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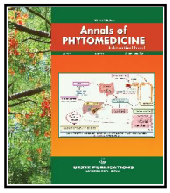

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Effect of essential oils and prebiotic on serum biochemical parameters of crossbred lactating cattle

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Abstract

This study investigated the effects of dietary supplementation with peppermint oil, lemon grass oil and mannan oligosaccharides (MOS) on various biochemical parameters in lactating dairy cattle over a period of 90 days. Total 30 animals were randomly distributed into five treatment groups, *i.e.*, control (T0) fed with basal diet, T1 group supplemented concentrate with 0.1% peppermint oil, T2 group with 0.1% lemongrass oil, T3 group with mannanoligosaccharide (MOS) @12 g /day /cattle and T4 group was provided a combination of 0.05% of each oil and 6 g MOS. Serum biochemical parameters were studied at 0, 30, 60 and 90 days of trial. Key findings indicate that EO supplementation significantly ($p<0.05$) lowered serum urea levels in T4 group at 30 days, in T2 and T4 groups at 60 days, and in all treatment groups at 90 days. Moreover, significant ($p<0.05$) reductions in aspartate transaminase (AST) and alanine transaminase (ALT) were noted in treatment groups, especially pronounced at 90 days, highlighting a hepatoprotective effect attributed to the bioactive components in EOs and MOS. The other parameters like glucose, protein profile and triglycerides did not vary significantly among treatment groups. Overall, the results revealed the beneficial role of EO and MOS supplementation in improving liver function and protein utilization in ruminants, suggesting a viable dietary strategy to enhance animal health and efficiency of nutrient use without negative side effects.

1. Introduction

The misuse of antibiotics in livestock has led to antibiotic resistance, posing global health risks (Coimbra *et al.*, 2022). Consequently, there is growing interest in natural alternatives like essential oils (EOs) and prebiotics to promote livestock health and productivity (Nehme *et al.*, 2021). These phytobiotics synergize with microbial flora, enhance rumen fermentation and overall health status (Kalantar *et al.*, 2017; Alizadeh *et al.*, 2010).

Essential oils (EOs) are natural compounds extracted from aromatic herbs through methods like hydrodistillation, historically pioneered by Arabs. These oils have been extensively studied for their therapeutic properties, including hepatoprotective effects (Bakkali *et al.*, 2008). Studies have reported essential oils to have antioxidant, anti-inflammatory, antimicrobial, anticarcinogenic and antidiabetic properties (Mehrotra, 2021; Deka *et al.*, 2021). Marjani *et al.* (2012) observed a significant reduction in alanine transaminase, alkaline phosphatase and gamma glutamyl transferase on supplementation of peppermint oil at various doses. Peppermint essential oil (PEO) has gained attention in ruminant feeding due to its potential to improve rumen fermentation, reduce methane production, and exhibit antimicrobial properties, thereby enhancing feed efficiency and gut health (Patra *et al.*, 2019). Lemongrass essential oil, derived from the aromatic grass plant *Cymbopogon citratus*, boasts a myriad of therapeutic properties. α-citral and β-citral are the main components, while, citronella, β-myrcene, limonene and geraniol are also present in lemongrass essential oil (LGEO) but in relatively lower concentrations (Schaneberg and Khan, 2002). Ghanima *et al.* (2021) demonstrated that lemongrass essential oil notably decreased levels of uric acid, creatinine, urea as well as ALT and AST levels of serum.

Prebiotics like mannan-oligosaccharides (MOS) sourced from *S. cerevisiae* cell wall promote the growth of beneficial gut microbes, enhance animal performance, stabilize rumen pH, and reduce toxin production (Chaucheyras and Durand, 2010 ; Hady *et al.*, 2012). Considering their potential to enhance livestock health, the current research aimed to assess the impact of supplementation of peppermint oil, lemongrass oil, and MOS on serum biochemical parameters of crossbred lactating cattle.

2. Materials and Methods

The site of the current study was IDF, College of Veterinary and Animal Sciences, GBPUAT, Pantnagar, UK, India. The highest temperature in the region can be reached to 44°C in the summer, and the lowest temperature of 1°C can occur in the winter.

2.1 Experimental animals

Thirty lactating animals up to fourth lactation from the crossbred cattle herd of IDF, Pantnagar, were chosen and equally distributed lactation-wise in different treatment groups. The experiment was performed for a period of 3 months. A combination of green and dry

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fodder with concentrate as per their body weight and milk production was fed to experimental animals. Concentrate feed was provided at the time of milking and supplementation with peppermint oil, lemon grass oil and MOS was done according to different treatment groups.

2.2 Grouping of experimental animals

The experimental cattle were distributed into Control (T0, without any supplement), Treatment 1 (T1, supplemented with peppermint oil @ 0.1% of concentrate diet), Treatment 2 (T2, supplemented with lemon grass oil @ 0.1% of the concentrate diet), Treatment 3 (T3, supplemented with mannan oligosaccharide (MOS) @ 12 g /day /cattle), and Treatment 4 (T4, combination of essential oils and prebiotic was provided, *i.e.,* peppermint oil @ 0.05% of concentrate, lemon grass @ 0.05% of concentrate and MOS @ 6 g/cattle/day). Each group consisted of 6 animals.

2.3 Collection of blood sample and storage

The blood samples were collected at 0, 30th, 60th and 90th day of the experimental study for serum biochemical analysis. The site for blood collection was prepared in a sterile manner by trimming the hair and cleaning the area with sterile gauze and spirit. A 5 ml blood sample was aseptically drawn from the jugular vein using a disposable syringe equipped with a 16-gauge needle, early at 8 am. The blood was immediately placed into a 5 ml vacutainer tube with a clot activator. Subsequently, the samples were quickly transported to the lab in a container chilled with ice packs. The blood samples were then stored at 4°C till the separation of serum from them. Then centrifugation of the samples was done at 3000 rpm for a duration of 10 min. The collected serum sample was then stored at – 20°C until analyses of biochemical parameters.

2.4 Parameters studied

Key serum biochemical parameters, including glucose, triglyceride, urea, total protein, albumin, globulin, and liver enzymes, *i.e.*, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were assessed. Diagnostic kits of ERBA Mannheim company and UV-VIS spectrophotometer were utilized for these analyses.

2.5 Statistical analysis

The data obtained from study was analyzed statistically by one-way ANOVA (Snedecor and Cochran, 1994). The means were compared using Duncan's post hoc analysis, with a significance estimated at 5% and 1% level.

3. Results

The mean concentrations of glucose and triglycerides remained within the normal range at 0, 30, 60, and 90 days across all treatment groups, with no significant differences observed among them. The overall glucose and triglyceride concentrations showed non- significant differences among different treatments. However, at 30 days, the mean urea concentration was significantly (p<0.05) lower in animals of T4 and highest in animals of T0 group. Urea concentrations in treatment groups T1, T2, and T3 were comparable to the other groups at 30 days. At 60 days, urea concentrations in animals of T2 and T4 groups were significantly (p<0.05) lower than control, while concentrations in animals of T1 and T3 groups were similar to other groups. By the 90-days of the trial, urea concentrations in animals of T1, T2, T3, and T4 were significantly (p<0.05) lower in comparison to animals of group T0. The overall urea concentration was also significantly (p<0.05) lower for animals of T1, T2, T3, and T4 groups than control group (Table 1).

Table 1: Average serum glucose, triglycerides and urea of different treatment groups

Days	T0	T1	T2	T3	T4
Glucose (mg/dl)					
0	59.16 ± 4.11	60.16 ± 3.55	62.50 ± 3.88	62.33 ± 4.26	62.16 ± 4.80
30	63.16 ± 2.70	63.33 ± 2.98	62.00 ± 4.02	61.16 ± 5.21	66.33 ± 2.85
60	62.66 ± 4.12	63.00 ± 2.76	65.50 ± 2.21	63.16 ± 4.03	63.83 ± 2.99
90	60.00 ± 3.25	66.66 ± 2.77	64.83 ± 2.83	65.66 ± 2.37	62.33 ± 3.67
Overall	61.25 ± 1.71	63.29 ± 1.49	63.70 ± 1.58	63.08 ± 1.94	63.66 ± 1.74
Triglycerides (mg/dl)					
0	19.58 ± 0.29	18.52 ± 0.63	19.07 ± 0.53	18.83 ± 0.48	19.61 ± 1.79
30	19.38 ± 0.59	18.67 ± 0.50	17.85 ± 0.49	18.21 ± 0.71	18.14 ± 0.63
60	16.31 ± 1.01	16.38 ± 0.44	17.41 ± 0.71	17.45 ± 0.79	16.38 ± 0.71
90	17.66 ± 0.69	17.05 ± 0.51	17.02 ± 0.68	16.27 ± 0.26	16.37 ± 0.40
Overall	18.23 ± 0.42	17.66 ± 0.31	17.84 ± 0.32	17.69 ± 0.34	17.63 ± 0.56
Urea (mg/dl)					
0	23.24 ± 1.54	20.17 ± 1.30	23.68 ± 2.14	22.14 ± 1.81	22.80 ± 1.65
30	24.58 ± 0.76^{b}	21.04 ± 0.87^{ab}	22.29 ± 1.62^{ab}	21.25 ± 1.64^{ab}	18.95 ± 0.67^{a}
60	24.80 ± 0.99^{b}	22.81 ± 1.12^{ab}	19.84 ± 1.09^{a}	21.62 ± 1.82^{ab}	19.64 ± 1.13^{a}
90	26.11 ± 0.89^{b}	21.11 ± 1.43^{a}	20.74 ± 1.20^{a}	21.48 ± 1.78^{a}	20.18 ± 1.26^{a}
Overall	24.68 ± 0.55^{b}	21.28 ± 0.59^{a}	21.63 ± 0.79^{a}	21.62 ± 0.82^{a}	20.39 ± 0.65^{a}

Values bearing different superscripts within a row differ significantly (p<0.05).

The average values of protein profile have been presented in Table 2. The mean values of total protein, albumin, globulin and A/G ratio were observed to be in the normal range at all collection days. The protein profile was found to vary non-significantly across all the treatment groups at 0, 30, 60 and 90 days of treatment. The overall protein profile was non-significantly different for all the treatment groups.

Table 2: Average serum protein profile of different treatment groups

Days	T0	T1	T2	T3	T4
Total protein (g/dl)					
0	8.18 ± 0.86	8.13 ± 0.91	8.40 ± 0.54	8.02 ± 1.08	8.91 ± 0.96
30	7.96 ± 1.10	8.40 ± 1.02	8.44 ± 0.63	8.51 ± 1.11	8.61 ± 0.98
60	7.97 ± 1.14	7.85 ± 0.80	8.55 ± 0.79	8.36 ± 1.17	8.16 ± 0.74
90	7.96 ± 1.04	8.25 ± 0.74	7.65 ± 0.52	8.07 ± 0.87	8.49 ± 0.55
overall	8.13 ± 0.46	8.38 ± 0.46	8.04 ± 0.37	8.04 ± 0.51	8.67 ± 0.44
Albumin (g/dl)					
0	4.17 ± 0.20	4.15 ± 0.20	4.30 ± 0.12	4.36 ± 0.27	4.08 ± 0.28
30	4.26 ± 0.34	4.45 ± 0.20	4.13 ± 0.44	4.83 ± 0.28	4.64 ± 0.33
60	4.38 ± 0.15	4.16 ± 0.28	4.13 ± 0.18	4.61 ± 0.17	4.71 ± 0.25
90	4.38 ± 0.22	4.26 ± 0.11	4.55 ± 0.24	4.36 ± 0.22	4.63 ± 0.24
Overall	4.51 ± 0.14	4.54 ± 0.16	4.48 ± 0.16	4.79 ± 0.14	4.68 ± 0.16
Globulin (g/dl)					
0	4.08 ± 0.16	4.23 ± 0.20	4.46 ± 0.16	4.43 ± 0.19	4.28 ± 0.14
30	4.26 ± 0.13	4.18 ± 0.09	4.50 ± 0.16	4.40 ± 0.24	4.17 ± 0.12
60	4.13 ± 0.22	4.10 ± 0.16	4.31 ± 0.24	3.99 ± 0.14	4.43 ± 0.28
90	3.82 ± 0.10	4.16 ± 0.28	4.06 ± 0.28	4.33 ± 0.16	4.33 ± 0.18
Overall	4.07 ± 0.08	4.17 ± 0.09	4.33 ± 0.10	4.29 ± 0.09	4.30 ± 0.09
A/G ratio					
0	0.99 ± 0.06	0.95 ± 0.08	0.93 ± 0.07	0.95 ± 0.09	0.95 ± 0.06
30	0.99 ± 0.06	1.06 ± 0.05	0.90 ± 0.06	1.10 ± 0.04	1.11 ± 0.08
60	1.15 ± 0.09	1.15 ± 0.10	1.11 ± 0.04	1.24 ± 0.05	1.13 ± 0.12
90	1.33 ± 0.07	1.22 ± 0.08	1.25 ± 0.14	1.20 ± 0.05	1.19 ± 0.10
Overall	1.12 ± 0.04	1.10 ± 0.04	1.05 ± 0.05	1.12 ± 0.03	1.10 ± 0.04

Values bearing different superscripts within a row differ significantly ($p<0.05$).

Table 3: Average aspartate amino transferase and alanine aminotransferase enzymes of different treatment groups

Days	T0	T1	T2	T3	T4
AST (U/L)					
0	85.18 ± 4.29	89.01 ± 5.52	90.48 ± 5.48	89.60 ± 3.15	84.88 ± 4.00
30	95.49 ± 1.02^{b}	89.89 ± 1.54^{ab}	89.60 ± 4.37^{ab}	88.42 ± 3.02^{ab}	82.52 ± 1.49^{a}
60	95.49 ± 2.28^{b}	87.83 ± 5.01^{ab}	83.70 ± 3.81^{a}	88.42 ± 1.82^{ab}	81.64 ± 2.30^{a}
90	93.72 ± 2.18^{b}	79.58 ± 2.28^{a}	81.05 ± 2.93^{a}	81.35 ± 1.70^{a}	75.16 ± 1.35^{a}
Overall	92.47 ± 1.54^{b}	86.58 ± 2.04^{a}	86.95 ± 2.16^{a}	86.95 ± 1.35^{a}	81.05 ± 1.39^{a}
ALT (U/L)					
0	33.60 ± 2.28	32.71 ± 4.10	34.48 ± 2.44	27.70 ± 4.44	33.30 ± 2.30
30	35.95 ± 0.87^{b}	31.24 ± 0.98^{ab}	32.42 ± 1.26^{ab}	32.42 ± 3.01^{ab}	28.29 ± 0.64^{a}
60	31.83 ± 2.70^{b}	28.29 ± 2.23^{ab}	23.87 ± 0.75^{a}	27.41 ± 2.73^{ab}	22.99 ± 1.02^{a}
90	32.42 ± 1.41^{b}	27.11 ± 1.08^{a}	26.52 ± 2.14^{a}	26.52 ± 1.58^{a}	25.93 ± 0.87^{a}
Overall	33.45 ± 0.96^{b}	29.84 ± 1.23^{a}	29.32 ± 1.22^{a}	28.51 ± 1.52^{a}	27.63 ± 1.01^{a}

Values bearing different superscripts within a row differ significantly ($p<0.05$).

The mean values of AST and ALT levels have been presented in Table 3. At the beginning of the study (0 day), the mean values of AST and ALT were non-significantly different for the groups. However, after 30 days, the mean AST and ALT values differ significantly and were lower (p<0.05) in the T4 group and highest in animals of T0. Meanwhile, levels in the animals of T1, T2, and T3 groups were comparable to other groups. By the 60th day of treatment, AST and ALT concentrations were significantly lower (p<0.05) in the T2 and T4 in comparison to control, with similar levels observed in the T1, T2, and T3 groups. Finally, by the 90th day, both AST (p<0.01) and ALT (p<0.05) concentrations were found significantly lower in animals of T1, T2, T3, and T4 when compared to T0. Overall AST and ALT values were also significantly (p<0.05) lower for treatments T1, T2, T3, and T4 compared to T0.

4. Discussion

The present findings of non-significant changes in glucose concentration align with previous findings by Orzuna-Orzuna *et al.* (2022) and in a meta-analysis involving ruminants. Furthermore, it was observed that EO supplementation did not negatively impact protein breakdown, as evidenced by the lack of significant effect on serum levels of albumin, globulin, and total protein (Dorantes-Iturbide *et al.*, 2022). El-Essawy *et al*. (2021) observed similar findings, reporting that EO supplementation had no significant effect on several biochemical parameters in ruminants, including total protein, albumin and globulin for the protein profile, while total lipids, triglycerides, and cholesterol for the lipid profile. Similarly, Joshi *et al.* (2023) reported a non-significant effect on serum albumin at 3 months on herbal supplementation in lactating Badri cattle. Additionally, El-Essawy *et al.* (2021) found that EO supplementation led to a decrease in blood urea nitrogen (BUN) concentration, indicating improved protein digestion and utilization, likely due to EO-mediated inhibition of proteolysis (Cardozo *et al.*, 2006; Fraser *et al.*, 2007) which supported the present study. Furthermore, EO supplementation in beef cattle has been associated with a reduction in serum urea concentration (Orzuna-Orzuna et *al.*, 2022). The reduction in urea levels is attributed to an increase in the relatively larger population of the bacterial family *Lachnospiraceae*, known to negatively correlate with serum urea levels in cattle (Zhou *et al.*, 2020; Qiu*et al.*, 2022). Similarly, Dorantes-Iturbide *et al.* (2022) demonstrated that EO supplementation decreased urea concentration and had no significant effect on triglyceride levels at low and moderate doses, while at high doses, triglyceride levels were significantly reduced. MOS has been found to reduce ruminal ammonia concentration, maintain ruminal pH and modulate the microbial population which may be associated with reduced urea levels.

In terms of liver health, EO supplementation demonstrated a hepatoprotective effect, as evidenced by decreased concentrations of ALT and AST (Uchida *et al.*, 2017; AL-Azzami and Mohammed, 2023). This protective effect may be attributed to bioactive compounds present in EOs, such as Neral and citral B found in lemongrass essential oil (Uchida *et al.*, 2017). Citral has been proposed to aid in detoxifying processes and lowering oxidative stress in the liver. Plants are natural sources of antioxidants and can minimize oxidative stress by reducing free radical formation (Kilaru *et al.*, 2023). The menthol in peppermint oil helps lower oxidative stress in the body, which in turn reduces lipid peroxidation and thereby provides hepatocyte protective effect (Marjani *et al.*,2012). Peppermint oil and lemon grass oil were thus found to regulate liver enzyme functions. Gupta and Kori (2022) observed reduced (p<0.05) levels of ALT and AST through herbal extract supplementation and reported increased liver function.

The liver, the primary organ affected by absorbed chemicals from the intestine, releases enzymes upon cell damage, reflected in elevated liver enzyme levels. Thus, lower levels of AST and ALT suggest better liver function and performance. MOS (mannan oligosaccharides) may protect the liver by reducing harmful gut microbes and metabolites produced. Similarly, MOS supplementation led to a significant reduction in AST and ALT levels, indicating a potential protective effect on liver function (Yalcinkaya *et al.*, 2008; Kairalla, 2022; Youssef *et al.*, 2023). Muhammad *et al.* (2020) found non-significant differences in protein profile with MOS treatment. However, Shoukry *et al.*(2023) reported that treated groups receiving various levels of prebiotics (MOS + beta-glucan) exhibited significantly elevated concentrations of total protein and albumin in treatment groups. However, other blood parameters such as globulin, urea, creatinine, AST, and ALT did not show significant differences.

5. Conclusion

It can be concluded that supplementation with peppermint oil, lemongrass oil and mannan oligosaccharides (MOS) in diet positively impacts liver health in ruminants, as indicated by the significant reduction in AST and ALT enzyme levels. Furthermore, EO supplementation improved protein digestion and utilization, evident from lower urea concentrations without adversely affecting glucose, triglycerides, total protein, albumin, or globulin levels. These findings suggest that EOs and MOS can be beneficial for ruminant health, supporting efficient nutrient utilization and liver function without negative impacts on metabolic parameters.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

References

Al-Azzami, A.A. and Mohammed, T.T. (2023). Effect of adding dry leaves of lemongrass (*Cymbopogon citratus*) to the diet on some biochemical tests of blood in broiler (ross 308). In: IOP Conference Series: Earth and Environmental Science, 1252(1): 012125. IOP Publishing.

Alizadeh, M.A.; Shariatmadari, F. and Karimi, M.A. (2010). The effect of essential oil, prebiotic, probiotic and antibiotic on performance and immune response of broilers chickens. Veterinary Research and Biological Products, **23**:10-17.

Bakkali, F.; Averbeck, S.; Averbeck, D. and Idaomar, M. (2008). Biological effects of essential oils: A review. Food and Chemical Toxicology, **46**(2):446-475.

Benchaar, C.; Hristov, A.N. and Greathead, H. (2009). Essential oils as feed additives in ruminant nutrition. In: T. steiner (ed.), Phytogenics in Animal Nutrition (pp:111-146). Nottingham University Press.

Cardozo, P.W.;Calsamiglia, S.; Ferret, A. and Kamel, C. (2006). Effects of alfalfa extract, anise, capsicum, and a mixture of cinnamaldehyde and eugenol on ruminal fermentation and protein degradation in beef heifers fed a high-concentrate diet. Journal of Animal Science, **84**(10):2801-2808.

Chaucheyras-Durand, F. and Durand, H. (2010). Probiotics in animal nutrition and health. Beneficial Microbes, **1**(1):3-9.

Coimbra, A.; Miguel, S.; Ribeiro, M.; Coutinho, P.; Silva, L.; Duarte, A.P. and Ferreira, S. (2022).Thymuszygis essential oil: Phytochemical characterization, bioactivity evaluation and synergistic effect with antibiotics against staphylococcus aureus. Antibiotics, **11**:146. doi:10.3390/antibiotics 11020146.

Deka, N.J.; Nath, R.; Tamuly, S.; Hazorika, M.; Pegu, S.R. and Deka, S.M. (2021). Green synthesis and characterization of silver nanoparticles using leaves extract of Neem (*Azadirachta indica* L.) and assessment of its *in vitro* antioxidant and antibacterial activity. Ann. Phytomed., **10**(1):171-177.

Dorantes-Iturbide, G.;Orzuna-Orzuna, J.F.; Lara-Bueno, A.; Mendoza-Martínez, G.D.; Miranda-Romero, L.A. and Lee-Rangel, H.A. (2022). Essential oils as a dietary additive for small ruminants: A meta-analysis on performance, rumen parameters, serum metabolites, and product quality. Veterinary Sciences, **9**(9):475.

El-Essawy, A.M. ; Anele, U.Y. ; Abdel-Wahed, A.M. ; Abdou, A.R. and Khattab, I.M. (2021). Effects of anise, clove and thyme essential oils supplementation on rumen fermentation, blood metabolites, milk yield and milk composition in lactating goats. Animal Feed Science and Technology, **271**:114760.

Fraser, G.R. ; Chaves, A.V. ;Wang, Y.;McAllister, T.A.; Beauchemin, K.A. and Benchaar, C. (2007). Assessment of the effects of cinnamon leaf oil on rumen microbial fermentation using two continuous culture systems. Journal of Dairy Science, **90**(5):2315-2328.

Ghanima, M.M.A.;Swelum, A.A.;Shukry, M.; Ibrahim, S.A.; Abd El-Hack, M.E.;Khafaga, A.F.; Alhimaidi, A.R.; Ammari, A.A.; El-Tarabily, K.A. and Younis, M. E.M. (2021). Impacts of tea tree or lemongrass essential oils supplementation on growth, immunity, carcass traits, and blood biochemical parameters of broilers reared under different stocking densities. Poultry Science, **100**(11):101443.

Gupta, V. and Kori, M.L. (2022). Assessment of hepato and nephroprotective potential of polyherbal combinations against STZ-induced diabetic liver and kidney complications in wistar rats. Ann. Phytomed., **11**(1):311-319.

Hady, M.M.; El-Banna, R.A.;Teleb, H.M. and Shimaa, R.A. (2012). Impact of manna oligosaccharide (bio-mos) and esterified glucomannan (mtb-100) dietary supplementation on performance and health status of barki lambs under egyptian conditions. International Journal of Chemistry and Applied Chemical Engineering, **3**:264-268.

Joshi, D.; Kumar, S.; Palod, J.; Rahal, A.; Ghosh, A. K.; Sodhi, M. and Rastogi, S. K. (2023). Effect of dietary substitution of dried Moringa oleifera Lam. leaves on blood- serum proteins of Badri cattle. Ann. Phytomed., **12**(2):943-948.

Kairalla, M.A. (2022). Effect of graded levels of (Mannan oligosaccharide and â-Glucans) as a growth promoter on productive performance and physiological performance of broiler chickens. Egyptian Poultry Science Journal, **42**:549-559.

Kalantar, M.; Hosseini, S.M.; Yang, L.; Abbas, Raza, S.H.;Gui, L.;Rezaie, M.;Khojastekey, M.; Wei, D.; Khan, R.; Yasar, S.; Syed, S. F.; Kachiwal, A.B.; Elkhairey, M.; Lei, Q.; Kaleri, R.R. and Abd El-Aziz, A.H. (2017). Performance, immune, and carcass characteristics of broiler chickens as affected by thyme and licorice or enzyme supplemented diets. Open Journal of Animal Sciences, **07**(02):105-109.

Kilaru, N.B.; Challa, S.R.; Saka, V.P.; Kodali, T.; Toleti, V.; Koppula, S. and Pingili, R. (2023). Hepatoprotective activity of herbal extracts and other compounds against acetaminophen-induced hepatotoxicity by various mechanisms: A narrative review. Ann. Phytomed., **12**(2):70-88.

Marjani, A.; Rahmati, R.;Mansourian, A.R. and Veghary, G. (2012). Effect of peppermint oil on serum lipid peroxidation and hepatic enzymes after immobility stress in mice. The Open Biochemistry Journal, **6**: 51.

Mehrotra, N. (2021). Herbs that heal: Nature's pharmacy endowed remedies for better health. Ann. Phytomed., **10**:6-22.

Muhammad, S.L.; Sheikh, I.S.;Bajwa, M.A.; Mehmood, K.; Rashid, N.; Jan, S.U.; Akhter, M.A.; Majed Rafeeq, M.; Babar, W.;Magsi, R.A.; Mandokhail, Z.K.; Hameed, S.; Fayyaz, A.; Shah, H.A. and Rehman, U.A. (2020). Effect of mannan oligosaccharide (MOS) on growth, physiological and immune performance parameters of broiler chickens. Pak-Euro Journal of Medical and Life Sciences, **3**:76-85.

Nehme, R.; Andrés, S.; Pereira, R.B.; Ben Jemaa, M.;Bouhallab, S.; Ceciliani, F.; López, S.; Rahali, F.Z.;Ksouri, R.; Pereira, D.M. and Abdennebi-Najar, L. (2021).Essential oils in livestock: from health to food quality. Antioxidants, **10**:330. doi: 10.3390/antiox10020330.

Orzuna-Orzuna, J.F.;Dorantes-Iturbide, G.; Lara-Bueno, A.; Miranda-Romero, L.A.; Mendoza-Martínez, G.D. and Santiago-Figueroa, I. (2022).A meta-analysis of essential oils use for beef cattle feed: rumen fermentation, blood metabolites, meat quality, performance and, environmental and economic impact. Fermentation, **8**(6):254.

Patra, A.K.; Park, T.; Braun, H.S.; Geiger, S.; Pieper, R.; Yu, Z. and Aschenbach, J.R. (2019). Dietary bioactive lipid compounds rich in menthol alter interactions among members of ruminal microbiota in sheep. Frontiers in Microbiology, **10**:470160.

Qiu, X.; Qin, X.; Chen, L.; Chen, Z.; Hao, R.; Zhang, S.; Yang, S.; Wang, L.; Cui, Y.; Li, Y.; Ma, Y.; Cau, B. and Su, H. (2022).Serum biochemical parameters, rumen fermentation, and rumen bacterial communities are partly driven by the breed and sex of cattle when fed high-grain diet. Microorganisms, **10**:323.

Schaneberg, B. T. and Khan, I. A. (2002). Comparison of extraction methods for marker compounds in the essential oil of lemon grass by GC. Journal of Agricultural and Food Chemistry, **50**:1345-1349.

Snedecor, G.W. and Cochran, W.B. (1994). Statistical methods. 8th ed. The lowa state University Press, Ames, IOWA, USA.

Uchida, N.S.; Silva-Filho, S.E.; Aguiar, R.P.;Wiirzler, L.A.M.; Cardia, G.F.E.; Cavalcante, H.A.O and Cuman, R. K.(2017). Protective effect of *Cymbopogon citratus* essential oil in experimental model of acetaminophen-induced liver injury. The American Journal of Chinese Medicine, **45**(3): 515-532.

Yalcinkaya, I.; Guengoer, T.; Ba°alan, M. and Erdem, E. (2008). Mannan oligosaccharides (MOS) from Saccharomyces cerevisiae in broilers: effects on performance and blood biochemistry. Turkish Journal of Veterinary and Animal Sciences, **32**:43-48.

Youssef, I.M.; Khalil, H.A.; Jaber, F.A.;Alhazzaa, R.A.;Alkholy, S.O.;Almehmadi, A. M. and Abo-Samra, M. A. (2023). Influence of dietary mannan-oligosaccharides supplementation on hematological characteristics, blood biochemical parameters, immune response and histological state of laying hens. Poultry Science, **102**(11):103071.

Zhou, R.; Wu, J.; Lang, X.; Liu, L.; Casper, D.P.; Wang, C.; Zhang, L. and Wei, S. (2020). Effects of oregano essential oil on *in vitro* ruminal fermen tation, methane production, and ruminal microbial community. Journal of Dairy Science, **103**: 2303-2314.

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