. Seven groups, each consisting of five rabbits and four rooms, were randomly selected from among the rabbits. At 13 weeks of age, the trial came to an end after eight weeks. The following dietary interventions were employed: C: control; RPO 0.5: 0.5 g RPO/kg food and basal diet; RPO1.0: 1.0 g RPO/kg diet; RPO1.5: 1.5 g RPO/kg diet; BPO0.5: 0.5 g BPO/kg diet; BPO1.0: 1.0 g BPO/kg diet; and BPO1.5: 1.5 g BPO/kg diet.

2.4. Effects of Phytogenic Supplements on Semen and Seminal Morphological Characteristics

As demonstrated by the significantly greater seminal characteristics or parameters, such as semen volume, motility, concentration, normal cells and life cell ratio, testis length, weight, volume, and epididymis head weight, Anaso et al. (2023) found that the inclusion of PEO in rabbits' diets was advantageous and did not pose any risks. Comparably, the results of Anaso et al. (2024a) demonstrate that the inclusion of PEO in rabbits' diet was advantageous and did not offer any risks, as evidenced by the significantly improved right and left testis length, weight, and volume.

According to El-Ratel et al. (2021), rabbit bucks randomly assigned to four experimental treatments of exactly ten rabbits each showed improvements in libido, vitality, sperm cell concentration, sperm outputs, intact acrosome and membrane integrity, progressive motility, and fertility when supplemented with extra virgin olive oil (EVOO), betaine (BET), or ginger (GIN). The first treatment served as the control group and was fed the commercial pellet diet (CPD) without any supplements. For three consecutive months throughout the summer (warm) season, the other three treatments were given the same basal CPD augmented with 300 milligrams of EVOO, 1000 mg of BET, and 200 mg of GIN per kilogram of diet.

In line with earlier research, Ahmed and Abdallah (2020) found that, after the conclusion of treatments, thyme essential oil (TEO) improved sperm motility, viability, and ejaculate volume in comparison to the positive control (PC) and negative control (NC) groups. In a study employing approximately 150 male Californian rabbits that were 70 days old and divided into five dietary treatments-a basal diet as a negative control, a basal diet supplemented with an antibiotic as a positive control, and a basal diet supplemented with 60, 120, or 180 mg/kg of TEO-it was found that abnormal sperm was significantly decreased with increasing TEO when compared to PC and NC groups. The duration of the experiment was roughly sixty days.

2.5. Effect of Phytogenic Supplements on Body Thermoregulatory Parameters of Rabbits

According to Anaso and Alagbe (2025), supplementing with *P. thonningii* essential oil improved body thermoregulation by lowering the experimental rabbits' serum mineral profile and temperature.

Extra virgin olive oil, betaine, lemongrass essential oil, gallic acid, vitamin C, and vitamin E supplements were found to have beneficial and mitigating effects on the rearing and growth of rabbits under extreme heat load in terms of decreased body temperatures (Daader et al., 2018). In this trial, rabbits were given either a diet that contained no supplements (the control group) or a supplement that contained either 200 mg of vitamin E, 1000 mg of betaine, 400 mg of lemongrass essential oil, 500 mg of garlic acid, 15 g of extra virgin olive oil, or 500 mg of vitamin C per kilogram of the basal diet.

2.6. Effect of Phytogenic Supplements on Carcass Characteristics and Meat Quality

Benlemlih et al. (2014) conducted a study to examine the effects of antibiotics and dietary supplements of thyme and fennel essential oils on rabbits' caecal microbiota and zootechnical parameters. About 40 white New Zealand rabbits that had just been weaned and were about 35 days old were split up into two groups and given two different dietary treatments: EOFT (a diet that included essential oil of *Feoniculum vulgaris* and *Thymus capitatus*) and OTC (a diet that included oxytetracycline in drinking water). After roughly 25 days of the experiment, the OTC group's mean carcass yield was higher than the EOFT group's. In contrast to the findings of Benlemlih et al. (2014), Denli et al. (2004) found no impact on carcass weight or carcass yield when quail were fed thyme essential oil. In a similar vein, Bassiony et al. (2015) investigated and assessed the impact of varying concentrations of cinnamaldehyde and thymol as essential oil bioactive compounds on growth performance, carcass traits, certain blood and caecum characteristics, and the economic efficiency of growing rabbits. They found that dietary treatments had no discernible effects on the relative weight of the carcass, digestive tract, abdominal fat, and caecum weight and length.

According to Rhouma et al. (2018), who carried out a study to assess the impact of varying thymol concentrations on zootechnical performances, caecal microflora, and the quality of rabbit carcass during the summer, adding thymol to the diet had no discernible effect on carcass yields during this time. Anaso et al. (2024d) found that supplementing the experimental rabbits with *P. thonningii* essential oil improved their carcass characteristics. They found that the ideal supplementation level was 4 ml PEO/kg diet, which was more effective at increasing the dressing percentage without compromising the meat's organoleptic qualities.

2.7. Effect of Phytogenic Supplements on Microbial and Fermentation Profile

Studies are required to assess the efficacy of antibiotics and comprehend the mechanisms underlying bacterial resistance because the current growth of multidrug-resistant bacteria has presented a serious threat to public health in Nigeria and throughout Africa (Anaso and Alhassan, 2025). In comparison to the control treatment, Elghalid et al. (2020) found that both higher and lower dose mixtures of herbal plants and spices enriched with special extracts and essential oil increased beneficial Lactobacillus spp. bacteria and decreased the concentrations of coliform bacteria and E. coli. They also found that the additives mixture improved feed conversion and daily gain and positively altered the caecal bacteria profile, with the lower dose of the phytogenic additives mixture having better results than the high dose. *P. thonningii* essential oil supplementation enhanced feed utilization, nutrient digestibility, growth performance, and decreased caecal pathogenic bacterial counts, all of which improved the experimental rabbits' health state, according to Anaso et al. (2025b). Similarly, Rhouma et al. (2018) shown that the quantity of *Lactobacilli* and *E. coli* is significantly impacted by the presence of thymol. In fact, the rabbits who received the two thymol dosages had more *Lactobacilli* than the control group. Furthermore, the quantity of *E. coli* in treatment one was decreased by this supplementation. Ninety rabbits (35 days old) were split up into three equal groups for this experiment: T: the thymol-free control group and the two thymol-containing groups (T1 and T2), which were given 200 and 300 g/T of thymol, respectively. From day 35 to day 77, duplicates of six rabbits were fed each of the three diets. However, Benlemlih et al. (2014) found no difference in the caecal counts of E. coli and *C. perfringens* between the OTC (diet with oxytetracycline in drinking water) and EOFT (diet with essential oil of *Feoniculum vulgaris* and *Thymus capitatus*) diets. 40 white New Zealand weaned rabbits (35 days old) were split into two groups and given the dietary treatments EOFT and OTC in this experiment.

3. Conclusion

Important bioactive substances with pharmacological actions and qualities, including antioxidant, antibacterial, and anti-inflammatory qualities, are included in phytogenic feed supplements that enhance rabbit growth performance, carcass features, caecal fermentation, feed and nutrient intake, nutrient digestibility, and feed utilization efficiency. By decreasing the number of harmful bacteria (*E. Coli*, *Coliform*, and *Streptococcus* spp.) and increasing the number of beneficial bacteria (*Lactobacillus* spp.), phytogenic feed supplements improve the caecal microbial profile of rabbits. They also lower rectal temperature while improving the rabbits' blood profile, oxidative status, and immune response. Additionally, supplementing the experimental rabbits' diet with phytogenic feed increases their capacity for reproduction.

4. Recommendations

All levels of government should support universities through agricultural research institutes, faculties of agriculture, and ministries of agriculture so that they can conduct additional research and work with veterinary pharmaceutical companies on simple and inexpensive extraction methods, which will increase production levels. Legislation prohibiting the illegal use of antibiotics should be a top priority for governments at all levels. This is because essential oils and phytogenic feed ingredients can be used to increase animal output.

Conflict of Interest Declaration Information

There is no conflict of interest.

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