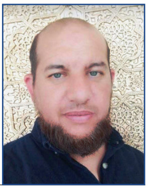
Evaluation of body condition, daily milk production and biochemical parameters during the postpartum period according to calving season in Montbeliard dairy cows reared in the semi-arid region – Algeria



F. Chacha, D. E. Gherissi, R. Lamraoui, F. Bouzebda-Afri and Z. Bouzebda*

Abstract

The aim of this study was to evaluate the effect of calving season on postpartum changes of certain blood metabolites and minerals and of the body condition score evaluation (BCS) in Montbeliard dairy cows reared under semi-arid conditions. Blood samples were collected from 74 clinically healthy dairy cows of 10 semi-intensive Algerian dairy herds once month during a whole year. Animals were grouped according to the occurrence of their calving to four different seasons (autumn, winter, spring and summer). Albumin, urea, glucose, total cholesterol, calcium, phosphorus and magnesium plasma levels were analysed using the colorometric method adapted to each biochemical parameter. One-way repeated measures analysis of variance (ANOVA) showed a significant effect of season ($P<0.05$, $P<0.01$ and at $P<0.001$) on all parameters, except BCS. The highest plasma concentrations of urea nitrogen, albumin, total cholesterol, and phosphorus were recorded in summer, though calcium was significantly lower during this period. A significant negative correlation was found between blood glucose, total cholesterol and phosphorus during winter calving, urea nitrogen in spring calving, and magnesium and calcium

Faicel CHACHA*, DVM, PhD, Research master class B in Biotechnology Research Center, Constantine, Algeria, (Corresponding author, e-mail: f.chacha@crbt.dz); Djallel Eddine GHERISSI, DVM, PhD, HDR, Laboratory of Animal Productions, Biotechnologies and Health, in institute of Agronomic and Veterinary Sciences, University of Souk-Ahras, BP 41000, Algeria; Ramzi LAMRAOUI, DVM, PhD, Department of Biology of Living Organisms, faculty of Natural and Life Sciences. University of Batna 2, Batna (05110), Algeria; Farida BOUZEBDA-AFRI, Professor, Laboratory of Animal Productions, Biotechnologies and Health, in institute of Agronomic and Veterinary Sciences, University of Souk-Ahras, BP 41000, Algeria; Zoubir BOUZEBDA, Professor, Laboratory of Animal Productions, Biotechnologies and Health, in institute of Agronomic and Veterinary Sciences, University of Souk-Ahras, BP 41000, Algeria

in summer calving. The results of this study highlight the evolutionary pattern of blood biochemical metabolites and electrolytes, BCS and daily milk production of Montbeliard dairy cows during the postpartum period according to calving season. They provide reliable information to assess the risk of metabolic activity failures during these very important productive stages, i.e., open days, ascending and peak production periods.

Key words: *biochemical profile; body condition score; season; semi-arid; postpartum*

Introduction

Milk is an important part of the diet in Algeria, regardless of income. The annual per capita consumption increased from 30.1 L in 1964 to 145 L in 2018, in comparison to to the average world milk consumption (ONIL 2018). Dairy cattle breeding holds an important place in the national economy. The national cattle population is estimated at 1,780,591 heads including nearly a million dairy cows (FAOstat 2019). Despite the size of the national dairy herd, it remains below production capacity and covers only 57% of the raw milk demand at the national level, and the remainder is covered by imports (ONIL 2018). Although sheep farming is the main activity in the semi-arid regions in Algeria (Lamraoui et al., 2014), cattle farming has gradually integrated into production systems giving rise to significant animal diversity. In this unfavourable semi-arid environment, breeders often find it difficult to resolve the various constraints related to controlling the well-being, health and productivity of herds, in particular reproductive performance (Chacha et al., 2018a,b; Haou et al., 2021).

The postpartum period is a period of high metabolic stress, during which dairy cows with a more severe and prolonged negative energy balance face an increased risk of disease and culling (Rajala-Schultz et al., 2001; Butler, 2000; Folnožić et al., 2016; Folnožić et al., 2019a,b). Significant associations between nutritional status before calving and in early lactation with subsequent reproductive performance and the incidence of intramammary infections have been reported in a number of studies (Boland and Lonergan, 2003; Konigsson et al., 2008; Kočila et al., 2013; Đuričić et al., 2020a, Dobos et al., 2022). Metabolic profiles are frequently used to assess energy status, which also impacts dairy cow fertility (Wathes et al., 2007; Turk et al., 2016; Đuričić et al., 2020b; Kovács et al., 2020). Furthermore, poor nutritional condition during the peripartum and postpartum periods leads to a depressed immune system, which decreases the animal's ability to respond to infectious challenges. This is likely responsible for the high incidence of diseases and infertility.

In this study, we observed a lack of information on the blood biochemistry of dairy cattle in Algeria, particularly for animals imported from temperate countries (France) and subjected to different bioclimatic conditions in semi-intensive herds. Thus, this study evaluated the concentrations of specific biochemical parameters during the post-partum period of Montbeliard cows according to calving season.

Materials and methods

Animals

The study was carried on a producing herd of 74 Montbeliard dairy cows at 10 semi-intensive dairy farms (Table 1) in Setif Province, Algeria, situated between 35.5° and 36.5° N and 4.7° and 6° E. The relief is relatively rugged in the northern part and dominated by forested mountains, and is rather flat in the centre and south. Located in the semi-arid region of Algeria, with a highly variable level of precipitation between years and from north to south, with averages of 200 to 600 mm per year and mean temperature oscillations from 5°C (January) to 26°C (July). The average altitude varies between 700 and 1300 m. Setif Province has long been a favourable region for cereal cultivation and livestock farming.

Cow age ranged from 3 to 7 years. The nutritional status and reproductive condition was examined for a 20 cows that calved during summer (Jul–Sept, parity = 3.1±1.29; Mean±SD), 13 cows in autumn (Oct–Dec, parity= 2.07±0.56), 17 cows in spring (Apr–Jun, parity = 2.29 ± 0.77) and 24 cows in winter (Jan–Mar, parity = 1.87 ± 1.05). Animals were monitored during four peripartum months divided into two periods: prepartum, which included 1 month prior to parturition to calving, and postpartum, which included calving to 3 months of lactation. All animals in the study were selected based on a clinically normal status of the genital tract with no history of dystocia, caesarean section, retained foetal membranes, acute mastitis or periparturient paresis. Common farming and livestock conditions were established for all visited farms. In the winter, the food calendar was based on the distribution of basic rations incorporating hay (meadows or oats) and sorghum silage, complemented by concentrate supplementary ration according to individual needs. In spring, herds grazed on natural grasslands and fallow, while during summer and fall, the substantial ration is composed of mowed grass and/ or cereal stubble residues. These animals are kept in a stall barn housing system. Reproductive management is based on natural breeding, though artificial insemination is also used as a second choice.

Data and Sample Collection

Blood samples were obtained on a monthly basis from months 1 to 3 postpartum by puncture of the coccygeal blood vessel using evacuated heparinized tubes. Blood samples were centrifuged at 2000 x g and plasma was harvested and stored at -20°C until analysis. The body condition score (BCS) was estimated by the same observer once a month on a scale of 1–5 (Edmonson et al., 1989) beginning from 1 month prepartum to 3 months postpartum.

Analytical Procedures

The plasma components were analysed spectrophotometrically by colorimetric method commercial kits (Spinreact®). The metabolic profile test MPT components and analytical methods were as follows: indicators used for protein metabolism were albumin (Alb, Green bromcresol albumin method) and blood urea nitrogen (BUN, Urease-GLDH), for energy metabolism, glucose (Glc, using an Accu-Chek Active human blood glucose meter), total cholesterol (Cho, Cholesterol oxidase), and for mineral metabolism, plasma calcium (Ca, o-cresolphtalein complexone), plasma inorganic phosphorus (P, Phosphomolybdate) and magnesium (Mg, Xylidyl blue method).

Ethical statement

Animals were studied in accordance with the ethical principles of animal experimentation and international animal welfare guidelines (Terrestrial Animal Health Code 2018, section 7. Art 7.5.1) and national executive decree No. 95-363 of November 11, 1995 (Algeria).

Statistical analysis

Statistical analysis of data was performed using XL-stat software (version 14). Results were subjected to one-way ANOVA analysis to determine the effect of physiological stages and season on the measured biochemical parameters. The results are described as mean ± standard deviation. The differences were considered significant at *P*<0.05, *P*<0.01 and *P*<0.001.

Results

Body condition score

The pattern of change in body condition score, occurring between the last month of the dry period and the third postpartum month, showed significant variation during the study period characterized particularly by a downward trend visible during the first month after parturition for dairy cows calving in autumn, winter or spring (*P*=0.01-0.001). This regression is followed by a recovery that sets in from the second and third month after calving (Table 1). It was observed that this situation remains weak until the third month after giving birth for calving in the summer (*P*>0.05).

With respect to the effect of the calving season on the lost body condition score; the results of the present study did not reveal any significant effects. The decreased score ranged from 0.55±0.23 to 0.82±0.76.

Daily milk production

Cows calving during spring expressed a good average of daily milk production, this situation is also verified for the average peak of lactation. Thus, a highly significant beneficial effect was observed in cows calving during this season, compared to females calving during the rest of the year (Figure 1).

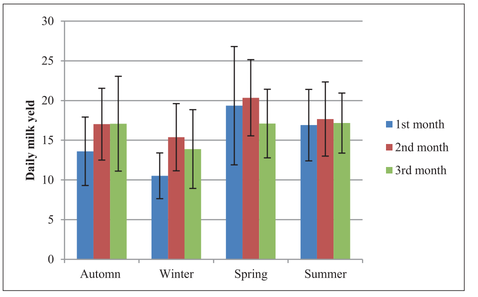


Figure 1. Daily milk production during the postpartum period in relation to season

Evaluation of the biochemical profile according to calving season

The dynamics of blood metabolite variation during the first three months after parturition in relation to calving season reveals a significant effect (*P*<0.05, *P*<0.01 and *P*<0.001) for all the studied parameters.

The mean serum glucose concentration was significantly low during the first month after parturition (0.57 ± 0.05 g/L, *P*<0.05) in autumn (Figure 2). Serum cholesterol level was weakly dependent on seasonal variations (Figure 3), with a strongly significant increase in levels observed from the start to the third month of lactation (*P*<0.01) in cows calving in winter and in summer (*P*<0.05). The lowest level of cholesterol was during the 3rd postpartum month in spring (*P*<0.05).

Plasma urea and albumin levels (Figures 4 and 5) showed a strong

Table 1. Body condition, in pre and postpartum period in relation to the season

Parameters	Season	-30d	30d	60d	90d	*P*period*
BCS	Autumn	3.92±0.35	3.43±0.46	3.54±0.43	3.98±0.42	0.001
	Winter	3.88±0.39	3.19±0.56	3.18±0.50	3.4±0.36	0.006
	Spring	3.88±0.47	3.14±0.5	3.29±0.47	3.77±0.53	0.01
	Summer	3.98±0.29	3.43±0.46	3.23±0.51	3.35±0.61	0.48
	P*season	0.86	0.45	0.24	0.03	

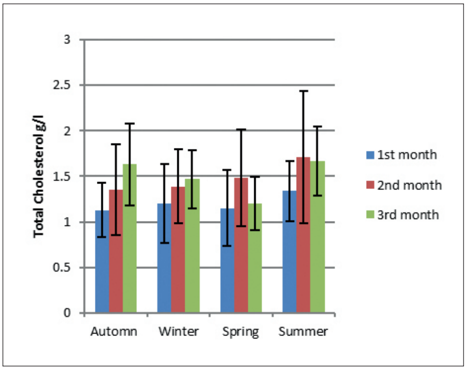


Figure 2. Average plasma total cholesterol concentrations during the postpartum period as a function of the calving season

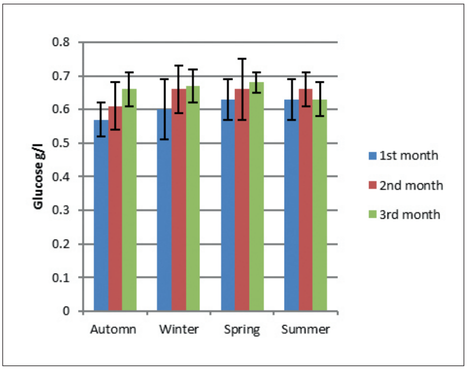


Figure 3. Average plasma glucose concentrations during the postpartum period as a function of the calving season

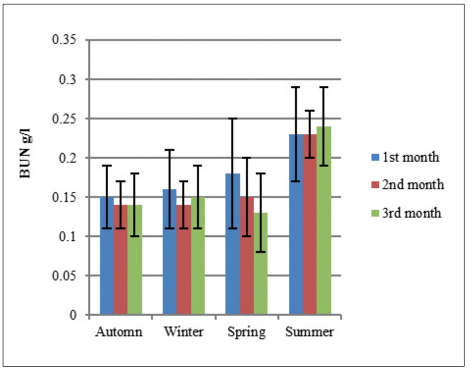


Figure 4. Average plasma urea nitrogen concentrations during the postpartum period as a function of the calving season

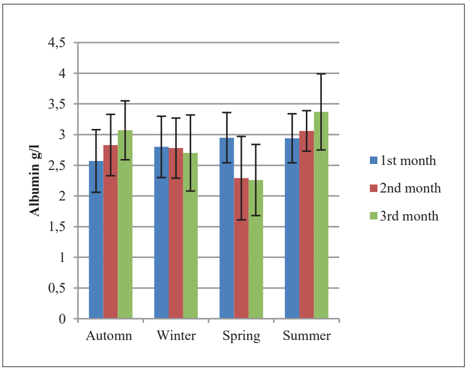


Figure 5. Average plasma albumin concentrations during the postpartum period as a function of the calving season

difference by calving seasons. In cows calving in spring, albuminemia (2.26±0.58 g /L) was observed, while cows calving in summer had a higher concentration with a maximum during the third month after parturition (3.37±0.62 g/L, *P*<0.01). The mean plasma urea level remained relatively stable throughout the postpartum period of cows calving during summer. However, the urea values in dairy cattle whose postpartum period coincides with the autumn season were significantly (*P*<0.001) the lowest (0.14±0.04 to 0.15±0.04 g/L). The plasma blood electrolyte concentration patterns in cows in relation to calving season showed that calcium levels remained stable from the first to third month of lactation, and that levels were lower during summer (P<0.01 and <0.001) (Figure 6).

Phosphorus levels during the postpartum period, depended on the calving season (Figure 7), decreased from the first to the third postpartum month (7.39±2.63 to 2.85±1.18 mg/dL, *P*<0.001) and (4.72±2.74 to 3.45±1.77 mg/dL, *P*<0.01) in cows calving during autumn and winter, respectively.

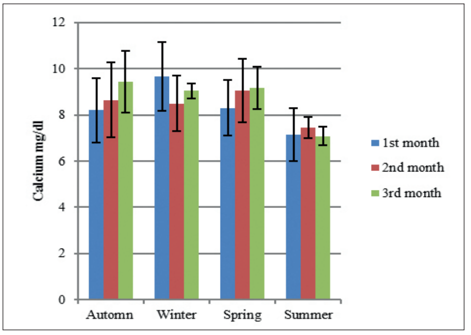


Figure 6. Average plasma calcium concentrations during the postpartum period as a function of the calving season

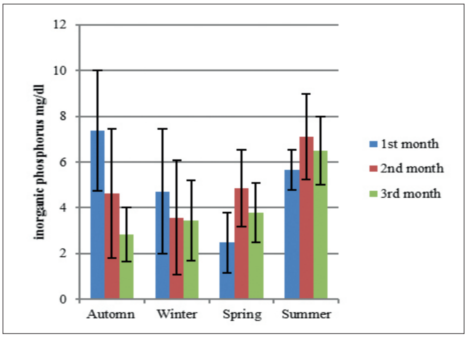


Figure 7. Average plasma inorganic phosphorus concentrations during the postpartum period as a function of the calving season

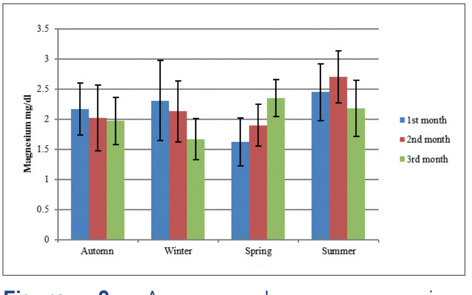


Figure 8. Average plasma magnesium concentrations during the postpartum period as a function of the calving season

A gradual increase of phosphorus (5.65±0.88 to 7.12±1.88 mg/dL) was recorded from the first to the second month of lactation in cows calving in summer (P<0.01). In cows calving in spring, this parameter increased (2.48±1.32 to 4.84±1.68 mg/dL), (P<0.01) from the first to the second month, and then declined (to 3.79±1.29 mg/dL) during the third postpartum month. The mean levels of plasma magnesium showed a significant increase (P<0.001) in dairy cows calving during summer (2.45±0.47 and 2.70±0.43 mg/dL) in comparison to those calving in spring (1.62±0.40 and 1.9±0.35 mg/dL) in the first two postpartum months (Figure 8). A similar trend was observed for magnesium and phosphorus concentrations. Magnesium levels decreased (P<0.01) from the first to third postpartum months in dairy cows calving in autumn and winter (2.17±0.40 to 1.97±0.40 mg/dL and 2.31±0.67 to 1.67±0.34 mg/dL, respectively), opposed to a significant increase (P<0.001) observed in cows calving in spring (from 1.62±0.40 to 2.35±0.31 mg/dL). In the third postpartum month, magnesium levels were significantly higher in spring and summer than in winter and autumn (P<0.05).

Discussion

The mean concentrations of blood serum parameters assayed on the studied dairy cows are in agreement with reports in the literature (Bruger-Picoux, 1995; Kraft and Dürr, 2005; Graber et al., 2010; Mouffok et al., 2011; Odhiambo et al., 2013). This study focused on explaining the different pattern of changes of biochemical parameters during the postpartum period according to calving season in Montbeliard dairy cows from a semi-arid region.

Plasma concentrations of glucose were decreased in the three months of the postpartum period in animals calving during summer compared to those calving in winter, which corroborates other reports (De Rensis et al., 2002; Grunwaldt et al., 2005; Nonaka et al., 2008;

Shehab-El-Deen et al., 2010). Possible mechanisms by which heat stress reduce plasma glucose concentrations include an increase in respiratory rate resulting in a rapid uptake of blood glucose by the respiratory muscles thus causing a decrease in blood glucose levels under thermal stress, as well as a reduction in DMI (Flamenbaum et al., 1995). Glucose has also been shown to play a role in the relationship between energy balance and postpartum reproductive efficiency in dairy cows (Folnožić et al., 2016).

The concentrations of total cholesterol in the plasma recorded here our study are similar to the variation ranges reported previously (120 and 220 mg/dL: McDonald et al., 2002), and are also close to those reported by other authors (0.62–1.93 g/L: Ţăranu et al., 2010), (0.8–1.3 g/L: Bruger-Picoux, 1995). Some authors observed a decrease in serum cholesterol before calving, and then an increase in the three months after calving, reaching values of 1.25±0.02 g/L (Kappel et al., 1984) and 1.59 g/L (Douglas et al., 2006). Folnožić et al. (2015) recorded significantly lower concentrations of total cholesterol in late pregnancy compared to the second week postpartum, then at 60 days after parturition. According to Douglas et al. (2006), lower cholesterol concentrations can be observed in animals on a restricted diet due to lower DMI.

In this study, BUN was within the normal physiological limits (Ţăranu et al., 2010; 0.1–0.25 g/L) and (Whitaker et al., 1983; 0.1–0.3 g/L). In addition, cows calving in the hot summer season expressed a higher level of urea nitrogen than those calving during the temperate season. Similar results were observed by Rasooli et al. (2004), Senosy and Osawa (2013) and Mazzullo et al. (2014). Exposure of cows to a hot environment could stimulate thermoregulatory mechanisms and produce a reduction in the rates of metabolism, feed intake and productivity (De Rensis et al., 2002). It has been shown that thermal stress increases the catabolism of amino acids (AA) for energy (Rasooli et al., 2004), which originate from the mobilization of proteins from muscle tissue, and therefore caused an increase in BUN during the summer season.

The concentration of serum albumin was also within the normal physiological limits of 23–36 g/L and 25–38 g/L indicated by Brugère-Picoux (1995) and Ţăranu et al. (2010), respectively. Serum albumin showed higher levels in females calving in winter and summer, than those calving in spring; supporting the findings of Grunwaldt et al. (2005). The significantly higher albumin level in winter could be due to low water consumption during the wet season (Meyer and Harvey, 1998), but also to dehydration during the summer period (El-Nouty et al., 1990; Kaneko et al., 2008).

The results presented here show that plasma calcium levels were in agreement with the acceptable ranges listed by Puls (1988) (67–90 mg/L) and Ţăranu et al. (2010) (80–114 mg/L). However, our results are lower than those of Brugère-Picoux (1995) (92–124 mg/L). Research on calcium levels as a function of physiological state and seasonal variation show significantly lower levels in dairy cows when calving occurred during summer (Hadzimusic and Krnic, 2012). In addition to significant lower calcium values in cows 1 to 5 days after calving, Krnic et al. (2003) reported basic levels 5 to 10 days before calving. Olayemi et al. (2001) found that 39% of dairy cows have a calcium concentration less than 89 mg/L in the postpartum period. Finally, Khan et al. (2003), Grunwaldt et al. (2005) and Yokus and Cakir (2006) observed no significant seasonal effect on blood calcium levels, and Folnožić et al. (2019b) did not observe a significant change in relation to a clinoptilolite-based diet in comparison to control group.

The average concentration of inorganic phosphorus during the postpartum period of the studied animals was near that observed by Lefter et al. (2019), who recorded a mean concentration of 32.4 mg/L in Montbeliard dairy cows. Our results are also similar to the reported levels in the postpartum period of Holstein dairy cattle studied by Yotov et al. (2014), with a mean score of 34.84±7.77 mg/L. However, our results are substantially lower during the same physiological period (postpartum) than other authors, such as Barui et al. (2015) and Kida et al. (2003), who reported levels of 64 mg/L and 54 mg/L, respectively. In addition, Folnožić et al. (2019b) recorded values between 40.5–89.9 mg/L around parturition in clinoptilolite-fed cows. Phosphorus values are considered to reflect the amount of phosphorus in the diet (Whitaker, 2000). Analysis of the results obtained in this study indicate that the blood phosphorus concentration seems to be strongly influenced by sampling season and the reproductive status of cows.

Low levels of blood phosphorus can frequently lead to a decrease in ovarian activity (Jeong et al., 2015) and conception rate (Costa et al., 2015). According to Chaudhary and Singh (2004), this deficiency is responsible for the delayed onset of puberty and silent or irregular oestrus in heifers. Moreover, the same authors indicated that reduced phosphorus levels are involved in the failure of oestrus, in a long inter-calving interval and even in embryonic death due to a lack of muscle tone. On the contrary, excess phosphorus makes the endometrium vulnerable to infections (Chaudhary and Singh, 2004).

The observed average level of magnesium is relatively close to that recorded by many authors during the postpartum period. Indeed, Roussel et al. (1982) reported a range between 20 and 35 mg/L, Puls (1988) indicated varying levels between 18 and 35 mg/L, Brugère-Picoux (1995) reported levels between 19 and 27 mg/L, and finally Ţăranu et al. (2010) reported blood magnesium levels ranging between 15 and 29 mg/L in the postpartum period. Moreover, Folnožić et al. (2019b) reported lower Mg concentrations around parturition. Our results also show significantly low values during late winter and early spring. This observation agrees with the description given by Zelal (2017), who described that the green forage systematically has low Mg concentrations (<2.0 g/kg dry matter). Our results are in line with those of Robinson et al. (1989), Kronqvist (2011) and Shah et al. (2017).

Conclusion

Both calving season and lactation stage had a significant influence on the studied biochemical parameters during the postpartum period of Montbeliard dairy cattle reared in a semi-arid region. Plasma concentrations of urea, albumin, total cholesterol, phosphorus and magnesium were significantly higher in dairy cows calving during summer, calcium level remained at low levels during the three postpartum months for the same cows.

The recorded variations of blood biochemical indices according to calving season provide an important indicator of metabolic status during the open reproductive period and gives animal health practitioners and stakeholders basic information for monitoring the main parameters for determining a metabolic profile and their importance in breeding management strategy. This particularly pertains to adopting reasonable nutrition strategies in line with lactation stage and calving season.

References

1. BARUI, A., S. BATABYAL, S. GHOSH, D. SAHA and S. CHATTOPADHYAY (2015): Plasma mineral profiles and hormonal activities of normal cycling and repeat

breeding crossbred cows: A comparative study. Vet. World 1, 42-45.10.14202/vetworld.2015.42-45
2. BOLAND, M. P. and P. LONERGAN (2003): Effects of Nutrition on Fertility in Dairy Cows. Advances in Dairy Technology 15, 19-32.
3. BRUGERE-PICOUX, J. (1995): Maladies métaboliques et biochimie clinique de la vache laitière. La Dépêche Techniqu 46-30.
4. BUTLER, W. R. (2000): Nutritional interactions with reproductive performance in dairy cattle. Anim. Reprod. Sci. 60-61, 449-457. 10.1016/S0378-4320(00)00076-2
5. CHACHA, F., Z. BOUZEBDA, F. BOUZEBDA-AFRI, D. E. GHERISSI, R. LAMRAOUI and C. H. MOUFFOK (2018a): Body condition score and biochemical indices change in Montbeliard dairy cattle: influence of parity and lactation stage. Glob. Vet. 20, 36-47.
6. CHACHA, F., Z. BOUZEBDA, F. BOUZEBDA-AFRI, D. E. GHERISSI, R. LAMRAOUI, A. DJAOUT and C. MOUFFOK (2018b): Effect of some blood metabolites in the conception risk of Montbeliard cows. Livest. Res. Rural Dev. 30. Article #89.
7. CHAUDHARY, S. and A. SINGH (2004): Role of Nutrition in Reproduction: A review. Intas Polivet. 5, 229-234.
8. COSTA, W. M., E. R. CARVALHO, M. H. C. PEREIRA, R. F. G. PERES and J. L. M. VASCONCELOS (2015): Supplementation with melengestrol acetate post TAI improves fertility in suckled Nelore cows. Anim. Reprod. 12, 660.
9. DE RENSIS, F., P. MARCONI, T. CAPELLI, F. GATTI, F. FACCIOLONGO, S. FRANZINI and R. J. SCARAMUZZI (2002): Fertility in postpartum dairy cows in winter or summer following estrous synchronization and fixed time A.I. after the induction of an LH surge with Gonadotropin releasing hormone (GnRH) or human chorionic gonadotropin (hCG). Theriogenology 58, 1675-1687. 10.1016/S0093-691X(02)01075-0
10. DOBOS, A., I. FODOR, Z. KREIZINGER, L. MAKRAI, B. DÉNES, I. KISS, D. ĐURIČIĆ, M. KOVAČIĆ and L. SZEREDI (2022): Infertility in dairy cows - Possible bacterial and viral causes. Vet. stn. 53, 35-43.10.46419/vs.53.1.8
11. DOUGLAS, G. N., T. R. OVERTON, H. G. BATEMAN, H. M. DANN, and J. K. DRACKLEY (2006): Prepartal plane of nutrition, regardless of dietary energy source, affects periparturient metabolism and dry matter intake. J. Dairy Sci. 89, 2141-2157. 10.3168/jds.S0022-0302(06)72285-8
12. ĐURIČIĆ, D., T. SUKALIĆ, F. MARKOVIĆ, P. KOČILA, I. ŽURA ŽAJA, S. MENČIK, T. DOBRANIĆ, M. BENIĆ and M. SAMARDŽIJA (2020a): Effects of dietary vibroactivated clinoptilolite supplementation on the intramammary microbiological findings in dairy cows. Animals, 10: 202. 10.3390/ani10020202. 10.3390/ani10020202
13. ĐURIČIĆ, D., B. BEER-LJUBIĆ, S. VINCE, R. TURK, H. VALPOTIĆ, I. ŽURA-ŽAJA, N. MAĆEŠIĆ, M. BENIĆ, I. GETZ and M. SAMARDŽIJA (2020b): Effects of dietary clinoptilolite supplementation on β-hydroxybutirate serum level and milk fat to protein ratio during early lactation in Holstein-Friesian cows. Micropor. Mesopor. Mat. 292, 109766. 10.1016/j.micromeso.2019.109766
14. EDMONSON, A. J., I. J. LEAN, L. D. WEAVER, T. FARVER and G. WEBSTER (1989): A body condition scoring chart for Holstein dairy cows. Int. J. Dairy Sci. 72, 68-78. 10.3168/jds.S0022-0302(89)79081-0
15. EL-NOUTY, F. D., A. A. AL-HAIDARY, and M. S. SALAH (1990): Seasonal variation in hematological values of high-and average yielding Holstein cattle in semi-arid environment. J. King Saud. Univ. 2, 173-182.
16. FAOstat (2019): Accessed from: http://faostat.fao.org/
17. ONIL (2018): National Interprofessional Office for Milk and Dairy Products (Algeria)
18. FLAMENBAUM, I., D. WOLFENSON, P. L. KUNZ, M. MAMAN and A. BERMAN (1995): Interactions between body condition at calving and cooling of dairy cows during lactation in summer. J. Dairy Sci. 78, 2221-2229. 10.3168/jds.S0022-0302(95)76849-7
19. FOLNOŽIĆ, I., R. TURK, D. ĐURIČIĆ, S. VINCE, J. PLEADIN, Z. FLEGAR-MEŠTRIĆ, H. VALPOTIĆ, T. DOBRANIĆ, D. GRAČNER, and M. SAMARDŽIJA (2015): Influence of body condition on serum metabolic indicators of lipid mobilization and oxidative stress in dairy cows during the transition period. Reprod. Domest. Anim. 50, 910-917. 10.1111/rda.12608
20. FOLNOŽIĆ, I., R. TURK, D. ĐURIČIĆ, S. VINCE, Z. FLEGAR-MEŠTRIĆ, I. VALPOTIĆ, P. SOBIECH, M. LOJKIĆ, H. VALPOTIĆ and M. SAMARDŽIJA (2016): The effect of parity on metabolic profile and resumption of ovarian cyclicity in dairy cows. Vet. arhiv 86, 641-653.
21. FOLNOŽIĆ, I., M. SAMARDŽIJA, D. ĐURIČIĆ, S. VINCE, S. PERKOV, S. JELUŠIĆ, H. VALPOTIĆ, B. BEER LJUBIĆ, M. LOJKIĆ, D. GRAČNER, I. ŽURA ŽAJA, N. MAĆEŠIĆ, J. GRIZELJ, T. DOBRANIĆ, G. REDŽEPI, Z. ŠOSTAR, R. TURK (2019a): Effects of in-feed clinoptilolite treatment on serum metabolic and antioxidative biomarkers and acute phase response in dairy cows during pregnancy and early lactation. Res. Vet. Sci. 127, 57-64. 10.1016/j.rvsc.2019.10.010
22. FOLNOŽIĆ, I., D. ĐURIČIĆ, I. ŽURA ŽAJA, S. VINCE, S. PERKOV, R. TURK, H. VALPOTIĆ, D. GRAČNER, N. MAĆEŠIĆ, M. LOJKIĆ, M. KOVAČIĆ and M. SAMARDŽIJA (2019b): The influence of dietary clinoptilolite on blood serum mineral profile in dairy cows. Vet. arhiv 89, 447-462. 10.24099/vet.arhiv.0662
23. GRABER, M. S., T. KOHLER, M. G. KAUFMANN DOHERR, R. M. BRUCKMAIER, and H. A. VAN DORLAND (2010): A field study on characteristics and diversity of gene expression in the liver of dairy cows during the transition period. J. Dairy Sci. 93, 5200-5215. 10.3168/jds.2010-3265
24. GRUNWALDT, E. G., J. C. GUEVARA, O. R. ESTEVEZ, A. VICENTE, H. ROUSSELLE, N. ALCUNTEN, D. AGUERREGARAY and C. R. STASI (2005): Biochemical and haematological measurements in beef cattle in Mendoza plain rangelands (Argentina). Trop. Anim. Health Prod. 37, 527-540. 10.1007/s11250-005-2474-5
25. HADZIMUSIC, N. and J. KRNIC (2012): Values of Calcium, Phosphorus and Magnesium Concentrations in Blood Plasma of Cows in Dependence on the Reproductive Cycle and Season. Journal of the Faculty of Veterinary Medicine, Istanbul University 78, 1-8.
26. HAOU, A., K. MIROUD and D. E. GHERISSI (2021): Impact des caractéristiques du troupeau et des pratiques d'élevage sur les performances de reproduction des vaches laitières dans le Nord-

Est algérien, Rev. Elev. Méd. Vét. Pays Trop. 74, 183-191.
27. JEONG, J. K., I. S. CHOI, H. G. KANG, T. Y. HUR, Y. H. JUNG and I. H. KIM (2015): Relationship between serum metabolites, body condition, peri- and postpartum health and resumption of postpartum cyclicity in dairy cows. Livestock Sci. 181, 31-37. 10.1016/j.livsci.2015.09.022
28. KANEKO, J. J., J. W. HARVEY and M. C. BRUSS (2008): Clinical Biochemistry of Domestic Animals. Academic press.
29. KAPPEL, L. C., R. H. INGRAHAM, E. B. MORGAN, L. ZERINGUE, D. WILSON and D. K. BABCOCK (1984): Relationship between fertility and glucose and cholesterol concentrations in Holstein cows. Am. J. Vet. Res. 45, 2607-2612.
30. KHAN, Z. I., M. ASHRAF, M.Y. ASHRAF, Z. RAHMAN and A. HUSSAIN (2003): Mineral status of livestock (Goats and Sheep) based on soil, dietary components and animal tissue fluids in relation to seasonal changes and sampling periods in specific region of Pakistan. J. Anim. Vet. 2, 478-495.
31. KIDA, K. (2003): Relationships of Metabolic Profiles to Milk Production and Feeding in Dairy Cows. J. Vet. Med. Sci. 65, 671-677. 10.1292/jvms.65.671
32. KONIGSSON, K., G. SAVOINI, N. GOVONI, G. INVERNIZZI, A. PRANDI, H. KINDAHL and M. C. VERONESI (2008): Energy balance, leptin, NEFA and IGF-1 plasma concentrations and resumption of postpartum ovarian activity in Swedish Red and White breed cows. Acta. Vet. Scand. 50, 3-9. 10.1186/1751-0147-50-3
33. KOČILA, P., A. JANŽEK, D. GRAČNER, T. DOBRANIĆ, D. ĐURIČIĆ, N. PRVANOVIĆ, N. FILIPOVIĆ, G. GREGURIĆ GRAČNER, LJ. BEDRICA, F. MARKOVIĆ, M. HORVAT and M. SAMARDŽIJA (2013): Progesterone concentration and energy balance influence on dairy cows with different milk yield during puerperium. Tierarztl. Umsch. 68, 266-274 (in German).
34. KOVÁCS, L., L. RÓZSA, M. PÁLFFY, P. HEJEL, W. BAUMGARTNER and O. SZENCI (2020): Subacute ruminal acidosis in dairy cows - physiological background, risk factors and diagnostic methods. Vet. stn. 51, 5-17. 10.46419/vs.51.1.1
35. KRAFT, W. and U. M. DÜRR (2005): Klinische Labordiagnostik in der Tiermedizin. Schattauer Verlag.
36. KRNIC, J., M. PODZO, A. HODZIC, M. HAMAMDZIC, E. PASIC-JUHAS i M. MIHALJEVIC (2003): Metabolicki profil krava u laktaciji i peripartalno. Veterinaria 52, 75-86.
37. KRONQVIST, C. (2011): Minerals to Dairy Cows with Focus on Calcium and Magnesium Balance. Dissertation. Acta Universitatis Agriculturae Sueciae.
38. LAMRAOUI, R., F. AFRI-BOUZEBDA, Z. BOUZEBDA, M. FRANCK and D. E. GHERISSI (2014): Effect of repeated administration of hCG on ovarian response in PMSG-superovulated Ouled Djellal ewes (Algeria). Tropicultura 32, 10-15.
39. LEFTER, N. A., A. VASILACHI, D. VOICU, M. HĂBEANU, A. GHEORGHE and A. I. GROSU (2019): Effect of sorghum grain inclusion in montbeliarde dairy cows diet on health status. Slovak. J. Anim. Sci. 52, 63-68.
40. MAZZULLO, G., C. RIFICI, S. F. LOMBARDO, S. AGRICOLA, M. RIZZO and G. PICCIONE (2014): Seasonal variations of some blood parameters in cow. Large Anim. Rev. 20, 81-84.
41. MOUFFOK, C., T. MADANI, L. SEMARA, M. BAITICHE, L. ALLOUCHE and F. BELKASMI (2011): Relationship between body condition score, body weight, some nutritional metabolites changes in blood and reproduction in Algerian Montbeliard cows. Vet. World 4, 461-466. 10.5455/vetworld.2011.461-466
42. NONAKA, I., N. TAKUSARI, K. TAJIMA, T. SUZUKI, K. HIGUCHI and M. KURIHARA (2008): Effects of high environmental temperatures on physiological and nutritional status of pre-pubertal Holstein heifers. Livest. Sci. 113, 14-23. 10.1016/j.livsci.2007.02.010
43. ODHIAMBO, J. F., U. FAROOQ, S. M. DUNN and B. N. AMETAJ (2013): Profiles of energy metabolites and haptoglobin in dairy cows under organic management in Alberta farms. Open. J. Anim. Sci. 3, 105-113. 10.4236/ojas.2013.32016
44. OLAYEMI, F. O., J. O. OYEWALE and J. L. FAJINMI (2001): Plasma electrolyte, protein and metabolite levels in Nigerain White Fulani cattle under two different management systems. Trop. Anim. Health. Prod. 33, 407-411.
45. PULS, R. (1988): Mineral levels in animal health, diagnostic data. Sherpa international, British Columbia, Canada.
46. RAJALA-SCHULTZ, P. J., W. J. A. SAVILLE, G. S. FRAZER and T. E. WITTUM (2001): Association between milk urea nitrogen and fertility in Ohio dairy cows. J. Dairy Sci. 84, 482-489. 10.3168/jds.S0022-0302(01)74498-0
47. RASOOLI, A., M. NOURI, G. H. KHADJEH and A. RASEKH (2004): The influences of seasonal variations on thyroid activity and some biochemical parameters of cattle. Iran J. Vet. Res. 5, 1383-1391.
48. ROBINSON, D. L., L. C. KAPPEL and J. A. BOLING (1989): Management practices to overcome the incidence of grass tetany. J. Anim. Sci. 67, 3470-3484. 10.2527/jas1989.67123470x
49. ROUSSEL, J. D., S. H. SEYBT and G. TOUPS (1982): Metabolic profile testing for Jersey cows in Louisiana: reference values. Am. J. Vet. Res. 43, 1075-1077.
50. SENOSY, W. and T. OSAWA (2013): Association among calving season and measures of energy status, resumption of ovulation and subclinical endometritis in early lactating dairy cows. Anim. Reprod. 10, 24-31.
51. SHAH, O. S., U. AMIN, A. R. BABA, T. HUSSAIN, Z. A. DAR, S. U. NABI and H. U. MALIK (2017): Studies on seasonal changes in mineral concentrations of cross breed cattle in Kashmir valley. J. Entomol. Zool. Stud. 5, 1828-1831.
52. SHEHAB-EL-DEEN, M. A. M. M., J. L. M. R. LEROY, M. S. FADEL, S. Y. A. SALEH, D. MAES and A. VAN SOOM (2010): Biochemical changes in the follicular fluid of the dominant follicle of high producing dairy cows exposed to heat stress early post-partum. Anim. Reprod. Sci. 117, 189-200. 10.1016/j.anireprosci.2009.04.013
53. ŢĂRANU, I., M. GRAS, G. C. PISTOL, M. MOŢIU, D. E. MARIN, N. LEFTER, M. ROPOTĂ and M. HĂBEANU (2014): ω-3 PUFA rich Camelina oil by-products improve the systemic metabolism and spleen cell functions in fattening pigs. PloS one, 9 (10), e110186. 10.1371/journal.pone.0110186

54. TURK, R., I. FOLNOŽIĆ, D. ĐURIČIĆ, S. VINCE, Z. FLEGAR-MEŠTRIĆ, T. DOBRANIĆ, H. VALPOTIĆ and M. SAMARDŽIJA (2016): Relationship between paraoxonase-1 activity and lipid mobilisation in transition dairy cows. Vet. arhiv 86, 601-612.
55. WATHES, D. C., M. FENWICK, Z. CHENG, N. BOURNE, S. LLEWELLYN, D. G. MORRIS, D. KENNY, J. MURPHY and R. FITZPATRICK (2007): Influence of negative energy balance on cyclicity and fertility in the high producing dairy cow. Theriogenology 68, 232-241. 10.1016/j.theriogenology.2007.04.006
56. WHITAKER, D. A. (2000): Use and interpretation of metabolic profiles in dairy cows. In: Andrews, A. H: The Health of Dairy Cattle. Blackwell Science, Oxford, UK. (89-107).
57. WHITAKER, D. A., J. M. KELLY and E. J. SMITH (1983): Subclinical ketosis and serum beta-hydroxybutyrate levels in dairy cattle. Br. Vet. J. 139, 462-463. 10.1016/S0007-1935(17)30393-7
58. YOKUS, B. and U. D. CAKIR (2006): Seasonal and physiological variations in serum chemistry and mineral concentrations in cattle. Biol. Trace Elem. Res. 109, 255-266. 10.1385/BTER:109:3:255
59. YOTOV, S. A., A. S. ATANASOV, G. B. GEORGIEV, J. D. DINEVA and N. A. PALOVA (2016): Investigation on some biochemical parameters and effect of hormonal treatment in anoestrous dairy cows with cystic ovarian follicle. Asian Pacific J. Reprod.3, 41-45. 10.1016/S2305-0500(13)60183-9
60. ZELAL, A. (2017): Hypomagnesemia Tetany in Cattle. Review article. J. Adv. Dairy Res. 5, 2. 10.4172/2329-888X.1000178

Procjena tjelesne kondicije, dnevne proizvodnje mlijeka i nekih biokemijskih parametara tijekom puerperija prema sezoni teljenja u montbeliard pasmine mliječnih krava uzgojenih u polusušnom području - Alžir

Faicel CHACHA, DVM, PhD, Research master class B in Biotechnology Research Center, Constantine, Algeria; Djallel Eddine GHERISSI, DVM, PhD, HDR, Laboratory of Animal Productions, Biotechnologies and Health, in institute of Agronomic and Veterinary Sciences, University of Souk-Ahras, BP 41000, Algeria; Ramzi LAMRAOUI, DVM, PhD, Department of Biology of Living Organisms, faculty of Natural and Life Sciences. University of Batna 2, Batna (05110), Algeria; Farida BOUZEBDA-AFRI, Professor, Laboratory of Animal Productions, Biotechnologies and Health, in institute of Agronomic and Veterinary Sciences, University of Souk-Ahras, BP 41000, Algeria; Zoubir BOUZEBDA, Professor, Laboratory of Animal Productions, Biotechnologies and Health, in institute of Agronomic and Veterinary Sciences, University of Souk-Ahras, BP 41000, Algeria

Cilj je ove studije bio procijeniti učinak sezone teljenja na promjene nekih metabolita i minerala u krvi nakon teljenja, kao i na tjelesnu kondiciju (BCS) u montbeliard mliječnih krava uzgojenih u polusušnim uvjetima. Kednom mjesečno tijekom cijele godine prikupljeni su uzorci krvi od 74 klinički zdravih krava 10 poluintenzivnih alžirskih mliječnih krda. Životinje su prema teljenju raspoređene na sva četiri godišnja doba, tj. jesen, zima, proljeće i ljeto. Analizirane su: razine albumina, uree, glukoze, ukupnog kolesterola, kalcija, fosfora i magnezija u plazmi uporabom kolorimetrijske metode prilagođene svakom biokemijskom parametru. Jednosmjerna analiza varijance ponovljenih mjerenja (ANOVA) pokazala je značajan učinak sezone (P<0,05, P<0,01 te P<0,001) na sve analizirane parametre, osim tjelesne kondicije. Najveće koncentracije amidnog dušika, albumina, ukupnog kolesterola, fosfora zabilježene su tijekom ljeta. Međutim, razina kalcija tijekom ljetnog razdoblja bila je značajno niža. Značajna negativna korelacija pronađena je između različitih razina glukoze u krvi, ukupnog kolesterola i fosfora za teljenje zimi, amidnog dušika za teljenje u proljeće te magnezija i kalcija za teljenje ljeti. Rezultati ove studije dobro su pokazali zajednički evolucijski obrazac biokemijskih metabolita i elektrolita, tjelesne kondicije i dnevne proizvodnje mlijeka prema sezoni teljenja u montbeliard mliječnih krava tijekom razdoblja nakon teljenja. Oni pružaju pouzdane informacije za procjenu rizika zatajenja metaboličkih aktivnosti tijekom vrlo važnih produktivnih razdoblja, odnosno tijekom dana od teljenja do koncepcije, razdoblja porasta i najviše proizvodnje.

Ključne riječi: *biokemijski profil, tjelesna kondicija, sezona, polusušno, razdoblje nakon teljenja*