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Effect of Some Nutraceuticals Such as Dates Fruits, L- Carnitine, Fenugreek, Royal Jelly and Silymarin on the Pregnancy and Lactational Performance of Rabbits

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ABSTRACT

One of the most significant elements affecting domestic animals' reproductive performance is feeding, particularly during the pregnancy and lactation periods. The purpose of this review is to describe what is currently known about the effect of some nutraceutical (dates fruit, L- carnitine, fenugreek, royal jelly and silymarin) on lactation, milk composition, growth performance and immunity in lactating rabbits. The benefits of using current nutraceuticals were recorded as an improvement of milk yield and its composition, kitts weights (at birth and weaning), survival rate as well as improvement the immunity, which give the positive effects on reproductive performance of rabbits. L-carnitine supplementation produces milk with higher milk fat. This may be due to greater serum triacyl glyceride concentration that was useful for milk fat synthesis. Fenugreek contains chemical components known as phytoestrogens, which give the positive effect on milk yield. Silymarin has galactagogues effect which result in an improvement of prolactin values and increases milk production. The increased milk output has a positive impact on the birth and weaning weights as well as daily growth of offspring. It can be concluded that dates, L-carnitine, fenugreek, royal jelly and silymarin have beneficial effects on milk quantity and quality, growth performance and immunity of does and their kittens.

Keywords: Rabbits, Lactation, Chemical Analysis of Milk, Growth Performance, Immunity, Dates, L-Carnitine, Fenugreek, Royal Jelly, Silymarin.

INTRODUCTION

Rabbits refers to a small mammal belonging to the *Leporidae* family in the *Lagomorpha* order (Angerbjorn, 2004). According to Zamaratskaia et al. (2023), Rabbits exhibit fast growth, brief cycles of puberty and gestation, continuous breeders and large litter sizes. Due to its brief reproductive cycle this lasts between 30 and 32 days. They can produce up to 40–60 kits annually, or 8–12 kits per litter, demonstrating their productive nature (Dalle Zotte, 2014). The Food and Agriculture

Organization reports that average production of rabbit meat was 1,156,840 ± 182,290 tones between 2010 and 2020, and average annual animal slaughter for meat consumption was 793,863,000 ± 107,399,917 (Pinto-Pinho et al., 2023). Arijeniwa et al. (2000), reported that rabbits do not compete with humans for food, and the only way to maintain their optimal performance is to combine forage and specially prepared feeds without reducing their ability to reproduce. Numerous interdependent elements, including the animal's genetic makeup, nutrition, temperature, photoperiod, and stress, affect the success of animal production and reproduction. Among these, nutrition has a significant impact on the capacity to meet goals for both reproduction and production (Iyeghe-Erakpotobor and Ashworth, 2003). According to Fellous et al. (2012), there is a growing requirement for animal sources of protein due to the increased human population in developing countries. Petracci et al. (2009) state that meat of rabbits is becoming more popular as a high- nutrient and healthy. The maintenance of an animal's ability to reproduce depends critically on nutrition. Imbalances in rabbit does' nutritional/energy requirements can causes a major metabolic problem and a negative energy balance, reducing their reproductive performance (Menchetti et al., 2020). The energy balance and physical condition of rabbit does have been demonstrated to influence reproductive efficiency (Castellini, 2007). Insufficient energy and nutrition during the reproductive cycle can lead to metabolic disorders like hypo glycemia, production of non-esterified fatty acids (NEFAs) and β-hydroxybutyrate (β-HB) from body fat (Marchiani et al., 2015). Pregnancy and lactation are physiological conditions that alter the animal metabolism (Tanritanir et al., 2009). Bell et al. (2000), reported that all metabolic pathways is necessary to support the growth of the fetus are active throughout pregnancy. The physiological and nutritional conditions of the animal have an impact on the physicochemical characteristics of the milk chemical composition (Suarez-Trujillo et al., 2021). According to studies by Więcek et al. (2018), The fatty acids (FA) composition of milk greatly affected by diet, with genetic predispositions having some influence (Kęsek et al., 2014). Date palms are rich in beneficial elements for human health. It is derived from palm trees, which belong to the genus Phoenix and family *Arecaceae*. Eighty percent of the mature date palm is made up of sugar; the remaining material is made up of fat, protein, and minerals like folic acid, copper, iron, and magnesium. Furthermore, a nursing mother needs the nutrients found in palm dates (Suyati et al., 2016). L-carnitine could be added to a doe's diet throughout the latter stages of nursing and pregnancy. Without having an unfavorable impact on hepatic or renal functions, they could enhance milk yield and composition during lactation, growth performance, and some blood components. Furthermore, using L-carnitine as antioxidants is an efficient strategy to manage oxidative stress (El-Ela et al., 2017). Human milk production is increased by the use of both herbal and pharmacological galactagogues (Khan et al., 2018). One of the most popular products is fenugreek. The pea family seed fenugreek has a number of therapeutic uses, including galactagogue actions (Yadav and Baquer, 2014). Fenugreek seeds have anti-cancerous,

anti-bacterial, hepatoprotective activity, hypo-cholesterolemic agent and provide lactational aid also increases young rabbit weight gain and increases milk production in rabbit does (Rekik and Bergaoui, 2016). Additional substances that may similarly have a galactagogic effect include silymarin, an active milk thistle extract. Its content of flavonolignans, bioflavonoid phytoestrogens with a structure similar to steroids, may account for its capacity to maintain plasma membranes and shield the liver through the facilitation of detoxification (Sherif and Al-Gayyar, 2013). They might also decrease the endogenous receptor antagonism of milk production, which would operate on estrogen receptors (Pradhan and Girish, 2006). Prolactin raised by silymarin in female rats (Capasso et al., 2009). Furthermore, milk exhibited inhibitory efficacy against *Staphylococcus aureus* (Reyes et al., 2020). Also, silymarin has a variety of biological and pharmacological effects; these effects include hepatoprotective, enhanced protein synthesis, antioxidant, and cell regeneration (Nezar and Al-Deri, 2020).

Effect of some feed additives on lactation and milk composition

A female rabbit can yield approximately 7 kg of milk during lactation period. The amount and composition of milk produced determines the success of rabbit rearing. The presence of essential fatty acids in milk influences the growth and survival of young during the nursing period (Maertens et al., 2006). The mammary glands release more than 95% of lipids in the form of milk fat globules (MFG) (Chai et al., 2022). The physiological and nutritional states of the animal have an impact on the milk chemical makeup (Suarez-Trujillo et al., 2021). Jin et al. (2017) and Więcek et al. (2018), reported that the diet has the highest effect on the fatty acid (FA) composition of milk, with genetic predispositions having some influence (Kęsek et al., 2014). Rabbit milk productivity rises until 19-21 days, after which it falls. It was discovered that a quick increase or decrease in milk production after the 21st day promotes the development of young animals and aids the transition to vegetable diet before and after weaning. Breeding rabbits with this lactation curve trait would allow for early weaning. Early weaning is usually not associated with breast inflammation; however, some rabbits may develop mastitis, the condition develops when the milk is not taken out in correct amount after kindling. Timely milking of rabbits is essential to prevent the spread of numerous infections (Casado et al., 2006). Rabbit's milk has a protein level that is four times higher than that of cow and goat, while it has around five times less sugar-lactose. Rabbit's milk amino acids were 4.5 - 5.0 times higher than that of cow and goat. Furthermore, an increase in rabbit milk lysozyme activity indicates that it is more resistant to the impacts of adverse environmental conditions (Darin et al., 2021). Rabbit's milk contains more fat, protein, and energy than cow or sow milk, resulting in rapid growth in young animals. Rabbit's milk is characterized by its low lactose content. During lactation peak, protein output exceeds that of Holstein milk cows. The number of kits suckling and the order of parity (primiparous vs. multiparous) all have a significant impact on milk yield (Maertens et al., 2006). Nutrition is a critical element determining the milk production and composition of rabbit does (El-Sabrout

et al., 2017), and it accounts for a significant portion of the production cost in a rabbit work. Rabbits milk has a high energy, lipid, and protein content while having low lactose content (Kolawole et al., 2013). This could explain the absolute pre-weaning growth pattern of young rabbits. Optimal feeding, which influences milk supply, has a good impact on litter size as well as litter weight at kindling and weaning (Assan, 2018). During four weeks of lactation, does fed on biologically treated discarded palm fronds (Bio-DPF) had considerably higher milk output compared to other groups. The higher feed intake during the suckling stage may have contributed to the improvement in milk output in these treatments (Salama and Abo El-Azayem, 2018). The blood prolactin levels in palm-supplemented females increased considerably. Date palm consumption reduced malondialdehyde (MDA), lipid peroxidation marker, while increasing glutathione (GSH). Dates could be provided as a diet supplement in lactating females that enhance maternal health and breastfeeding, as well as increased health, development, and reduced stress circumstances in litters (Ebrahimi et al., 2017). Milk from animals fed discarded dates had significantly higher levels of milk yield from the discarded date's rations than other groups (El-Shora et al., 2014). Dates contain oxytocin, which contract muscle surrounding the alveoli and forces milk into the ducts of milk, playing a crucial role in the let-down or milk ejection reflex (Suyati et al., 2016). Kikuchi and Miki (1978) found that dates contain cholesterol, beta-sitosterol, isofucosterol, stigmasterol, and campesterol, which are precursors of estrogen synthesis (Burtis and Bruns, 2014). Al-Sayyed et al. (2014), found that palm fruit elevates rat blood estrogen hormone levels. Estrogen (E2) prepares the breast tissue during pregnancy in mammals for lactation (Freeman et al., 2000). El-Shora et al. (2014), revealed that chemical composition of milk increased in animal supplemented with rejected dates. Additionally, milk from does was given discarded dates had greater value of protein than does fed the control diet (Salama et al., 2016). According to AL-Dobaib et al. (2009), the milk from Aradi goat does who received rejected dates had considerably higher quantities of protein and solids not fat, than other milk constituents. They linked the higher percentage of non-fiber carbohydrates (NFC) in dates to the high level of protein content in milk. In addition to the non-fiber carbohydrates, milk's protein content is typically linked to the diet's fast fermentable carbohydrates (sugar, starch), low NFC diets result in low protein content values. On the other hand, diets high in NFC increase milk protein content. L-carnitine is a Small-molecule quaternary amine found naturally in microorganisms, plants, and animals. In general, plants have lower levels of carnitine than mammals, with heart and skeletal muscle containing particularly high levels. L-carnitine's primary job is to move fatty acids with long chain from the extramitochondrial to the mitochondrial regions. L-carnitine could be added to rabbit doe's diet throughout the latter stages of nursing and pregnancy. Without having an unfavorable impact on hepatic or renal functions, that enhance performance, milk yield and composition during the first 12 weeks of lactation, growth performance, and some blood components. El-Ela et al. (2017),

reported that using L-carnitine as antioxidants is an efficient strategy to manage oxidative stress. According to research by Ramanau et al. (2005), animals treated with L-carnitine during lactation yield more milk than control group. L-carnitine may improve how well animals in strongly negative energy balance, especially primiparous animals, utilize their body fat (Blavi et al., 2021). Carlson et al. (2007), who discovered that animals fed L-carnitine had higher milk fat levels. Furthermore, animals fed L-carnitine produced milk that was equivalent to that of unsupplied animals, but with a high level of fat and protein content (Pirestani and Aghakhani, 2018). This result may be due to greater serum triacyl glyceride concentrations that were useful for milk fat synthesis could account for the higher milk fat percentages in the L-carnitine group (Carlson et al., 2006). In addition, non-esterified fatty acids (NEFA) may be more easily converted to ß-hydroxybutyrate (BHB), a necessary step before milk fat synthesis, in cows given an L-carnitine supplement. Fahmy et al. (2019), reported that increased milk yield (total and daily) in rabbits treated with LC may be attributable to the beneficial effects of LC as an antioxidant on energy balance, metabolism, and the health of the mammary glands during lactation. Additionally, Scholz et al. (2014) observed a trend of improved milk production in animals and reported that LC improved metabolic health during lactation. Seleem et al. (2006), noted that treating rabbits with LC increased the yield of milk secretion. Additionally, Pirestani and Aghakhani (2018) discovered that LC had a good impact on milk production. This is likely because LC helps to balance the production of protein and energy in a positive way. The results obtained may be due to LC can raise the concentration of adenosine triphosphate (ATP) by moving fatty acids with long chain across the inner mitochondria membrane for β-oxidation, hence promoting the application of fatty acids and energy (Vanella et al., 2000). The annual herbaceous plant known asTrigonella foenum-graecum L.(fenugreek) is valued for both its nutritional content and therapeutic properties (Khorshidian et al., 2016). Traditionally, galactagogues and appetite stimulants have been made from its dried seeds and leaves (Dandotiya et al., 2013). Rekik and Bergaoui (2016) found that feeding rabbit does fenugreek seeds enhances their ability to produce milk. Fenugreek seed and oil provided groups showed the greatest percent values of protein contents of the rabbits' milk in both the first and second lactation periods in comparison to the other examined group (Abdel-Rahman et al., 2016). Fenugreek seeds significantly boost milk yield when added to rabbit diets. This may be because seeds of fenugreek are high in diosgenin and phytoestrogens. Which are xenoestrogens with an estradiol-like structure and the capacity to produce estrogenic effects (Yildiz, 2019). El-Hammady and Abdel-Kareem (2015), demonstrated that Fat from fenugreek seeds contains lactogenic promoting factors that stimulate glands to secrete more milk, which may be the reason for the increased milk production in rabbits fed a diet supplemented with fenugreek seeds. Supplementing lactating rabbit doe with royal jelly (RJ), a non-hormonal therapy, can increase milk production, and this positively reflected on litter weight at weaning and post weaning mortality. Additionally, RJ had

no detrimental effects on the New Zealand whit (NZW) rabbits' ability to reproduce (Fahmy et al., 2019). El-Tarabany et al. (2019), found that supplementing with RJ enhances the milk's protein, fat, and total solids content in nursing animals. These findings conflict with those of Ivanova et al. (2022), who found that, in comparison to the control group, the animals who fed royal jelly have milk with a reduced fat content. Although there was no change in the protein and solid nonfat content, they are still within the range previously noted for the breed (Ivanova et al., 2011). El-Tarabany et al. (2019), who found that feeding RJ to lactating animals increases their daily milk and milk composition (proteins, fats, and total solids) than the untreated group. Additionally, Bonomi et al, (2004) observed that adding royal jelly to animals was able to significantly increase their milk supply. Estrogenic qualities of royal jelly is mediated by the interaction with estrogenic receptors (Suzuki et al., 2008). The complex components of RJ as a source of nutrients that may be involved in metabolic pathways and tissue formation, as well as its vasodilative, antioxidant, and energy-producing properties, may be the cause of the increase in milk yield following RJ treatment (Fahmy et al., 2019). RJ have a number of pharmacological effects in experimental animals, including antioxidant and metabolic effects (Liu et al., 2008) as well as vasodilative effects (Shinoda et al., 1978), which may improve the functions of the mammary glands by increasing blood flow to them. Silymarin, which is the active ingredient in Milk thistle (MTE) (Silybum marianum L.), which is thought to be a galactagogue and is utilized in alternative medicine, may also contribute to these results (Jackson, 2010). Herbal galactagogues have been shown in some trials to enhance milk yield (Mortel and Mehta, 2013). Refaie et al. (2019), found that supplementing diets with silymarin (extract from milk thistle seeds) improved the performance of the does during the gestation and lactation stages by increasing the amount of milk they produced (galactagogues effect). In female rats, extracts of herbal galactagogues increased serum prolactin levels significantly; this appears to be the mechanism by which milk production is increased (Capasso et al., 2009, and Capasso, 2014). Supplementing animals with silymarin during lactation and transition can temporarily raise level of prolactin, boost feed intake. According to Jiang et al. (2020), these benefits will increase the animals' milk yield and, in turn, improve the performance of offspring. According to Pinheiro et al. (2007), silybin, one of the flavonolignans of silymarin, possess structure like estrogen that can bind to and activate estrogen receptors. It also possesses estrogen-like actions. A diet rich in MTE gradually increased the levels of plasma prolactin hormone ($P \leq 0.05$) (Refaie et al., 2019). The anti-dopaminergic activity (Capasso, 2014) and estrogenic actions (Demirci et al., 2014) of silymarin may be the cause of the improvement in prolactin values in the studied groups. The mammary glands' ability to produce milk for nursing newborns and to develop during pregnancy is both enhanced by the pituitary gland's activation of prolactin hormone secretion (Ben-Jonathan et al., 2006). According to Arviv et al. (2016), feeding animal’s milk thistle has no adverse effects. Furthermore, Kranti et al. (2013) report

that silymarin, the active ingredient in MTE, has an antioxidant activity that prevents oxidation of lipid present in the cell membrane (Liebler, 1992). Tedesco et al. (2004) reported that Supplementation of silymarin enhance milk yield but did not change milk parameters (fat, protein, and lactose) in treated and control goats. Additionally, Onmaz et al. (2017), found that treated animals with 20 g silymarin/head/day had a reduction in milk protein and fat.

Effect of some feed additives on immunological parameters

Supplementation of rabbit to dates fruit showed increase in ALT, AST, total protein, and ALP. However, there is no significant difference in albumin levels between date-treated and control groups (Abdul Ameer and Hassan, 2022). They are regarded as the most important tests for detecting liver dysfunction. However, it is likely that the vitamin C found in date plays a function in hepatoprotection (Combs et al., 1987). Adding Bio-DPF to rabbit meals resulted in higher total protein and globulin levels compared to other treatments. Incorporating Bio-DPF into rabbit diets may boost immunity and protein availability for milk production (Salama and Abo El-Azayem, 2018). Halabi et al. (2022), found that specifically, against Candida albicans and Staphylococcus aureus, Egyptian date extracts shown strong antibacterial efficacy against all tested multidrug resistant microorganisms. Total phenolics, flavonoids, and tannins were all present in the highest concentrations in the fresh fruit of dates, which also had the strongest antibacterial activity and showed potential antioxidant activity. Compounds present in Date fruit have strong antioxidant, antimutagenic, antibacterial and anti-inflammatory characters (Vayalil, 2012). Date fruit's pulp and seed extracts exhibit broad-spectrum antibacterial activity, generally linked to phenolic chemicals that are thought to produce hydrogen peroxide, which suppresses the growth of bacteria. These results indicate that these fruits, or the extracts made from them, may provide a low-cost means of shielding people against a variety of bacterial diseases (Fernández et al., 2022). In heat-stressed rabbits, adding LC to the basal diet reduced rectal temperature, heart rate, and respiration rate, while increasing growth rate and feed conversion ratio (Liang et al., 2022). The rabbits fed the LC diet also had higher blood hemoglobin, white blood cell counts, total protein, glucose, and red blood cell counts compared to those fed the basal diet (Ayyat et al., 2021). Adding 100 mg kg−1 LC to male rabbit diet improved heat stress-induced semen quality (El-Tohamy et al., 2012). These positive effects could be attributed to LC boosting antioxidant capacity (Qiao et al., 2021). Adding L-carnitine in water to developing NZW rabbits dramatically boosted plasma protein (Seleem et al., 2006). El-kelawy (2017), showed that feeding LC-containing diets considerably raised phagocytic power. Furthermore, Cakir and Yalcin (2007) discovered a possible benefit of LC on immunity of broilers. Research has shown that supplementing broiler pigeons and chickens with LC can improve their subsequent antibody responses (Deng et al., 2006). White cell activation may be facilitated by LC immunomodulatory mechanisms through lipid oxidation (Broderick et al., 2017) or by stimulating the release and secretion of immunomodulatory hormones like triiodothyronine (Calder,

2020) and insulin (Rooney et al., 2020). Aziz et al. (2018), LC may increase lymphocyte survival by enhancing the proliferative response to mitogens and preventing apoptosis. Abdel-Rahman et al. (2016) reported that powdered and germinated fenugreek seeds were given to rabbits, there was a noticeable increase in WBCS and neutrophil counts during the first and second lactation periods. Also, significant increase in phagocytic activity and phagocytic index in rabbits given powdered and germinated fenugreek seeds during the first and second lactation periods when compared to control groups. Additionally, compared to the other groups, the phagocytic power of catfish fed fenugreek diet were significantly greater (Emeish and Saad el-deen, 2016). This may result from Flavonoid and saponins (like yamogenin and diosgenin) found in fenugreek that protect cells against damage (Kaviarasan et al., 2004). The presence of scopoletin, a coumarin derivative of fenugreek that has been reported to inhibit the electron transport chain in prokaryotes, and the phenolic extract of fenugreek, which may cause bacterial cell lysis, are two possible mechanisms that could be responsible for the gastroprotective action. Another possibility is the creation of an acidic environment by changing the urease activity of the bacteria. (Randhir and Shetty, 2007). Moreover, According to Vahabi et al. (2011), one of the most potent antibacterial extracts was T. foenum-graceum extract. According to reports, T. foenum-graceum leaves (Sharma et al., 1996) and seeds (Billaud and Adrian, 2001) have pharmacological properties with a variety of therapeutic effects. Furthermore, Khan and Naz (2009) found that broiler chicks treated with fenugreek infusion exhibited antibiotic-like and antibacterial qualities. Asma et al. (2022) reported that giving bucks royal jelly may enhance their condition, especially kidney and liver markers, and prevent summer infertility. Bhalchandra et al. (2018), reported that the experimental rats' total white blood cell (WBC) count increased considerably following royal jelly therap. Wang et al. (2023), showed that leukocyte content increased in the treated groups following treatment with major royal jelly proteins (MRJPs). This suggests that MRJPs could improve mice's immunity by counteracting the leukocyte decrease that was clearly caused by cyclophosphamide. Because leukocytes have a particular phagocytic activity, they have specific roles in the fight against cancer, bacterial infections, and inflammatory illnesses. Consequently, raising leukocyte counts can boost immunity and reduce the chances of disease (Dong et al., 2022). A flavonoid obtained from Silybum marianum is silymarin, the milk thistle, has been utilized extensively in the management of prenatal illnesses and liver failure (Surai, 2015). According to Comelli et al. (2007), it is mostly composed of silybin, isosilybin, silychristin, and silydianin. It is a potent antioxidant that inhibits the actions of the enzymes responsible for the production of ROS in addition to directly removing free radicals (Yin et al., 2011). Khazaei et al. (2022) reported that feeding of Japanese quail with milk thistle powder (0.5% and 1%) increased feed consumption, weigh of body and enhanced carcass components. Together with lowered HDL, ALT, and AST, improved antioxidant total plasma, increased white blood cell count, calcium, vitamin D3, and albumin, blood constituents such as

total protein and albumin were also improved. Silymarin also reduced the spleen and bursa of Fabricius relative weights. According to review, milk thistle can enhance quail's immune system, feed conversion ratio, and growth performance. Furthermore, silymarin has also been shown to have a broad anti-inflammatory impact in mammals (Kaur et al., 2010). Silymarin demonstrated its anti-inflammatory properties by inhibiting the nuclear factor kappa B (NF-κB) signaling pathway, which has the ability to control the expression of genes linked to inflammation (Esmaeil et al., 2017). According to Opletal and Skrivanova (2010), silymarin has chemo preventive action against chemical, viral, bacterial, and fungal toxins. It also prevents lipid peroxidation and stabilises the liver parenchyma's cell membranes. Four major components make up silymarin, a pharmacologically useful substance: silybin, isosilybin, silychristin, and silydianin (Ding et al., 2001). According to studies by Suchý et al. (2008), silymarin functions in four different ways: it acts as an antioxidant, an absorber, and a regulator of intracellular glutathione; it stabilises and regulates cell membrane permeability, preventing hepatotoxic substances from entering hepatocytes; it promotes ribosomal RNA synthesis and simulating liver regeneration, it is thought that absorbing free radicals is a crucial mechanism for maintaining liver (Fraschini et al., 2002).

Effect of some feed additives on growth performance

Bio-DPF addition to doe diets improved litter size at birth, weaning, litter weight at birth, litter weight at weaning, total litter gain, kid weight at birth, and daily weight gain of kid when compared to control group (Salama and Abo El-Azayem, 2018). Salama et al. (2016), found that When rabbits were fed diets that included wasted dates increased in litter weight at birth and kid weight at weaning. According to Iyeghe-Erakpotobor et al. (2008), these outcomes might be the consequence of dates offering the essential nutrients for a variety of possible benefits to health, which allowed the rabbits to produce high-quality milk for the young. Additionally, Al-Shahib and Marshall (2003) found that the flesh of dates contains 0.2-0.5% oil, and the seeds contain 7.7-9.7% oil with high content of unsaturated fatty acids, which include palmatic, oleic, linoleic, and linolenic acids. These findings may explain the enhancement in performance of group supplemented with discarded dates. Essien et al. (2024) demonstrated that growth performance of weaned rabbits fed varied amounts of date palm waste was identified. The test component had no significant effect on any of the growth indicators ($P > 0.05$. Incorporating date palm waste as a 15% replacement for maize in rabbit diets improved ash and nitrogen free extract digestibility while having no negative effect on weaner rabbit growth performance. Adding L-carnitine (LC) to the diets of rabbits fed in summer conditions on their performance, physiological indicators, and carcass features were studied by Ayyat et al. (2021), who stated that growth indices, feed conversion ratios and economic efficiency were dramatically enhanced in LC group. In heat-stressed rabbits, adding LC to the basal diet reduced rectal temperature, heart rate, and respiration rate, while increasing growth rate and feed conversion ratio (Liang et al., 2022). Daily weight increase, feed

efficiency values and feed conversion of developing NZW rabbits supplemented in the drinking water with L-carnitine preparation were significantly ($P<0.05$) higher (Seleem et al., 2006). El-Ela et al. (2017), showed that Supplementing animals with L-carnitine improved weights of birth and weaning and the daily growth of the bunnies. Animals in the LC group consumed more feed ($p<0.05$). When the LC group was compared to the control, the rates of lambing and fecundity tended to be greater. Certain metabolites in the ewes may change in response to LC supplementation. The ability of dams to efficiently partition energy to promote fetal growth and continue pregnancy may contribute to a propensity toward a greater lambing rate (Masoomi et al., 2024). Zeedan et al. (2014), this outcome could be due to the increased milk supply and contents of total solid, total protein, and milk fat. Furthermore, this could be a result of increased milk production and increased nutrition and energy transmission from the doe to the young. According to Ramanau et al. (2004), L-carnitine primary function is the transportation of fatty acids with long chain to the inner membrane of mitochondria, which is the site of β-oxidation. L. Carnitine feeding during pregnancy and breastfeeding has been linked to higher weight gain in bunnies during the suckling phase (Eder, 2009). Fenugreek improves performance, appetite, digestion, and carcass characteristics (El-Wafa et al., 2003). Seeds of fenugreek supplementation and probiotics combination increased growth, digestibility and hormones but do not have harmful impacts on carcass of rabbits (Abdel-Wareth et al., 2021). Abdel-Rahman et al. (2016), showed that group of bunnies that were nursing from dams that had been treated with powdered seeds fenugreek showed the greatest improvement in growth performance. The growth performance of suckling bunnies was shown to be enhanced by the supplementation of rabbit doe with fenugreek resulting in high milk protein content. Fenugreek seed supplementation enhances the amount of milk produced by doe and their weight (Rekik and Bergaoui, 2016). Furthermore, Elagib et al. (2013), observe an elevated daily gain as a result of fenugreek seed powder's stimulatory effect on broiler digestive system. Administering RJ to growing rabbits exposed to Egyptian summer heat stress conditions can reduce physiological strain by increasing their performance, as observed in higher BW gain and feed utilization. This improvement was also reflected in rabbit blood composition, demonstrating improved liver and renal function, as well as better feed usage, as seen with starch and mineral utilization. Furthermore, improved metabolic activities can be predicted from increased T3 levels counteracting the hypothyroid state that accompanied heat stress (Elnagar et al., 2010). El-Tarabany et al. (2019), reported that ewes supplemented with RJ produced more milk each day than ewes who were not treated. The litter weight in the RJ groups was considerably ($p<0.01$) higher than in the control group. Additionally, the findings reported by Jimoh and Ewuola (2017), showed that a rabbit's high milk output increases the average litter weight at weaning and the survival rate. RJ supplementation has been shown to increase milk supply, which has a good impact on pre-weaning mortality as well as litter size and weight at weaning (Fahmy et al., 2019). Refaie et al. (2019), showed that supplementation of

silymarin, or milk thistle seed extract to the diets of the does resulted in increase in the litter weight at birth and during the weaning process, the improvement in the weaning weight of the bunnies may have resulted from an increase in milk yield. Mohammad et al. (2019), which showed that exposing female rats to 200 mg\kg\day of milk thistle extract (MTE) increased their litter weight at birth relative to the control group due to an increase in milk production. Following dietary silymarin supplementation, there were improvement in villi height and the VH:CD ratio, in addition to a decrease in the depth of the crypt ($P < 0.05$). The findings suggest that giving silymarin to broiler chicks infected with E. coli could enhance their growth performance by reducing the number of microorganisms associated with ileal pathogens and increasing the size of their villi that absorbs nutrients (Jahanian et al., 2021).

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