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The values of some biochemical metabolic parameters in dairy cows supplemented with glycine chelated minerals

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Abstract. The paper presents data regarding the impact of some trace mineral supplementation on some pmetabolic parameters of glycine chelated mineral supplemented dairy cows. The study was made on thirty Holstein multiparous dairy cows, aging arround 62 ± 4.5 months that were divided randomly in two groups: C – Control receiving normal diet without glycine mineral supplementation and one experimental group (E) that received supplement of glycine chelated Cu, Zn, Mn and Fe as follows: 15 mg/kg Cu, 20 mg/kg Mn, 60 mg/kg Zn and, 100 mg/kg Fe, added in concentrate feed. The experiment was designed from day 30 of lactation until day 100 of lactation, and were assesed the potassium (K), phosphorus (P), glucose (Glu), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total proteins (TP), albumin (ALB), urea (U), and creatinine (CRE). In the experimental group we observed significant ($p<0.05$) decrease of K and P, the non significant decrease of glicaemia and urea and, a significant ($p<0,01$) decrease of liver parameters such as Ast and ALP in cows supplemented with glycine minerals comparing with controls. There also noted a non significant increase of total pproteins (TP), ALB and CRE in experimental group compared to control. We conclude that supplementing the dairy cows whit chelated minerals could have a benificial role on main biochemical metabolic parameters, being necessary more studies on a long term period.

Keywords*:* metabolic parameters, dairy cows, supplements, minerals, glycine chelate

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Introduction.

The metabolic profile, also known as biochemical profiling, is a valuable diagnostic tool used to assess the health status of dairy cows by analyzing various metabolites in the blood. This analysis provides information about the animal's nutritional and metabolic condition, helping to identify conditions such as ketosis, fatty liver, hypocalcemia, and other common metabolic disorders in high-producing dairy cattle (Kuhn M et al., 2006).

The profile typically includes measurements of blood glucose, non-esterified fatty acids (NEFA), beta-hydroxybutyrate (BHBA), calcium, phosphorus, and liver enzymes, which collectively reflect the energy balance, mineral status, and organ function (Oetzel GR, 2017).

Early detection of metabolic imbalances through biochemical analysis allows for prompt interventions, thereby improving animal welfare, productivity, and reproductive performance. In this regard, the metabolic profile is an essential component in the management and monitoring of dairy herd health, especially during the transition period when cows are most vulnerable to metabolic disorders (Grum DJ et al., 2018).

The aim of the presented study was to emphasize the influence of glycine chelated minerals on the level of some selected metabolic paraeters in some minerals supplemented dairy cows.

Materials and methods.

Object of the study. The research involved 30 multiparous Holstein dairy cows, with an average age of approximately 62±4.5 months and a body weight of 462±23 kg. These cows were housed individually in tie stalls at a private agricultural facility in Bihor County, Romania. The experimental procedures and animal inclusion criteria received approval from the Scientific Committee (Decision no. 62 /15.11.2020) and adhered to the EU Directive on Animal Experiments (Directive 2010/63/EU).

Experimental scheme. The cows were randomly assigned to two groups of 15 animals each: a control group (C) that was fed a standard diet without glycine mineral supplementation, and an experimental group (E) that received glycine-chelated copper, zinc, manganese, and iron (E.C.O. Trace®, Biochem, Germany) at specified doses: 15 mg/kg Cu, 60 mg/kg Zn, 20 mg/kg Mn, and 100 mg/kg Fe, incorporated into their concentrate feed.

The experiment starts from day 30 of lactation until day 100 of lactation. The feeding was twice a day, in an individual front as was previously reported (Goilean G et al., 2022, 2004). The total chemical content of the ratio is presented in table 1.

Table 1. **Content of ratio for dairy cows used in experiment**

Parameter	Unit	Values
DM	%	48.2
Crude Protein (CP)	%	16.96
Soluble protein	% from CP	49.5
NE	Mcal/kg	1.65
Ca	%	1.02
P	%	0.31
Mg	%	0.38
K	%	1.07
Na	%	0.33
Cl	%	0.32
Vitamin A	IU/kg	11 400
Vitamin D	IU/kg	3100
Vitamin E	IU/kg	35200
Fe	ppm	208.33
Zn	ppm	26.91
Cu	ppm	9.14
Mn	ppm	24.27
Se	ppm	0.19

At the end of the experimental period, blood samples were collected, allowed to clot to obtain serum, centrifuged, and then biochemical analyses were performed on the serum using a Randox RX Daytona analyzer with specific kits for potassium (K), phosphorus (P), glucose (Glu), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total proteins (TP), albumin (ALB), urea (U), and creatinine (CRE).

Statistical processing. Values were expressed as mean ± SD (standard deviation). To evaluate the difference between the studied groups, one-way ANOVA and the multiple t-test with Welch's correction using the Holm-Sidak method were employed, considering differences statistically significant when $p<0.05$ or less. The statistical software used was GraphPad Prism 9.2 for Windows (GraphPad Software, San Diego, USA).

Results.

The results of the present study are presented in the table 2 and figures 1 to 5.

Table 2. **The meabolic parameters dynamic in dairy cows with and withouth minerals**

Lot **Parameter**	**C** **X±Sx**	**E** **X±Sx**
K (mmol/l)	6.88±0.51	5.78±0.21 *
P (mg/dL)	9.11±0.81	6.95±0.36 *
Glu (mg/dL)	57.52±0.89	55.89±0.71
AST (UI/L)	144.4±21.75	110.20±20.17 **
ALP (UI/L)	205.07±24.01	127.14±8.39 **
PT (g/dL)	6.42±0.13	6.86±0.23
Alb (g/dL)	3.52±0.08	3.68±0.17
Urea (mg/dL)	22.60±0.89	20.60±1.94
Cre (mg/dL)	1.10±0.03	1.22±0.08

Comparative E/C * – $p<0.05$, ** – $p<0.01$

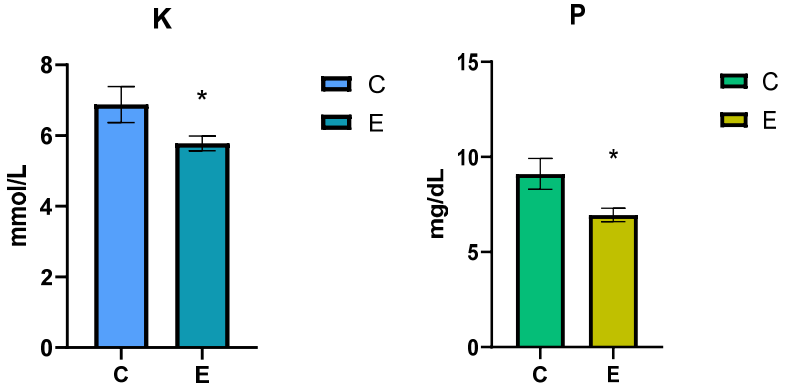

Figure 1. **Graphical representation of k and P in dairy cows supplemented or not with minerals**
Comparision E/C: * – $p<0.05$

Analyzing the dynamics of serum potassium and phosphorus in cows in the experimental group that received mineral supplements, we found a significant decrease ($p<0.05$) in their levels (potassium E/C: - 15.98%, phosphorus E/C: -23.71%).

Blood glucose levels decreased in cows that received mineral supplements with Zn, Cu, Mn and Fe compared to cows in the control group, the decrease, although evident, was not statistically significant ($p>0.05$) (E/C: -2.89%).

The most significant decrease was recorded in AST and ALP values, thus they decreased significantly in the group that received mineral supplementation compared to the cows in the control group (AST – E/C: -23.68%, ALP – E/C: -38.01%).

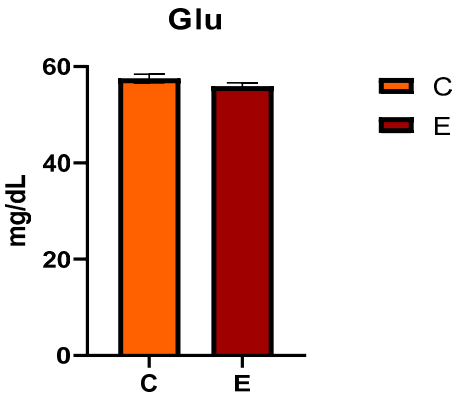

Figure 2. **Graphical representation of glicaemia in dairy cows supplemented or not with minerals**

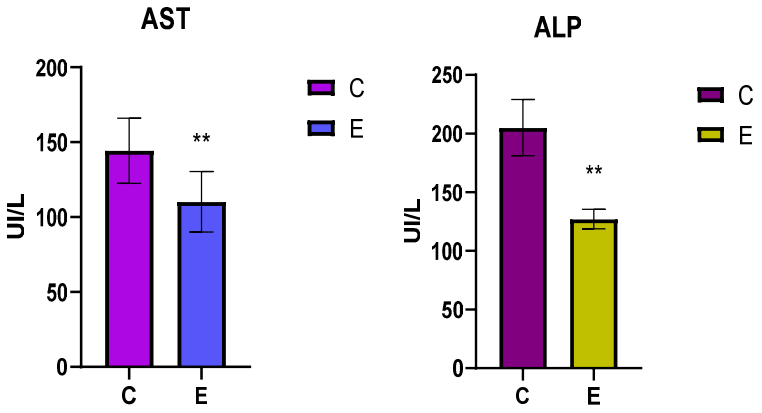

Figure 3. **Graphical representation of AST and ALP in dairy cows supplemented or not with minerals**

Comparision E/C: ** – $p<0.01$

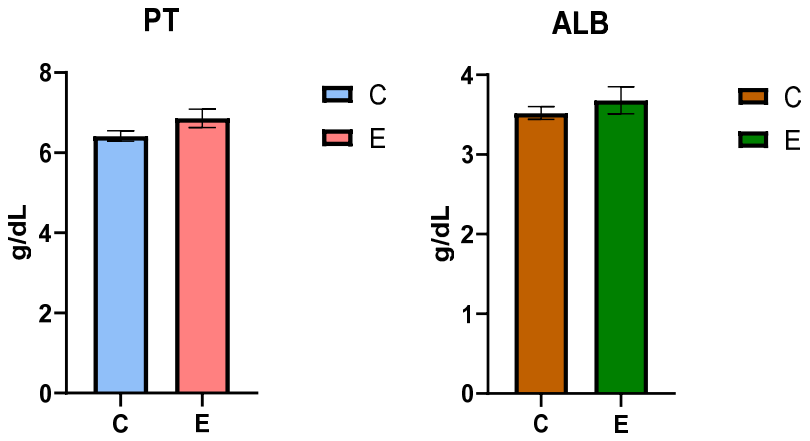

Figure 4. **Graphical representation of PT and ALB in dairy cows supplemented or not with minerals**

Serum protein levels increased in cows that received a mineral supplement diet compared to those in the control group, thus both total protein levels and serum albumin levels increased, the increase being statistically insignificant (p>0.05) (PT – E/C: +6.85%, ALB – E/C: +4.54%).

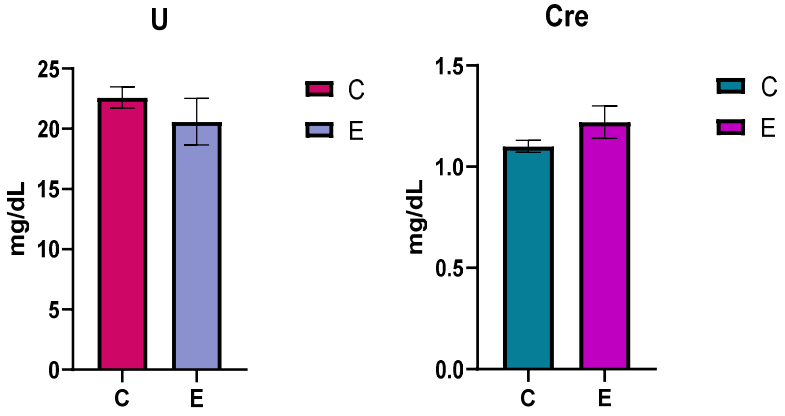

Figure 5. **Graphical representation of U and Cre in dairy cows supplemented or not with minerals**

Serum urea decreased insignificantly (p>0.05) in cows that received mineral supplements compared to those in the control group (E/C: -8.84%), while serum creatinine increased slightly in the group that received mineral supplements compared to the control group, but this increase was not statistically significant (p>0.05) (E/C: +10.91%).

Discussion.

The metabolic parameters of dairy cows are critical indicators of their health, productivity and general well-being. The recent study evaluating the effects of supplementation with minerals, such as copper (Cu), zinc (Zn), manganese (Mn) and iron (Fe), provides valuable information on how these minerals in microquantities influence serum biochemical profiles in dairy cattle.

The results obtained in the study on the effects of mineral supplementation on biochemical parameters in dairy cows are consistent with the literature, but also bring some new aspects that are worth discussing. First, the significant decrease in serum potassium and phosphorus in the experimental group indicates a possible adjustment of mineral metabolism in the context of mineral supplementation. This observation is in line with previous studies that have shown that supplementation with certain minerals can influence serum mineral homeostasis, but the results vary depending on the dosage and composition (Kincaid, 2011). For example, Kincaid et al. (2011) reported a decrease in serum phosphorus under conditions of mineral supplementation, attributing this phenomenon to a metabolic balancing effect or mobilization of minerals from stores. Mohebbi-Fani M et al. (2012) demonstrated that adjustments in mineral balance can modulate serum phosphorus levels, especially when dietary intake is optimized. Reduced serum phosphorus may suggest improved utilization or reduced mobilization from bone stores, but clinical significance depends on whether values remain within normal physiological limits. Similarly, serum potassium levels are tightly regulated; significant decreases could impact neuromuscular function if they fall below critical thresholds (Reece WB et al., 2014). However, because values remained above the thresholds of deficiency, these changes likely indicate metabolic adjustments rather than pathology.

Glucose is the main source of energy, and its regulation is crucial in lactating cows to support milk production. Micronutrients, such as Zn and Mn, are cofactors for enzymes involved in carbohydrate metabolism (Kelley KT et al., 2011). Although the decrease was not statistically significant, it suggests that mineral supplementation may subtly influence glucose metabolism. Blood glucose levels, although

decreased by 2.89%, were not statistically significant, suggesting that Zn, Cu, Mn, and Fe supplementation did not have a major impact on glucose metabolism under the conditions of our study. The literature indicates that mineral status can affect insulin sensitivity and glucose utilization. For example, Mn is crucial for insulin synthesis and action (Li L et al., 2018). In the existing literature, the effects of minerals on blood glucose are variable; for example, Suttle NF (2010) reported that zinc plays an important role in insulin function and glucose metabolism, but the effects may be influenced by the dose administered and the initial condition of the animals (Suttle NF, 2010). Thus, the lack of a significant difference in our case may be attributed to the dose or duration of the study.

A notable aspect is the significant decrease in the liver enzymes AST and ALP, indicating a possible improvement in liver function or a reduction in liver stress following mineral supplementation. Increased levels of these enzymes are often associated with liver stress or bone turnover (Lala V et al., 2025). These results are consistent with the studies of Sato J et al. (2005), which highlighted that adequate mineralization can help reduce oxidative stress and liver damage in cattle. In addition, the decrease in liver enzymes may suggest an improvement in liver health, which is important for overall metabolism and productive performance.

Serum protein levels, including total and albumin, increased slightly, although not statistically significant. This trend, however, may indicate a beneficial effect of mineral supplementation on hepatic protein synthesis, an aspect also supported by studies by Goff JP (2004), who highlighted that minerals such as zinc and copper play a crucial role in immune function and protein synthesis. Proteins such as albumin are indicators of nutritional status and hepatic synthetic capacity (Reece WB et al., 2014). Slightly increased levels suggest possible improvements in protein synthesis, possibly due to better mineral status, supporting hepatic function. Zinc and copper are co-factors for numerous enzymes involved in amino acid metabolism and protein synthesis (Kelley KT et al., 2011). Thus, adequate mineral nutrition may support better protein turnover, essential for milk synthesis and general health. The same dynamic was noted by (Klein GS et al., 2025) in dairy cows supplemented with zinc and selenium.

Regarding urea and creatinine, the insignificant decrease in serum urea and the moderate increase in creatinine do not indicate a significant impairment of renal function, but these results should be interpreted with caution, given that the differences were not statistically significant. Urea is a marker of protein catabolism and nitrogen metabolism, and its reduction may indicate a more efficient use of nitrogen (Reece WB et al., 2014). The small increase in creatinine, an indicator of muscle mass and renal function, remains within normal limits, suggesting that there are no adverse effects on renal health. Studies by Cheng L et al. (2020) emphasize that mineral supplementation does not negatively affect renal function if doses are adequate and if there are no other concomitant pathologies.

Conclusions.

Overall, the findings suggest that supplementation with minerals, such as Cu, Zn, Mn and Fe, influences various serum biochemical parameters in dairy cows, mainly indicating an improved metabolic status. Significant reductions in liver enzymes (AST and ALP) suggest better liver health, while stability in mineral levels may reflect better mineral balance. Trends in serum protein and glucose levels, although not statistically significant, support the hypothesis that adequate mineral nutrition supports metabolic functions essential for milk production. Supplementation with Cu, Zn, Mn and Fe appears to have positive effects on key metabolic parameters in dairy cows, supporting their health and productivity.

Future research should focus on larger populations and long-term effects to confirm these benefits and optimize supplementation strategies.

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