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Effect of some nutraceutical 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).

REFERENCES

Abdel-Rahman, H.; Fathalla, S.I.; Assayed, M.E.; Masoad, S.R. and Nafeaa, A.A. (2016). Physiological studies on the effect of fenugreek on productive performance of white New-Zealand rabbit does. Food and Nutrition Sciences, 7(13): 1276-1289.

Abdel-Wareth, A.A.; Elkhateeb, F.S.; Ismail, Z.S.; Ghazalah, A.A. and Lohakare, J. (2021). Combined effects of fenugreek seeds and probiotics on growth performance, nutrient digestibility, carcass criteria, and serum hormones in growing rabbits. *Livestock Science*, *251*: 104616.

Abdul Ameer, H.A. and Hassan, N.F. (2022). Investigation of Hematological and Biochemical Effects of Feeding Date in the Early Morning on Empty Stomach vs. after Nutrition on Rabbits. Archives of Razi Institute, 77(1): 235-239.

Al-Dobaib, S.N.; Khalil, M.H.; Hashad, M. and Al-Saef, A.M. (2007). Growth, carcass and caecal traits in V-line and crossbred rabbit fed diets containing discarded dates. *World Rabbit Science*, *15*(2): 81-90.

Al-Dobaib, S.N.; Mehaia, M.A. and Khalil, M.H. (2009). Effect of feeding discarded dates on milk yield and composition of Aradi goats. Small Ruminant Research, 81(2-3): 167-170.

Al-Sayyed, H.F.; Takruri, H.R.; Shomaf, M.S. and Al-Saleh, A. (2014). The effect of date palm fruit (Phoenix dactylifera L.) on the hormone 17-ß-estradiol in 7, 12-dimethylbenz (a) anthracene-induced mammary cancer in rats. Mediterranean Journal of Nutrition and Metabolism, 7(1): 5-10.

Al-Shahib, W. and Marshall, R.J. (2003). The fruit of the date palm: its possible use as the best food for the future? International journal of food sciences and nutrition, 54(4): 247-259.

Angerbjorn, A. (2004). Hares and rabbits (Leporidae). Grzimek's Animal Life Encyclopedia, 16: 505-516.

Arijeniwa, A.; Otaikhian, S.O. and Imaseum, J.A. (2000, September). Performance of weaner rabbits fed: Poultry Grower Mash" supplemented with different grass legume rations. In *Proceedings of 5th Annual Conference of Animal Sci. Ass. Nig.(ASAN) Sept* (pp. 19-22).

Arviv, A.; Muklada, H.; gel, J.; Voet, H.; Glasser, T.; Dvash, L. and Landau, S.Y. (2016). Targeted grazing of milk thistle (Silybum marianum) and Syrian thistle (Notobasis syriaca) by goats: Preference following preconditioning, generational transfer, and

toxicity. Applied Animal Behaviour Science, 179: 53-59.

Asma, S.T.; Bobiş, O.; Bonta, V.; Acaroz, U.; Shah, S.R.A.; Istanbullugil, F.R. and Arslan-Acaroz, D. (2022). General nutritional profile of bee products and their potential antiviral properties against mammalian viruses. *Nutrients*, *14*(17): 3579.

Assan, N. (2018). Factors influencing does milk production and their implication for kit performance in rabbits. Scientific Journal of Animal Science, 7(1): 471-478.

Ayyat, M.S.; Abd El-Latif, K.M.; Helal, A.A. and Al-Sagheer, A.A. (2021). Interaction of supplementary L-carnitine and dietary energy levels on feed utilization and blood constituents in New Zealand White rabbits reared under summer conditions. *Tropical Animal Health and Production*, *53*(2): 279.

Aziz, R.L.A.; Abdel-Wahab, A.; El-Ela, F.I.A.; Hassan, N.E.H.Y.; El-Nahass, E.S.; Ibrahim, M.A. and Khalil, A.T.A. (2018). Dose-dependent ameliorative effects of quercetin and l-Carnitine against atrazine-induced reproductive toxicity in adult male Albino rats. Biomedicine and pharmacotherapy, 102: 855-864.

Bell, A.W.; Burhans, W.S. and Overton, T.R. (2000). Protein nutrition in late pregnancy, maternal protein reserves and lactation performance in dairy cows. Proceedings of the Nutrition Society, 59(1): 119-126.

Ben-Jonathan, N.; Hugo, E.R.; Brandebourg, T.D. and LaPensee, C.R. (2006). Focus on prolactin as a metabolic hormone. Trends in Endocrinology and Metabolism, 17(3): 110-116.

Bhalchandra, W.; Alqadhi, Y.A. and Ninawe, A. (2018). Ameliorative role of bee honey and royal jelly against cisplatin induced Alteration In Hematological parameters in Male wister albino Rat. Int J Pharm Pharmaceut Sci, 10(4): 10.

Billaud, C. and Adrian, J. (2001). Le fenugrec: Composition, valeur nutritionnelle et physiologique. Sciences des aliments, 21(1): 3-26.

Blavi, L.; Solà-Oriol, D.; Llonch, P.; López-Vergé, S.; Martín-Orúe, S.M. and Pérez, J.F. (2021). Management and feeding strategies in early life to increase piglet performance and welfare around weaning: A review. Animals, 11(2): 302.

Bonomi, A.; Bonomi, B.M. and Veterinarie, B. (2004). The use or royal jellly in dairy cattle feeding. Effects on productive and reproductive efficiency. Rivista di Scienza dell'Alimentazione (Italy), 33(4).

Broderick, T.L.; Cusimano, F.A., Carlson, C. and Tamura, L.K. (2017). Acute exercise stimulates carnitine biosynthesis and OCTN2 expression in mouse kidney. Kidney and Blood Pressure Research, 42(3): 398-405

Burt, S. (2004). Essential oils: their antibacterial properties and potential applications in foods—a review. International journal of food microbiology, 94(3): 223-253.

Burtis, C.A. and Bruns, D.E. (2014). Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics-E-Book: Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics-E-Book. Elsevier Health Sciences.

Cakir, S. and Yalcin, S.A.K.İ.N.E. (2007). Effects of L-carnitine supplementation in diets with low or normal energy level on growth performance and carcass traits in broilers. Revue de médecine vétérinaire, 158(6): 291-296.

Calder, P.C. (2020). n-3 PUFA and inflammation: from membrane to nucleus and from bench to bedside. Proceedings of the Nutrition Society, 79(4): 404-416.

Capasso, R. (2014). Effect of Silitidil, a standardized extract of milk thistle, on the serum prolactin levels in female rats. Natural product communications, 9(7),

Capasso, R.; Aviello, G.; Capasso, F.; Savino, F.; Izzo, A.A.; Lembo, F. and Borrelli, F. (2009). Silymarin BIO-C®, an extract from Silybum marianum fruits, induces hyperprolactinemia in intact female rats. Phytomedicine, 16(9): 839-844.

Carlson, D.B.; Litherland, N.B.; Dann, H.M.; Woodworth, J.C. and Drackley, J.K. (2006). Metabolic effects of abomasal L-carnitine infusion and feed restriction in lactating Holstein cows. Journal of dairy science, 89(12): 4819-4834.

Carlson, D.B.; McFadden, J.W.; D'Angelo, A.; Woodworth, J.C. and Drackley, J. K. (2007). Dietary L-carnitine affects periparturient nutrient metabolism and lactation in multiparous cows. Journal of dairy science, 90(7): 3422-3441.

Casado, C.; Piquer, O.; Cervera, C. and Pascual, J. J. (2006). Modelling the lactation curve of rabbit does: Towards a model including fit suitability and biological interpretation. Livestock Science, 99(1): 39-49.

Castellini, C. (2007). Reproductive activity and welfare of rabbit does. *Italian Journal of Animal Science*, *6*(sup1): 743-747.

Chai, C.; Oh, S. and Imm, J. Y. (2022). Roles of milk fat globule membrane on fat digestion and infant nutrition. Food Science of Animal Resources, 42(3): 351.

Combs, G.F.; Levander, O.A.; Spallholz, J.E. and Oldfield, J.E. (1987). Textbook of Selenium in Biology and Medicine. Part B, Van Hostrand Company, New York, 752.

Comelli, M.C.; Mengs, U.; Schneider, C. and Prosdocimi, M. (2007). Toward the definition of the mechanism of action of silymarin: activities related to cellular protection from toxic damage induced by chemotherapy. Integrative cancer therapies, 6(2): 120-129.

Dalle Zotte, A. (2014). Rabbit farming for meat purposes. Animal Frontiers, 4(4): 62-67.

Dandotiya, H.; Singh, G. and Kashaw, S. K. (2013). The galactagogues used by Indian tribal communities to overcome poor lactation. International Journal of Biotechnology and Bioengeneering Research, 4(3): 243-248.

Darin, A.O.; Antipova, L.V.; Goz, A.R.; Ippolitova, L.I. and Kumalagova, Z.H. (2021, February). Rabbit milk as a source of nutrition for newborns. In IOP Conference Series: Earth and Environmental Science (Vol. 640, No. 3, p. 032051). IOP Publishing.

Demirci, B.; Dost, T.; Gokalp, F. and Birincioglu, M. (2014). Silymarin improves vascular function of aged ovariectomized rats. Phytotherapy research, 28(6): 868-872.

Deng, K.; Wong, C.W. and Nolan, J.V. (2006). Long-term effects of early-life dietary L-carnitine on lymphoid organs and immune responses in Leghorn-type chickens. Journal of Animal Physiology and Animal Nutrition, 90(1-2): 81-86.

Ding, T.M.; Tian, S.J.; Zhang, Z.X.; Gu, D.Z.; Chen, Y.F.; Shi, Y.H. and Sun, Z.P. (2001). Determination of active component in silymarin by RP-LC and LC/MS. Journal of pharmaceutical and biomedical analysis, 26(1): 155-161.

Dong, Y.J.; Lin, M.Q.; Fang, X.; Xie, Z.Y.; Luo, R. Teng, X. and Chen, S.H. (2022). Modulating effects of a functional food containing Dendrobium officinale on immune response and gut microbiota in mice treated with cyclophosphamide. Journal of Functional Foods, 94: 105102.

Ebrahimi F,S.; Hemmati, M. and Malekaneh, M. (2017). Effects of the date palm fruit (Phoenix dactylifera L.) on prolactin, IGF-1, and stress factors in lactating female rats and its impact on their litters' development. *Mediterranean Journal of Nutrition and Metabolism*, *10*(3): 251-258.

Eder, K. (2009). Influence of L-carnitine on metabolism and performance of sows. British Journal of Nutrition, 102(5): 645-654.

Elagib, H.A.; Abbas, S.A. and Elamin, K.M. (2013). Effect of different natural feed additives compared to antibiotic on performance of broiler chicks under high temperature. Bull. Env. Pharmacol. Life Sci, 2(11): 139-144.

El-Ela, A., Hafez, Y.H., Abdel-Hafez, M.A. and El-Ghandour, A.A. (2017). Effect of L-carnitine and Co-enzyme Q10 treatments on immune response, productive and reproductive performance of Damascus goats and their offspring. 2-Productive, reproductive performance and some blood metabolites during late pregnancy and lactation periods. Egyptian Journal of Sheep and Goats Sciences, 12(3): 1-22.

El-Hammady, H.Y. and Abdel-Kareem, A.A.A. (2015). Reproductive performance of rabbit does producing low number of weaned kids treated with some dried herbal seeds. Egyptian Poultry Science Journal, 35(2).

El-kelawy, M. (2017). Effects of L-carnitine on production performance, blood parameters, lipid metabolism and antioxidative properties of broiler chicks. Egyptian Poultry Science Journal, 37(3): 873-892

Elnagar, S.A.; Elghalid, O.A. and Abd-Elhady, A.M. (2010). Royal jelly: can it reduce physiological strain of growing rabbits under Egyptian summer conditions? *Animal*, *4*(9): 1547-1552.

El-Sabrout, K.; Aggag, S. and El-Raffa, A. (2017). Comparison of milk production and milk composition for an exotic and a local synthetic rabbit lines. Veterinary World, 10(5): 526.

El-Shora, M.A.; Abo El-Fadel, M.H.; Deraz, T.A. and El-Diahy, Y.M. (2014). Effect of using discarded dates on productive and reproductive performance of lactating Friesian cows. Journal of Animal and Poultry Production, 5(12): 775-789.

El-Tarabany, M.S.; El-Tarabany, A.A.; Atta, M.A.; Ahmed-Farid, O.A. and Mostafa, M.M. (2019). Effect of royal jelly on milk composition and blood biochemical parameters in lactating ewes. The Journal of Agricultural Science, 157(2): 176-181.

El-Tohamy, M.M.; Kotp, M.S.; El-Nattat, W.S. and Mohamed, A.H. (2012). Semen characteristics and oxidative/antioxidati in semen and serum of male rabbits supplemented with antioxidants during heat stress. *Iranian Journal of Applied Animal Science*, *2*(2): 175-183.

El-Wafa, S.A.; Sayed, M.A.M.; Ali, S.A. and Abdallah, A.G. (2003). Performance and immune response of broiler chicks as affected by methionine and zinc or commercial zinc-methionine supplementations.

Esmaeil, N.; Anaraki, S.; Gharagozloo, M. and Moayedi, B. (2017). Silymarin impacts on immune system as an immunomodulator: One key for many locks. International Immunopharmacology, 50: 194–201.

Essien, C.A.; Sam, I.M. and Okon, U. (2024). Effect of date palm waste on growth performance, and nutrient digestibility of weaner rabbits. University of Ibadan, Nigeria. 49th Conf., Nig. Soc. For Anim.

Faemeish, W.A.L.A.A. and Gsaad El-deen, A.Y.A. (2016). Immunomodulatory effects of thyme and fenugreek in sharptooth catfish, Clarias gariepinus. Assiut Veterinary Medical Journal, 62(150): 45-51.

Fahmy, S.; Hussein, H.A. and Farag, B.F. (2019). Impact of hormonal and non-hormonal treatments on milk production and reproductive performance of lactating New Zeland White rabbits. Archives of Agriculture Sciences Journal, 2(2): 1-11.

Fellous, N.; Reguig, K.B. and Baziz, H.A. (2012). Reproductive performance of local breed of Algerian rabbits raised in experimental station.

Fernández-López, J.; Viuda-Martos, M.; Sayas-Barberá, E.; Navarro-Rodríguez de Vera, C. and Pérez-Álvarez, J.Á. (2022). Biological, nutritive, functional and healthy potential of date palm fruit (Phoenix dactylifera L.): Current research and future prospects. Agronomy, 12(4): 876.

Fraschini, F.; Demartini, G. and Esposti, D. (2002). Pharmacology of silymarin. Clinical drug investigation, 22: 51-65.

Freeman, M.E.; Kanyicska, B.; Lerant, A. and Nagy, G. (2000). Prolactin: structure, function, and regulation of secretion. Physiological reviews.

Halabi, A.A.; Elwakil, B.H.; Hagar, M. and Olama, Z.A. (2022). Date fruit (Phoenix dactylifera L.) cultivar extracts: nanoparticle synthesis, antimicrobial and antioxidant activities. Molecules, 27(16): 5165.

Ivanova, T.; Popova, T. and Balkanska, R. (2022). Effect of the Dietary Royal Jelly Supplementation in Ewes of Bulgarian Dairy Synthetic Population on the Body Weight of the Lambs and the Milk Composition.

Iyeghe-Erakpotobor, G.T. and Ashworth, C.J. (2003). Relationship of liveweight, liver weight and progesterone metabolism of Landrace× Large White and Meishan pigs during early pregnancy.

Iyeghe-Erakpotobor, G.T.; Adeosun, Y.G.; Sekoni, A.A. and Esievo, L.O. (2008). Reproductive performance of rabbit does on concentrate to forage (Stylosanthes hamata) combinations. Livestock Research for Rural Development, 20(11): 2008.

Jackson, P. (2010). Complementary and alternative methods of increasing breast milk supply for lactating mothers of infants in the NICU. Neonatal Network, 29(4): 225-230.

Jahanian, E.; Mahdavi, A.H. and Jahanian, R. (2021). Silymarin improved the growth performance via modulating the microbiota and mucosal immunity in Escherichia coli-challenged broiler chicks. Livestock Science, 249: 104529.

Jiang, X.; Lin, S.; Lin, Y.; Fang, Z.; Xu, S.; Feng, B. and Wu, D. (2020). Effects of silymarin supplementation during transition and lactation on reproductive performance, milk composition and haematological parameters in sows. Journal of Animal Physiology

and Animal Nutrition, 104(6): 1896-1903.

Jimoh, O.A. and Ewuola, E.O. (2017). Milk yield and kit development of four breeds of rabbit in Ibadan, Nigeria. Journal of Animal Science and Technology, 59: 1-7.

Jin, C.; Fang, Z.; Lin, Y.; Che, L.; Wu, C.; Xu, S. and Wu, D. (2017). Influence of dietary fat source on sow and litter performance, colostrum and milk fatty acid profile in late gestation and lactation. Animal Science Journal, 88(11): 1768-1778.

Kaur, G. Athar, M. and Alam, M.S. (2010). Dietary supplementation of silymarin protects against chemically induced nephrotoxicity, inflammation and renal tumor promotion response. Investigational new drugs, 28: 703-713.

Kaviarasan, S.; Vijayalakshmi, K. and Anuradha, C. V. (2004). Polyphenol-rich extract of fenugreek seeds protect erythrocytes from oxidative damage. Plant Foods for Human Nutrition, 59: 143-147.

Kęsek, M.; Szulc, T. and Zielak-Steciwko, A. (2014). Genetic, physiological and nutritive factors affecting the fatty acid profile in cows' milk-a review.

Khan, R.U. and Naz, S. (2009). Effect of fenugreek (Trigonella foenum-graecum) seed extract on visceral organs of broiler chicks. ARPN J. Agric. Biol. Sci, 4: 58-61.

Khan, T.M., Wu, D.B.C. and Dolzhenko, A.V. (2018). Effectiveness of fenugreek as a galactagogue: A network meta-analysis. Phytotherapy Research, 32(3): 402-412.

Khazaei, R.; Seidavi, A. and Bouyeh, M. (2022). A review on the mechanisms of the effect of silymarin in milk thistle (Silybum marianum) on some laboratory animals. Veterinary Medicine and Science, 8(1), 289-301.

Khorshidian, N.; Yousefi Asli, M.; Arab, M.; Adeli Mirzaie, A. and Mortazavian, A.M. (2016). Fenugreek: potential applications as a functional food and nutraceutical. Nutrition and Food Sciences Research, 3(1): 5-16.

Kikuchi, N. and Miki, T. (1978). The separation of date (Phoenix dactylifera) sterols by liquid chromatography. Microchimica Acta, 69: 89-96.

Kolawole, F.S.O.; Kikelomo, A.M.; Taiwo, O.J. and Sunday, F.S. (2013). Yield, intake and chemical profile of Milk of Commercially available rabbits at first parity. Res. Rev. J. Agr. Allied. Sci, 20.

Kranti, M.V.; Mahesh, V.; Srinivas, P.; Ganesh, Y.V.; Godwin, P.A. and Mangala Lahkar, M.L. (2013). Evaluation of the protective effect of silymarin on doxorubicin induced chronic testicular toxicity in rats.

Liang, Z. L.; Chen, F.; Park, S.; Balasubramanian, B. and Liu, W. C. (2022). Impacts of heat stress on rabbit immune function, endocrine, blood biochemical changes, antioxidant capacity and production performance, and the potential mitigation strategies of nutritional intervention. *Frontiers in Veterinary Science*, *9*: 906084.

Liebler, D. C. (1992). Peroxyl radical trapping reactions of α-tocopherol in biomimetic systems. In Vitamin E in health and disease (pp. 85-96). CRC Press.

Liu, J.R.; Yang, Y.C.; Shi, L.S. and Peng, C.C. (2008). Antioxidant properties of royal jelly associated with larval age and time of harvest. Journal of agricultural and food chemistry, 56(23): 11447-11452.

Maertens, L.E.B.A.S.; Lebas, F. and Szendrö, Z.S. (2006). Rabbit milk: A review of quantity, quality and non-dietary affecting factors. World Rabbit Science, 14(4): 205-230.

Marchiani, S.; Vignozzi, L.; Filippi, S.; Gurrieri, B.; Comeglio, P.; Morelli, A. and Baldi, E. (2015). Metabolic syndrome-associated sperm alterations in an experimental rabbit model: relation with metabolic profile, testis and epididymis gene expression and effect of tamoxifen treatment. *Molecular and cellular endocrinology*, *401:* 12-24.

Masoomi, M.; Kheirandish, P.; Javadmanesh, A.; Danesh Mesgaran, S.; Izadi, H. and Danesh Mesgaran, M. (2024). Rumen-protected l-carnitine supplementation during mating period altered metabolic status and reproductive performance of ewes. Journal of Animal Physiology and Animal Nutrition, 108(2): 300-309.

Menchetti, L.; Barbato, O.; Sforna, M.; Vigo, D.; Mattioli, S.; Curone, G. and Brecchia, G. (2020). Effects of diets enriched in linseed and fish oil on the expression pattern of toll-like receptors 4 and proinflammatory cytokines on gonadal axis and reproductive organs in rabbit buck. *Oxidative Medicine and Cellular Longevity*.

Mohammad, B.I.; Alzamely, H.; Al Gharrawi, F. and Al-Aubaidy, H.A. (2019). Milk thistle seed extract favorably affects lactation and development of mammary gland in female rats. Egyptian Journal of Veterinary Sciences, 50(1): 27-36.

Mortel, M. and Mehta, S.D. (2013). Systematic review of the efficacy of herbal galactogogues. Journal of Human Lactation, 29(2): 154-162.

Nezar, A. and Al-Deri, A.H. (2020). Hematological study of silymarin on monosodium glutamate toxicity in rabbits. Plant Arch, 20(Suppl 2): 1-6.

Onmaz, A.; Ulger, I. and Ayaşan, T. (2017). Effects of silymarin (Silybum marianum) supplementation on milk and blood parameters of dairy cattle. *South African Journal of Animal Science*, *47*(6): 758-765.

Opletal, L. and Skrivanova, V. (2010). Natural substances and their biological activity (in Czech). Prague: Karolinum.

Petracci, M.; Bianchi, M. and Cavani, C. (2009). Development of rabbit meat products fortified with n-3 polyunsaturated fatty acids. Nutrients, 1(2): 111-118.

Pinheiro, S.H.; Del-Ben, C.M. and Graeff, F.G. (2007). Elevated mazes as animal models of anxiety: effects of serotonergic agents. Anais da Academia Brasileira de Ciências, 79: 71-85.

Pinto-Pinho, P.; Pinto, M.D.L.; Monteiro, J.; Fardilha, M.; Pinto-Leite, R. and Colaço, B. (2023). Pregnancy Complications and Feto-Maternal Monitoring in Rabbits. Veterinary Sciences, 10(10): 622.

Pirestani, A. and Aghakhani, M. (2018). The effects of rumen-protected choline and l-carnitine supplementation in the transition period on reproduction, production, and some metabolic diseases of dairy cattle. Journal of Applied Animal Research, 46(1): 435-440.

Pradhan, S.C. and Girish, C. (2006). Hepatoprotective herbal drug, silymarin from experimental pharmacology to clinical medicine. Indian journal of medical research, 124(5): 491-504.

Qiao, N.; Chen, H.; Du, P.; Kang, Z.; Pang, C.; Liu, B. and Li, Y. (2021). Acetyl-L-carnitine induces autophagy to promote mouse spermatogonia cell

recovery after heat stress damage. *BioMed research international*.

Ramanau, A.; Kluge, H. and Eder, K. (2005). Effects of L-carnitine supplementation on milk production, litter gains and back-fat thickness in sows with a low energy and protein intake during lactation. British journal of nutrition, 93(5): 717-721.

Ramanau, A.; Kluge, H.; Eder, K. and Spilke, J. (2004). Supplementation of sows with L-carnitine during pregnancy and lactation improves growth of the piglets during the suckling period through increased milk production. The Journal of nutrition, 134(1): 86-92.

Randhir, R. and Shetty, K. (2007). Improved α-amylase and Helicobacter pylori inhibition by fenugreek extracts derived via solid-state bioconversion using Rhizopus oligosporus. Asia Pacific Journal of Clinical Nutrition, 16(3).

Refaie, A.M.; Ghazal, M.N.; Abo El-Azayem, E.H.; El-maged, A. and Marwa, H. (2019). Impact of dietary supplementation of milk thistle (Silybum marianum) seed extract on doe rabbits' performance. Egyptian Journal of Nutrition and Feeds, 22(2), 375-382.

Rekik, I., and Bergaoui, R. (2016). Effet de l'incorporation du fenugrec (Trigonella fænum græcum L.) dans l'aliment sur la qualité de viande de la lapine. Journal of new sciences, Agriculture and Biotechnology., 31(3): 1742-1750.

Reyes-Camacho, D., Vinyeta, E., Pérez, J. F., Aumiller, T., Criado, L., Palade, L. M. and Solà-Oriol, D. (2020). Phytogenic actives supplemented in hyperprolific sows: effects on maternal transfer of phytogenic compounds, colostrum and milk features, performance and antioxidant status of sows and their offspring, and piglet intestinal gene expression. Journal of Animal Science, 98(1): skz390.

Rooney, H. B., O'Driscoll, K., Silacci, P., Bee, G., O'Doherty, J. V., and Lawlor, P. G. (2020). Effect of dietary L-carnitine supplementation to sows during gestation and/or lactation on sow productivity, muscle maturation and lifetime growth in progeny from large litters. British journal of nutrition, 124(1): 43-56.

Salama, W.A. and Abo El-Azayem, E.H. (2018). REPRODUCTIVE AND PHYSIOLOGICAL RESPONSE OF NEW ZEALAND WHITE RABBIT DOES FED ON DISCARDED PALM FRONDS. *Egyptian Journal of Rabbit Science*, *28*(2): 351-370.

Salama, W.A.; Suliman, M.A.; El-Shora, M.A. and Abd-El-Lateif, A.I. (2016). Effect of substitution of barley grains by discarded dates on reproductive performance of new zealand white rabbit does. Egyptian Journal of Nutrition and Feeds, 19(1): 127-138.

Scholz, H.; Ahrens, A.; Menn, F. and Heimendahl, E.V. (2014). Application of protected L-carnitine in dairy cows during transition and high lactation period.

Seleem, T.S.T.; Abd El-Motaal, A.E.M. and El-Kholy, K.H. (2006). Effect of L-carnitine preparation in drinking water on some productive and reproductive performance of NZW rabbits. In The 1st Conference on Clean Environment and Safety Food, December, Ain Shams University, Egypt.

Sharma, R.D.; Sarkar, A.; Hazra, D.K.; Misra, B.; Singh, J.B.; Maheshwari, B.B. and Sharma, S.K. (1996). Hypolipidaemic effect of fenugreek

seeds: A chronic study in non-insulin dependent diabetic patients. Phytotherapy Research, 10(4): 332-334.

Sherif, I.O. and Al-Gayyar, M.M. (2013). Antioxidant, anti-inflammatory and hepatoprotective effects of silymarin on hepatic dysfunction induced by sodium nitrite. Eur Cytokine Netw, 24(3): 114-121.

Shinoda, M.; Nakajin, S.; Oikawa, T.; Sato, K., Kamogawa, A. and Akiyama, Y. (1978). "Biochemical studies on vasodilative factor in royal jelly", Yakugaku Zasshi, 98: 139–145.

Suarez-Trujillo, A.; Luecke, S.M.; Logan, L.; Bradshaw, C.; Stewart, K.R.; Minor, R.C. and Casey, T.M. (2021). Changes in sow milk lipidome across lactation occur in fatty acyl residues of triacylglycerol and phosphatidylglycerol lipids, but not in plasma membrane phospholipids. Animal, 15(8): 100280.

Suchý, P.; Straková, E.; Kummer, V.; Herzig, I.; Písaříková, V.; Blechová, R. and Mašková, J. (2008). Hepatoprotective effects of milk thistle (Silybum marianum) seed cakes during the chicken broiler fattening. Acta Veterinaria Brno, 77(1): 31-38.

Surai, P.F. (2015). Silymarin as a natural antioxidant: an overview of the current evidence and perspectives. Antioxidants, 4(1): 204-247.

Suyati, S.; Roudhotul J.S. and Fitriani, Y. (2016). The Effect of Date Palm for The Smoothness of Breast Milk on Post Partum Maternal.

Suzuki, K.M.; Isohama, Y.; Maruyama, H.; Yamada, Y.; Narita, Y.; Ohta, S. and Mishima, S. (2008). Estrogenic activities of fatty acids and a sterol isolated from royal jelly. Evidence-based complementary and alternative medicine, 5: 295-302.

Tanritanir, P.; Dede, S. and Ceylan, E. (2009). Changes in some macro minerals and biochemical parameters in female healthy Siirt hair goats before and after parturation. Journal of Animal and Veterinary Advances, 8(3): 530-533.

Tedesco, D., Tava, A., Galletti, S., Tameni, M., Varisco, G., Costa, A., and Steidler, S. (2004). Effects of silymarin, a natural hepatoprotector, in periparturient dairy cows. *Journal of dairy science*, *87*(7): 2239-2247.

Tsuchiya, H.; Sato, M.; Miyazaki, T.; Fujiwara, S.; Tanigaki, S.; Ohyama, M. and Iinuma, M. (1996). Comparative study on the antibacterial activity of phytochemical flavanones against methicillin-resistant Staphylococcus aureus. Journal of ethnopharmacology, 50(1): 27-34.

Vahabi, S.; Najafi, E. and Alizadeh, S. (2011). In vitro antimicrobial effects of some herbal essences against oral pathogens. J Med Plant Res, 5(19): 4870-8.

Vanella, A., Russo, A., Acquaviva, R., Campisi, A., Di Giacomo, C., Sorrenti, V., and Barcellona, M. L. (2000). L-propionyl-carnitine as superoxide scavenger, antioxidant, and DNA cleavage protector. Cell biology and toxicology, 16: 99-104.

Vayalil, P.K. (2012). Date fruits (Phoenix dactylifera Linn): an emerging medicinal food. Critical reviews in food science and nutrition, 52(3): 249-271.

Wang, N.; Su, G.; Shi, B. and Shan, A. (2017). Effects of dietary L-Carnitine and fat type on the performance, Milk composition and immunoglobulin in sows, and immunological variables of sows and piglets during late gestation

and lactation. Czech J Anim Sci., 62: 185-94.

Wang, W.; Li, X.; Li, D.; Pan, F.; Fang, X.; Peng, W. and Tian, W. (2023). Effects of major royal jelly proteins on the immune response and gut microbiota composition in cyclophosphamide-treated mice. Nutrients, 15(4), 974.

Więcek, J.; Rekiel, A.; Bartosik, J.; Głogowski, R., and Kuczyńska, B. (2018). Colostrum and milk quality of sows fed different diets during mid-pregnancy.

Yadav, U.C. and Baquer, N.Z. (2014). Pharmacological effects of Trigonella foenum-graecum L. in health and disease. Pharmaceutical biology, 52(2): 243-254.

Yildiz, F. (Ed.) (2019). Phytoestrogens in functional foods. CRC Press.

Yin, F.; Liu, J.; Ji, X.; Wang, Y.; Zidichouski, J. and Zhang, J. (2011). Silibinin: A novel inhibitor of Aβ aggregation. Neurochemistry international, 58(3): 399-403

Zamaratskaia, G.; Havrysh, O.; Korzeniowska, M. and Getya, A. (2023). Potential and limitations of rabbit meat in maintaining food security in Ukraine. Meat science, 109293.

Zeedan, K.; El-Malky, O. and Abu El-Ella, A.A. (2014). Nutritional, physiological and microbiological studies on using Biogen-Zinc on productive and reproductive performance of ruminants. 2- Productive performance, digestion and some blood components of Damascus goats. Egyptian Journal of Sheep and Goats Sciences, 9(3): 1-18.