

Impact of a Low Level Laser Irradiation (LLLI) On Several Blood and Productive Parameters of Fresh Dairy Cows

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ABSTRACT: The objective of the research was to find out the effect of LLLI irradiation on cow physiological and productivity parameters at the peak of lactation. For the purpose of the trial, a total of 40 clinically healthy cows were grouped in the following 2 groups: test (n=20) and control group (n=20). Twenty cows in the test group were exposed to laser irradiation for 30 seconds daily for 8 continuous days. Blood and milk samples were collected three times: before starting the trial (before irradiation), at the end of the trial (after 8 days of irradiation) and 14 days after the end of the trial. LLLI irradiation for 30 seconds (8 consecutive days) at the peak of cow lactation had no effect whatsoever on changes in the total blood protein content, aspartatamine transeferase, leukocytes and phosphorus parameters in both the test and control group, however, the calcium concentration in the test group was found to remain stable over the entire course of the investigation. Was found to cause a statistically significant decrease in SCC in the test group as compared to the control group, and a statistically significant increase in milk protein content in the test group when compared to the control group.

KEYWORDS: LLLI, Cow, blood, milk, parameters.

I. INTRODUCTION

The postpartum period is associated with a high incidence of most dairy cattle diseases and a high risk of removal from the herd. Postpartum diseases often share risk factors, and these factors may trigger a cascade of other diseases [1]. These high lactational incidence risks of disease are attributable in part to the reduced immune function from approximately 2 weeks before to 3 weeks after calving. The severity of concurrent insulin resistance (IR), reduced feed intake, negative energy balance (NEB) and weight loss contribute to the degree and duration of the reduced immune defence. Innate immunity from PMN is a primary means of immune response in the uterus, and the PMN function is associated with the risk of retained placenta (RP) [2], metritis and endometritis [3]. There is a necessary immune and inflammatory response to the inevitable bacterial contamination of the uterus and the need for substantial tissue repair as part of involution. There is an emerging understanding that energy and fat metabolism are linked with inflammation. The mechanisms of pathogen detection, immune response, and to a lesser degree, regulation of inflammation in the uterus of dairy cows in the postpartum have been described [4, 5], and there are temporal associations with substantial metabolic changes [6]. These phenomena are being investigated in dairy cows where they appear to be central to health in the transition period [7]. This may be useful to understanding the determinants of effective inflammatory response in the reproductive tract of postpartum dairy cows. NEFA mobilization and a fatty liver lead to IR, especially in the liver [8]. Increased intracellular accumulation or decreased oxidation of NEFA leads to a build-up of fatty acid metabolites that block the action of insulin receptor substrate (IRS1 and 2) that in turn diminishes the signalling of a key enzyme (PI(3)K) for insulin action. A fatty liver is also associated with an impaired innate immune function. Circulating numbers of leucocytes (including both mature and immature PMN) increase to peak at or just after calving, and these counts were similar between cows with and without a fatty liver (>40 mg fat/g liver in the first 2 weeks postpartum) [9]. Other markers of liver health have also been associated with endometritis. In pasture-based cows at weeks 2, 4 and

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6, the postpartum aspartate aminotransferase and at weeks 4 and 6, the glutamate dehydrogenase were higher in cows with endometritis at week 6 [10]. Plasma albumin was slightly but significantly lower throughout the transition period in cows that had endometritis. It is unclear whether the difference in albumin is a direct reflection of liver health or an indicator of protein nutrition.

Low power laser irradiation has been shown to have positive bio-stimulation effects on living organisms both *in vitro* and *in vivo*, and in various applications in the medical field [11]. During the past two decades, many reports have indicated that laser irradiation can promote wound healing, but the mechanism remains unclear [12]

We did not find any information about LLLI effect on cow physiological and productivity parameters at the peak of lactation. **The objective of the research.** To find out the effect of LLLI irradiation on cow physiological and productivity parameters at the peak of lactation.

II. RELATED WORK

For the purpose of the trial, a total of 40 clinically healthy cows were grouped in the following 2 groups: test (n=20) and control group (n=20). Only fresh cows (up to 30 days postpartum) were selected for the trial. Before the trial, in its course and afterwards, all the cows under consideration were examined using general clinical investigation methods and their health condition was monitored continuously. The average age of the test and control cows was 3.4 and 3.7 years, respectively. Lithuanian black-and-white breed cows accounted for 68 %, and the Holstein breed – for 32 % of the total cows involved in the trial. A feed dispenser was used to feed the cows twice daily. The cows were milked in a rotary milking parlour containing 24 milking stalls (Westfalia surge, Germany) twice a day. The cows were kept in a loose housing barn, the manure was removed once a day, straw was used as a bedding, and an adapted feed ration was offered for each batch of cows (depending on the lactation days and productive performance). The cows were regularly let outdoors for exercise. Twenty cows in the test group were exposed to laser irradiation for 30 seconds daily for 8 continuous days.

Blood samples were collected three times: before starting the trial (before irradiation), at the end of the trial (after 8 days of irradiation) and 14 days after the end of the trial. For the purpose of investigation, blood samples were collected from *V. epigastrica* to vacuum test-tubes (BD Vacutiner, England) using 0.072 ml of the preservative EDTA IK₃ and using no preservative, for the purpose of obtaining blood serum. Afterwards, morphological and biochemical blood tests were performed. The total leukocyte count (LK) was determined in a Neubauer-Improved (Paul Marienfeld GmbH&Co. KG Lauda-Königshofen, Vokietija) counting chamber (Kraft 1987). The total blood concentrations of protein (B.b.), calcium (Ca), phosphorus (P) and aspartataminotransferase (AST) were determined using a computer-controlled Hitachi 705 analyzer (Hitachi, Japan). The data was processed using Dairy Plan C21 computer software and Microsoft Excel (2003).

The milk were collected three times: before starting the trial (before irradiation), at the end of the trial (after 8 days of irradiation) and 14 days after the end of the trial. Milk samples were collected in special disposable containers containing a preservative – Sedupol. The milk fat content, protein content, milk lactosis, total somatic cell count and milk urea were analysed at VĮ “Pieno tyrimai”.

Data analysis and statistics. The test data were processed using an SPSS statistical package (SPSS for Windows 15.0, SPSS Inc., Chicago, IL, USA, 2006). The data was considered reliable from a statistical point of view, where $p < 0.05$.

III. EXPERIMENTAL RESULTS

Low-level laser irradiation (LLLI) has been investigated widely for over 30 years [13] and has been shown to have a variety of biostimulatory effects. Increased proliferation after LLLI has been reported in many cell types including fibroblasts, keratinocytes, human osteoblasts, and lymphocytes [13]. Increased differentiation of cells is another effect of LLLI and has been shown in several studies, mostly regarding osteoblasts and osteoclasts [13].

No clinical changes were observed in both the test and control cow groups during the investigation or after it was completed. The majority of blood and productive parameters under investigation were found to vary almost the same in both the control and test groups. The changes obtained can be mainly associated with the days of lactation, as a

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significant change in the parameters under investigation was observed depending on the days of lactation. According to Hagmüller [14], the AST concentration in blood serum can increase temporally right after calving and to remain at this increased level for several days postpartum, while later it decreases. A similar trend was observed in this particular trial.

The variation in calcium content is an exception. The calcium content in the blood serum of the tested cows was found to remain constant over the entire trial, whereas that of the control cows – varied ($p < 0,05$) (Fig. 1.).

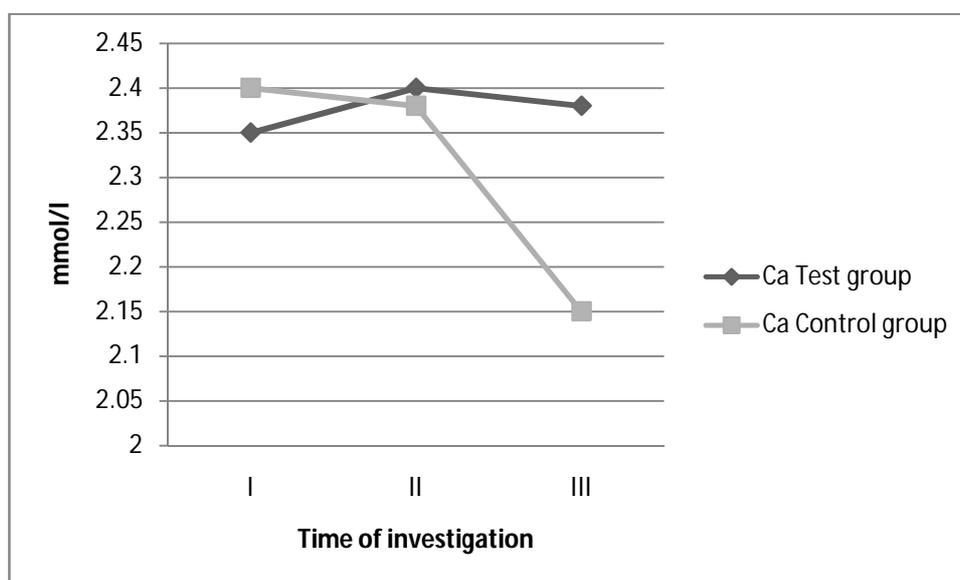


Fig. 1. Concentration of calcium during the investigation. The calcium content in the blood serum of the tested cows was found to remain constant over the entire trial, whereas that of the control cows – varied

All the other parameters varied in almost the same manner. According to Hagmüller [14], the calcium content in blood serum decreases during calving and right after calving, whereas later it is recovered. However, in this particular investigation, the calcium content in the blood serum of the tested cows was found to remain stable. This might have been caused by irradiation-increased synthesis of vitamins D2 and D3 from pro-vitamins, which might have had an effect on the stability of the calcium content in the blood plasma. According to Schmidl u. Forstner [15], hypercalcemia might be caused by plants, hypervitaminosis D. In this case, it leads to the conclusion that although the calcium content decreased in the control group, it was prevented from decreasing in the test group by the increased synthesis of D vitamins from pro-vitamins due to the exposure to laser irradiation. This stability of calcium content in the blood serum is highly important in a herd of high-producing cows at the beginning of their lactation. The increase in the total leukocyte count at the beginning of the trial might have resulted from a change in total leukocyte count or changes in the leukocyte fractions counts. Physiological leukocytosis is common both before and after calving [15]. Similar changes were observed in this particular investigation, too. Many cows were diagnosed with leukocytosis at the beginning of the trial, and a significant decrease in the total leukocyte count was observed at the end of the trial. The total leukocyte count in the blood of both cow groups varied similarly. Other biochemical blood parameters varied alike in both the test and control group.

Productive and milk composition parameters were found to vary almost the same in both groups involved. The exception was only a variation in the somatic cell count and milk protein content ($p < 0,05$) (Fig. 2 and 3).

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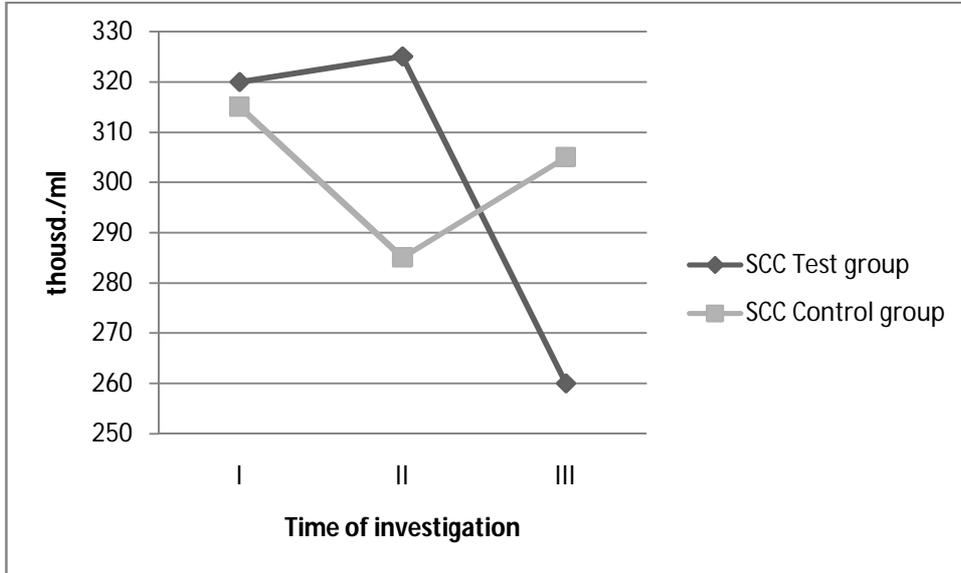


Fig. 2. Concentration of SCC during the investigation. Productive and milk composition parameters were found to vary almost the same in both groups involved. The exception was only a variation in the somatic cell count.

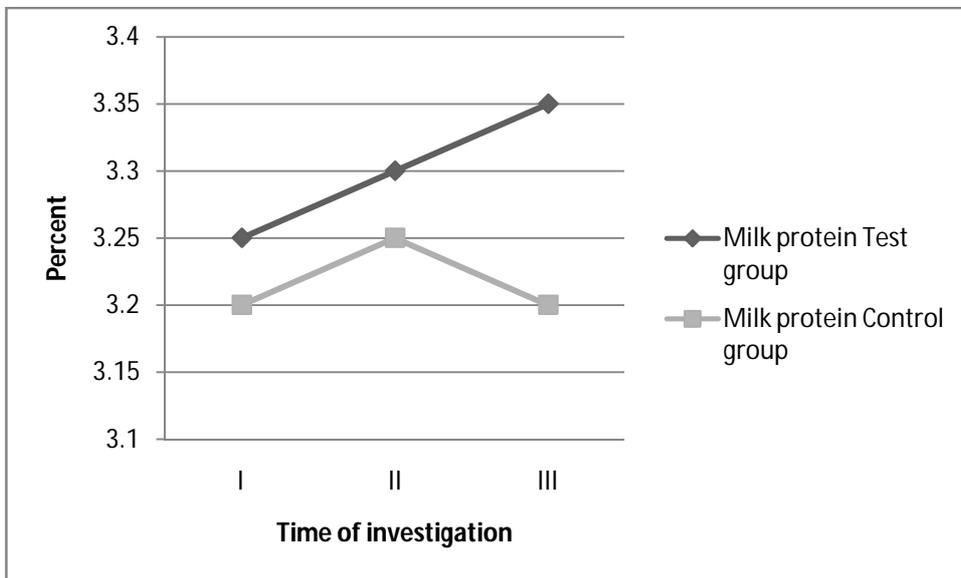


Fig. 3. Concentration of milk protein during the investigation. The exception was only a variation in the milk protein content.

The decrease in the somatic cell count observed in the test group can be linked to the stability of the calcium content shown by this group as according to Nir [16] abnormal calcium blood concentration is associated with a decrease in udder resistance and mastitis. This is because the decrease in calcium blood concentration results in the reduced ability of the streak canal to close after milking [17]. However, in this particular investigation, the test group exhibited a stable calcium content remaining in their blood, which had an effect on the decrease in the somatic cell count in their milk.

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The increase in the milk protein content in the test group can be linked to the intensified synthesis of prolactin, insulin or cortisone. According to Stelwagen [18], it is the increase in secretion of these hormones that is capable of causing an increase in milk protein content.

IV. CONCLUSION

1. LLLI irradiation for 30 seconds (8 consecutive days) at the peak of cow lactation had no effect whatsoever on changes in the total blood protein content, aspartatamine transerase, leukocytes and phosphorus parameters in both the test and control group, however, the calcium concentration in the test group was found to remain stable over the entire course of the investigation.

2. LLLI for 30 seconds (8 consecutive days) at the peak of cow lactation was found to cause a statistically significant decrease in SCC in the test group as compared to the control group, and a statistically significant increase in milk protein content in the test group when compared to the control group. The other productive parameters were observed to increase and decrease similarly in both groups under investigation.

3 LLLI at the peak of cow lactation should be continued while increasing the duration of laser irradiation.

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