Research Article

# Effect of Different Concentrations of Silymarin on Performance and Selected Physiological Traits in Local Lambs

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**Abstract** | Silymarin is a flavonolignan extracted from the milk thistle plant (Silybum marianum). Silymarin has various pharmacological properties, including hepatoprotective, antioxidant, anti-inflammatory, anticancer, and cardioprotective effects. The study aims to determine the influence of several levels of silymarin on the productive and biochemical parameters in local lambs. A total of 30 lambs are classified into three groups. G1 (ten lambs) received Silymarin (420 mg/kg) orally, G2 (ten lambs) received Silymarin (210 mg/kg) orally, while G3 (ten lambs) received distal water (control group). Several parameters are used in the current study to evaluate silymarin, such as Hb, PCV, Triglyceride, cholesterol, total body weight and feed conversion efficiency. The mentioned parameters are examined biweekly for eight consecutive weeks. The findings reveal an increase in Hb, PCV, body weight and total protein levels in G1 compared to G3 at ($p < 0.05$), as well as Hb, PCV, body weight, and total protein increased with increasing dose ($P < 0.05$). On the contrary, the value of feed conversion efficiency, triglycerides and cholesterol were decreased in G1 and G2 compared to G3 ($P < 0.05$). Furthermore, feed conversion efficiency, triglyceride, and cholesterol decreased with increased dose used ($P < 0.05$). Ultimately, we can conclude that Silymarin can improve hematological and biochemical parameters and decrease feed conversion efficiency, as well as triglycerides and cholesterol in local lambs.

**Keywords** | Silymarin, Hb, PCV, Triglyceride, Cholesterol, Protein, Lamb

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## INTRODUCTION

Silymarin is a flavonoid substance that is prepared from *Silybum marianum*. Silymarin is available as a mixture of flavonolignans, isosilybin, silychristin, silibinin, and silydianin (Saller et al., 2007; Lee et al., 2007). Silymarin mixtures are herbal drugs folk healers have traditionally used to treat several metabolic conditions (Saller et al., 2001). The structure of the flavonolignan phenolics ring of silymarin has pharmacological and antioxidant effects for gastrointestinal and hematologic disorders. Furthermore, silymarin prevents lung, prostate, bladder, and breast cancer (Svobodová et al., 2007). The culture of Silybum marianum is present in Canada, North America, Kashmir, and Mexico; it has reddish-purple flowers and large leaves. The fruits and seeds are the medicinal parts of the plant used for treatment (Dermarderosin, A. 2001).

Milk thistle was used for diseases of the spleen, biliary, liver, and stomach (Saller R et al., 2007; Cesanow, et al., 2006). Silymarin has beneficial effects on the general health of sheep and the study found that body weight improved with the administration of Silymarin and increased milk production. Silymarin improves milk quality by increasing the protein level in the milk (Khamisabadi, H. 2020).

The Silybum marianum seed extract contains many compounds, such as apigenin, silychristin, and silybin. Furthermore, many oils include oleic acids, palmitic acids, and linoleic acids. Dairy animals graze on this plant a. Silybum marianum did not affect the pH of the rumen. It also resulted in an increase in fatty acids after feeding Silybum marianum. Silymarin has inhibited gluconeogenesis and blood glucose reduction (Mojaddam et al., 2015).

Dawood (2023) found that adding Silymarin to the lambs feed improved rumen digestion by improving voltile fatty acids and ammonia.

The seeds of Silybum marianum have been used to treat liver and gallbladder diseases such as cirrhosis, hepatitis, and icterus. Active milk thistle extract included flavonolignans, silymarin, undefined fraction, and oxidized polyphenolic fraction (Radko & Cybulski, 2007).

The current study investigated the effect of silymarin on some biochemical profiles in local lambs.

## MATERIALS AND METHODS

### Animals and Study Design

A total of 30 local lambs were formed into three groups; each group consisted of ten lambs. The first group (G1) was administered Silymarin orally (420 mg/kg) for 56 days (8 weeks). The second group (G2) received Silymarin orally (210 mg/kg) for 56 days (8 weeks). The third group (control group) (G3) was administered distal water. The parameters evaluated include Hb, PCV, triceride, cholesterol, total protein, body weight, and conversion efficiency of the diet, which were examined biweekly for eight weeks. Silymarin was provided from the market under the legal name (Medo Company). All the animal-related procedures of the study received permission from the local ethics committee for the animal utilization protocol (576/P.G in 12 32023).

### Sample collection

Blood samples were taken from the jugular vein at rest of the animal to prevent movement and reactivity. The samples were placed in tubes with an anticoagulant. The tubes are carefully transferred to prevent hemolysis.

### Hb

Sahli's method was used for Hb estimation by converting hemoglobin into hematin acid, and then diluted produces a color of hematin acid, which matches the comparator (Olupot et al., 2019).

### PCV

PCV is a test used to measure the ratio of the volume occupied by the RBC to the total volume. The capillary blood tubes were centrifuged and the ratio was determined using percentage fractions.

### Triglyceride and cholesterol

Total cholesterol, triglycerides, and HDL were analyzed using the kit and humalyser spectrophotometer method (Susandari et al., 2004).

### Total protein

The spectrophotometric methods of erythrosin-B were used as described by Soedjak (1994).

### Feed conversion efficiency (FCE)

FCR is an indicator for the conventional measure of animal performance, dividing the feed intake weight by animal weight (Knott et al., 2003).

### Statistical analysis

Data are expressed as mean ± S.D. ANOVA (two-way) and LSD will be used to determine the comparisons. The probability level was (0.05) to determine the significance. SPSS (V: 27) is used for data processing (SAS 2010).

## RESULTS

Our findings showed an increasingly significant increase in Hb levels in G1 more than in G3 ($P < 0.05$) during all study periods. Furthermore, G2 showed an increasingly significant increase in Hb levels more than G3 ($P < 0.05$) during all periods, as illustrated in Table (1).

The results showed a significant increase in PCV in the first group compared to G3 during all study periods ($P < 0.05$). Furthermore, G2 showed a significant increase in PCV compared to G3 during all periods ($P < 0.05$), as illustrated in Table (2).

The results showed a significant decrease in triglyceride acid in G1 compared to G3 during all periods ($P < 0.05$). Furthermore, G2 showed a significant decrease in tricarboxylic acid compared to G3 during all periods ($P < 0.05$), as illustrated in Table (3).

The results showed a significant decrease in cholesterol in G1 compared to G3 during all periods ($P < 0.05$). Furthermore, G2 showed a significant decrease in cholesterol compared to G3 during all periods ($P < 0.05$), as illustrated in Table (4).

The results showed a significant increase in body weight in G1 compared to G3 during all periods ($P < 0.05$). Also, G2 showed a significant increase in body weight compared to G3 during all periods at ($P < 0.05$), as shown in Table (5).

The results showed a significant increase in total protein (g/dL) in G1 compared to G3 during all periods ($P < 0.05$). Furthermore, G2 showed a significant increase in total protein (g / dL) compared to G1 and G3 during all periods ($P < 0.05$), as illustrated in Table (6).

The results showed a significant decrease in the value of the feed conversion efficiency in G1 compared to G3 during

**Table 1:** Hb levels (g/dl) in study groups during study weeks

| Groups | Periods | | | |
|---|---|---|---|---|
| | 2nd week | 4th week | 6th week | 8th week |
| G1 | 10.19±0.12ABa | 10.24±0.19Aab | 10.64±0.17Abc | 10.71±0.16Ac |
| G2 | 10.01±0.11Aa | 10.4±0.19Aab | 10.41±0.18Abc | 10.51±0.11Ac |
| G3 | 9.8±0.26Ba | 9.76±0.41Ba | 9.82±0.23Ba | 9.82±0.07Ba |
| LSD (P<0.05) | 0.264 | | | |

The different capital letters are used for columnar comparison, while the small letters are used for horizontal comparison.

**Table 2:** PCV percentage in study groups through study weeks

| Groups | Periods | | | |
|---|---|---|---|---|
| | 2nd week | 4th week | 6th week | 8th week |
| G1 | 37.84±0.13ABa | 37.94±0.13Aab | 37.54±0.19Abc | 38.39±0.19Ac |
| G2 | 37.06±0.15Aa | 37.44±0.32Bb | 37.5±0.18Bb | 38.04±0.05Bc |
| G3 | 36.68±0.11Ba | 36.58±0.17Ca | 36.5±0.11Ca | 36.68±0.08Ca |
| LSD(P<0.05) | 0.214 | | | |

The different capital letters are used for columnar comparison, while the small letters are used for horizontal comparison.

**Table 3:** Triglyceride levels (mg/dl) in study groups throughout study weeks

| Groups | Periods | | | |
|---|---|---|---|---|
| | 2nd week | 4th week | 6th week | 8th week |
| G1 | 37.37±0.17Aa | 35.63±0.38Ab | 33.4±0.53Ac | 33.59±0.38Ad |
| G2 | 38.05±0.37Ba | 36.55±0.61Bb | 34.91±0.96Bc | 33.86±1.08Bd |
| G3 | 40.6±0.17Ca | 40.64±0.08Ca | 40.63±0.02Ca | 40.56±0.06Ca |
| LSD(P<0.05) | 0.665 | | | |

The different capital letters are used for columnar comparison, while the small letters are used for horizontal comparison.

**Table 4:** Cholesterol levels (mg/dl) in study groups during study weeks

| Groups | Periods | | | |
|---|---|---|---|---|
| | 2nd week | 4th week | 6th week | 8th week |
| G1 | 113.5±0.13Aa | 112.8±0.15Ab | 111.2±0.17Ac | 110.7±0.23Ad |
| G2 | 114.36±0.28Ba | 113.22±0.69Bb | 113.08±0.62Bc | 112.04±0.42Bd |
| G3 | 115.6±0.15Ca | 116.4±0.41Cb | 117.5±0.11Cc | 118.5±0.13Cd |
| LSD(P<0.05) | 0.449 | | | |

The different capital letters are used for columnar comparison, while the small letters are used for horizontal comparison.

**Table 5:** Body weight (Kg) levels in study groups during study weeks

| Groups | Periods | | | |
|---|---|---|---|---|
| | 2nd week | 4th week | 6th week | 8th week |
| G1 | 36.34±0.41Aa | 37.99±0.46Aab | 39.37±0.39Abc | 41.98±0.39Ac |
| G2 | 35.81±0.4Ba | 37.81±0.49Bb | 38.77±0.51Bc | 39.62±0.55Bd |
| G3 | 35±0.55Ca | 35.27±0.35Ca | 35.49±0.35Ca | 35.78±0.33Ca |
| LSD(P<0.05) | 0.562 | | | |

The different capital letters are used for columnar comparison, while the small letters are used for horizontal comparison.

**Table 6:** Total protein (g/dL) in study groups during study weeks

| Groups | Periods | | | |
|---|---|---|---|---|
| | 2nd week | 4th week | 6th week | 8th week |
| G1 | 6.99±0.16ABa | 7.13±0.17Aab | 7.25±0.15Abc | 7.42±0.13Ac |
| G2 | 6.81±0.08Aa | 6.91±0.08Bab | 7.04±0.07Bbc | 7.18±0.13Bc |
| G3 | 6.71±0.15Ba | 6.70±0.22Ca | 6.66±0.15Ca | 6.77±0.17Ca |
| LSD(P<0.05) | 0.188 | | | |

The different capital letters are used for columnar comparison, while the small letters are used for horizontal comparison.

**Table 7:** Feed conversion efficiency value in study groups through study weeks

| Groups | Periods | | | |
|---|---|---|---|---|
| | 2nd week | 4th week | 6th week | 8th week |
| G1 | 4.41±0.07Aa | 4.31±0.01Ab | 4.22±0.01Ab | 4.01±0.02Ab |
| G2 | 4.45±0.06ABa | 4.23±0.03Aa | 4.01±0.01Aa | 3.92±0.008Aa |
| G3 | 4.61±0.01Ba | 4.61±0.03Aa | 4.62±0.03Aa | 4.65±0.02Aa |
| LSD(P<0.05) | 0.043 | | | |

The different capital letters are used for columnar comparison, while the small letters are used for horizontal comparison.

all periods (P <0.05). Furthermore, G2 showed a significant decrease in feed conversion efficiency compared to G3 during all periods (P <0.05), as illustrated in Table (7).

## DISCUSSION

The results showed that Hb increased more in the Silymarin-treated group than in the control group and increased with increasing Silymarin dose. In the study, Roozbeh et al. The included (80) patients were divided into four groups: G1 received Silymarin, G2 received vitamin E, G3 received Silymarin and vitamin E, and G4 was the control. The study found that the administration of silymarin and vitamin E increased the mean hemoglobin of all treatment groups compared to the control. Silymarin could treat anemia (Roozbeh et al., 2011).

In another study, Nazemian et al. found that silymarin could modulate the immune system and prostaglandin production. Silymarin stimulates hemoglobin to produce more after 28 days of administration (p < 0.05) (Nazemian et al., 2010). Silymarin is a mixture of flavonolignans used to treat liver disease and anemia. Silymarin has immunostimulant effects in fish. The trout were fed a Silymarin supplemented diet for one month, increasing RBC, WBC, PCV, Hb, total protein and albumin (Ahmadi et al., 2012). Patients received silymarin (140 mg) daily for six months, and hemoglobin levels improved compared to healthy at (P<0.05) (Rastegarpanah, et al., 2015).

On the basis of our results, PCV increased in the Silymarin group more than in the healthy group. A study by El-Sawy et al. found that silymarin has a protective effect against the toxicological effects of dexamethasone on the liver in rats. Silymarin improved hematological parameters such as increased PCV, total protein, globulin, and RBC (El-Sawy et al., 2018). In the study, Ravikanth et al. concluded on hematological changes due to imidacloprid and spinosad and treatment with Vit E and Silymarin in broiler chicken for 28 days. There is an increase in PCV, MCH, and MCHC in the Silymarin treated group (Ravikanth et al., 2017). In a study, Eid et al. examined the effect of silymarin on topological aspects of ochratoxin A in laying hens. Silymarin has improved in the group that treated Silymarin compared to the OTA group by increasing RBC, WBC, and PCV (Eid et al., 2022).

Silymarin increased PCV, RBCs, total protein, and body weight in male rabbits treated with NiCl2. Forty male rabbits were assigned to four groups and treated for 35 days. Silymarin reversed the parameters (Ali et al., 2015).

Silymarin is used in herbal therapies to counteract the toxic effects of mycotoxins. The study was conducted in 70 Ross broilers with chronic mycotoxicosis treated with Silymarin. Silymarin helps keep Hb, PCV, and red blood cell levels in the normal range and could be used to decrease the toxic effects of mycotoxicosis (Talebi et al., 2015). On the basis of the results, triglycerides and cholesterol were reduced in the Silymarin-treated group. Silymarin can decrease triglyceride and cholesterol levels in the food restriction group. Furthermore, silymarin under a food restriction situation decreases the peripheral conversion of T4 to T3 (Mahjoor et al., 2008).

Groups treated with silymarin with NAFLD showed improvement in steatosis, dyslipidemia, and low levels of Triglyceride (Mengesha et al., 2021). Additionally, silymarin can reduce Triglyceride, HDL-C, and LDL-C (Jiang et al., 2022). The systematic study was conducted using all

available databases on Silymarin. Eight clinical trials found that silymarin affects cholesterol and triglycerides by decreasing serum levels in patients with heart disease and decreasing hyperlipidemia (Sadeghi et al., 2020).
A study found that hypertriglyceridemia is a dangerous syndrome. Silymarin can more effectively protect against hypertriglyceridemia by decreasing triglyceride and total cholesterol levels in adult male rats with hypertriglyceridemia compared to the control group (Poruba et al., 2019).

Our results showed that body weight and total protein increased in the Silymarin-treated group these results were agreed with (Al-Absawi et al., 2020) who found that feeding additive to small ruminant improve their performance. Silymarin significantly increases milk secretion in cows and sheep and improves liver function. Consumption of milk thistle significantly increases body weight, total protein, and albumin, as well as increased WBC, calcium, and Vit D3 (Khazaei et al., 2022). Silymarin has a role in the rat by inhibiting the growth of cancerous lesions, reducing lipid peroxides, and increasing glutathione (Yassin et al., 2022). The animals treated with silymarin increase in body weight. The weight of the liver increases significantly in the Silymarin group more than in healthy individuals (Gopalakrishnan et al., 2006).

Thioacetamide is used to induce chronic liver fibrosis in mice. Thioacetamide causes lower body weight, high cholesterol, and increased liver size. Silymarin has ameliorated thioacetamide lesions by increasing body weight and preventing liver damage (Chen et al., 2012). Silymarin has antioxidants and ameliorates the potential in cisplatin-induced rats' kidney tissues. Cisplatin causes a decrease in body weight, an increase in kidney wet weight, and a dilated urinary space. However, post-treatment of silymarin improves some health indicators or parameters by increasing body weight, returning it to normal values (Abdelmeguid et al., 2010).

According to the findings, the feed conversion efficiency decreased in the Silymarin-treated group as it did in the untreated group. Silymarin has a positive role in protecting birds from aflatoxins. Silymarin reduced the toxic effects of aflatoxins and improved the efficiency of feeding conversion in birds (Alhidary et al., 2017).

As in the untreated group, 100 and twenty-five Gimmizah cockerels treated with silymarin showed improved food intake and FCR during the experimental period. There are improvements in the relative weights of the liver, spleen, and testes. Furthermore, the group receiving silymarin increased the relative weight of the liver (Abdalla et al., 2018).

## CONCLUSIONS

The present study demonstrated that silymarin plays an important and vital role in improving the biochemical and hematological characterization such as Hb, PCV, triglycerides, cholesterol, total protein, body weight, and feed conversion efficiency. Therefore, silymarin has benefits in lamb production.

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## CONFLICT OF INTEREST

No conflict of interest.

## AUTHORS CONTRIBUTION

The author conceived of the presented idea, verified the analytical methods. also, investigate the findings of this work. Author contributed to the final manuscript.

## REFERENCES

Abdalla A. A., Abou-Shehema B. M., Hamed R., Elden M. R. (2018). Effect of silymarin supplementation on the performance of developed chickens under summer conditions 1-during growth period. Egyptian Poult. Sci. J., 38(1): 305-329.

Abdelmeguid N. E., Chmaisse H. N., Zeinab N. A. (2010). Protective effect of Silymarin on cisplatin-induced nephrotoxicity in rats. Pak J. Nutr., 9(7): 624-36.

Ahmadi K., Banaee M., Vosoghei A. R., Mirvaghefei A. R., Ataeimehr B. (2012). Evaluation of the immunomodulatory effects of silymarin extract (*Silybum marianum*) on some immune parameters of rainbow trout, Oncorhynchus mykiss (Actinopterygii: Salmoniformes: Salmonidae). Acta Ichthyologica Et Piscator., 42(2).

Al-Absawi Mo.K.H., Dawood T.N., Taha A.A. (2020). EFFECT OF Different concentrations of Bannana peels (MUSA ACUMINATA) powder supplementation on some productive performance and rumen digestibilty in iraqi goats kids. Biochem. Cellul. Archiv., 20(2): 4977–4986

Alhidary I. A., Rehman Z., Khan R. U., Tahir M. (2017). Anti-aflatoxin activities of milk thistle (*Silybum marianum*) in broiler. World's Poult. Sci. J., 73(3): 559-566.

Ali A., Dh W., Khudair A. N., AL-Masoudi E. A. (2015). Influence of Silymarin extracted from Silybum marianum seeds compared to legalon against nickel chloride induced

hematological and biochemical changes in male rabbits. Bas. J. Vet. Res, 14(2): 293-305.

Cesanow N, Fleminh H, Kelly GA (2006). PDR for nonprescription drugs, dietary supplements, and herbs. 27th ed. Montvale: Thomson PDR; 2006.

Chen I.-S., Chen Y.-C., Chou C.-H., Chuang R.-F., Sheen L.-Y., Chiu C.-H. (2012). Hepatoprotection of Silymarin against thioacetamide-induced chronic liver fibrosis. J. Sci. Food Agric., 92: 1441-1447. https://doi.org/10.1002/jsfa.4723

Dawood T.N, (2023). Concentrations of Silymarine on the rumen activities in lambs. Nativa J. 11,2:272-276.

Dermarderosin A (2001). The review of natural products. 1st ed. United States of America: Facts and Comparisions; 2001.

Eid Y. Z., Hassan R. A., El-soud S. A., Eldebani N. (2022). The Protective Role of Silymarin to Ameliorate the Adverse Effects of Ochratoxin-A in Laying Hens on Productive Performance, Blood Biochemistry, Hematological and Antioxidants Status. Brazilian J. Poult. Sci., 24.

El-Sawy A. E. S. F., El-Maddawy Z. K., Ashoura N. R. (2018). Role of Silymarin in Restoring the Deleterious Effects induced by Dexamethasone in Male Rats. Alexandria J. Vet. Sci., 59(2).

Gopalakrishnan R., Hanumantha R. B. R., Radhakrishnan V., Thiruvengadam D. (2006). Suppression of N-nitrosodiethylamine induced hepatocarcinogenesis by Silymarin in rats, Chemico-Biological Interactions, 161 (2): 104-114. ISSN 0009-2797, https://doi.org/10.1016/j.cbi.2006.03.007.

Jiang G., Sun C., Wang X., Mei J., Li C., Zhan H., Mao J. (2022). Hepatoprotective mechanism of Silybum marianum on nonalcoholic fatty liver disease based on network pharmacology and experimental verification. Bioengineered., 13(3): 5216-5235.

Khamisabadi H. (2020). Effects of Silymarin on milk production, liver enzymes, oxidative status and HSP70 gene expression in postparturient Sanjabi ewes. Cellul. Molecul. Biol., 66(1): 76–81. https://doi.org/10.14715/cmb/2019.66.1.13.

Khazaei R., Seidavi A., Bouyeh M. (2022). A review on the mechanisms of the effect of Silymarin in milk thistle (Silybum marianum) on some laboratory animals. Vet. Med. Sci., 8: 289– 301. https://doi.org/10.1002/vms3.641

Knott S. A., B. J. Leury, L. J. Cummins, F. D. Brien, F. R. Dunshea. (2003). Relationship between body composition, net feed intake and gross feed conversion efficiency in composite sire line sheep. In: Souffrant, W. B. and C. C. Metges (eds.). Progress in research on energy and protein metabolism. EAAP publ. no. 109. Wageningen

Lee J.I., Mahesh N., Barrett J.S. (2007). Analysis and comparison of active constituents in commercial standardized silymarin extracts by liquid chromatography–electrospray ionization mass spectrometry. J. Chromatogr. B 845: 95–103.

Mahjoor AA, Dehghan A (2008). Effect of Silymarin on metabolic factors of food-restricted over conditioned Wistar rats. Pak. J. Biol. Sci. 15;11(14):1835-9. https://doi.org/10.3923/pjbs.2008.1835.1839

Mengesha T., Gnanasekaran N., Mehare T (2021). Hepatoprotective effect of Silymarin on fructose induced nonalcoholic fatty liver disease in male albino wistar rats. BMC Compl. Med. Ther. 21, 104 (2021). https://doi.org/10.1186/s12906-021-03275-5

Mojaddam A., Chaji M., Mohammadabadi T., TABATABAEI V. S. (2015). Feeding Value of Silybum marianum for Sheep and its Effect on Fiber and Protein Digestion.

Nazemian F., Karimi G., Moatamedi M., Charkazi S., Shamsara J., Mohammadpour A. H. (2010). Effect of silymarin administration on TNF-α serum concentration in peritoneal dialysis patients. Phytother. Res., 24(11): 1654-1657.

Olupot-Olupot P, Prevatt N, Engoru C, Nteziyaremye J, Amorut D, Chebet M, Senyondo T, Ongodia P, Ndila CM, Williams TN, Maitland K (2019). Evaluation of the diagnostic accuracy and cost of different methods for the assessment of severe anaemia in hospitalised children in Eastern Uganda. Wellcome Open Res. 2019 Mar 18;3:130. https://doi.org/10.12688/wellcomeopenres.14801.2. PMID: 30854471; PMCID: PMC6402076.

Poruba M., Anzenbacher P., Racova Z., Oliyarnyk O., Hüttl M., Malinska H., Vecera R. (2019). The effect of combined diet containing n-3 polyunsaturated fatty acids and Silymarin on metabolic syndrome in rats. Physiolog. Res., 68: S39-S50.

Radko L., Cybulski W. (2007). Application of Silymarin in human and animal medicine. J. Pre-Clin. Clin. Res., 1(1).

Rastegarpanah, M., Malekzadeh, R., Vahedi, H. et al. A randomized, double blinded, placebo-controlled clinical trial of Silymarin in ulcerative colitis. Chin. J. Integr. Med. 21, 902–906 (2015). https://doi.org/10.1007/s11655-012-1026-x

Ravikanth V., Lakshman M., Madhuri D., Kalakumar B. (2017). Haematological alterations in broilers administered with imidacloprid and spinosad and its amelioration with Vitamin E and Silymarin. Int. J. Curr. Microbiol. App. Sci., 6(4): 496-500.

Roozbeh J., Shahriyari B., Akmali M., Vessal G., Pakfetrat M., Raees Jalali G. A., Ghahramani N. (2011). Comparative effects of Silymarin and vitamin E supplementation on oxidative stress markers, and hemoglobin levels among patients on hemodialysis. Renal Fail., 33(2): 118-123.

Sadeghi G., Mohammadzadeh F., Mazloum S. (2020). Effect of Milk Thistle on Hyperlipidemia: A Systematic Review. Navid No., 22(72): 64-73.

Saller R, Melzer J, Reichling J, Brignoli R, Meier R (2007). An updated systematic review of the pharmacology of Silymarin. Forsch Komp. Klas. Nat. 14:70–80.

Saller R., Meier R., Brignoli R. (2001). The use of Silymarin in the treatment of liver diseases. Drugs. 61 (14): 2035–2063.

Saller R., Melzer J., Reichling J., Brignoli R., Meier R. (2007). An updated systematic review of the pharmacology of Silymarin. Fosrch Komplementärmed. 14: 70–80.

SAS (2010). SAS/STAT Users Guide for Personal Computer. Release 9.13.SAS Institute, Inc., Cary, N.C., USA.

Schiefer W.C. (1980). Statistics for the biological sciences.2nd ed. Addison. Wesley pub comp, California, London.

Soedjak H. S. (1994). Colorimetric micromethod for protein determination with erythrosin-B. Anal. Biochem., 220: 142-148.

Susandari L, Lestarin CMS, Wahyuni HI (2004). Komposisi lemak tubuh kelinci yang mendapatpakan pellet dengan berbagai aras lisin Proc Seminar Nasional Teknologi Peternakan danVeteriner (Jakarta: Departemen Pertanian)

Svobodová A., Zdarilova A., Malisková J., Mikulková H., Walterová D., Vostalová J. (2007). Attenuation of UVA-induced damage to human keratinocytes by Silymarin. J. Dermatol. Sci. 46: 21–30.

Talebi A., Haghnazari Sadaghiani A., Zare P. (2015). Effects of Silymarin on blood parameters of broilers in an experimental chronic mycotoxicosis. J. Mycol. Res., 2(1): 31-39.

Yassin NYS, AbouZid SF, El-Kalaawy AM, Ali TM, Almehmadi

MM, Ahmed OM (2022). Silybum marianum total extract, Silymarin and silibinin abate hepatocarcinogenesis and hepatocellular carcinoma growth via modulation of the HGF/c-Met, Wnt/β-catenin, and PI3K/Akt/mTOR signaling pathways. Biomed. Pharmacother. 2022 Jan;145:112409. https://doi.org/10.1016/j.biopha.2021.112409. Epub 2021 Nov 12. PMID: 34781148.