THE EFFECT OF FORAGE QUALITY ON PRODUCTION AND HEALTH OF DAIRY COWS

DJELOVANJE KAKVOĆE KRMIVA NA PROIZVODNJU I ZDRAVLJE MLIJEČNIH KRAVA

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SUMMARY

Evaluation of energy metabolism by analysis of rations, rumen fermentation and blood markers of energy metabolism, carried out on the basis of 20 samplings from 363 dairy cows, and looking for mutual relationships in the transient phases and at the peak of lactation proved the following: - *In the period of preparation for parturition* – bulk type of rations contained increased values of neutral detergent fibres (NDF in 60% herds) and acid-detergent fibres (ADF in 50% herds), with borderline values of non-fibrous carbohydrates (NFC). The increased levels of acetic acid (in 57% of animals) and decreased levels of propionic acid (in 38% of animals) respectively, with wider ratio C2:C3=3.3:1 in 53% of animals, significantly limit adaptation of the rumen metabolism to the concentrate-type of feed ration after parturition. Such type of fermentation results in negative energy balance with tendency to lipomobilization (30% of animals) and manifestation of liver load (40% of animals). - *In the postpartal period* – change to concentrate type of TMR with increased levels of NFC in 50% of herds and low degree of adaptation of the rumen fermentation, resulted in rumen acidification (50% of animals), associated ketogenesis (34% of animals), increase hepatal load (64% of animals) and occurrence of ketosis (12 – 34% of dairy cows). - *In the period of lactation peak* – gradual stabilization of rumen as well as intermediary metabolism with manifestation of ketogenesis in 25% of examined animals, with nutritional and metabolic disorders of the liver in 52%animals, are observed. Further increase of the level of milk production and milk components requires improvement of the quality, nutritional value and digestibility of forages. Increase in the portion of concentrates for an increase of nutrient concentration in TMR manifests by the rumen acidification with the tendency to a decrease in milk fat, and increased manifestations of hoof disorders.

Key words: forage quality, NDF, NFC, rumen fermentation.

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INTRODUCTION

Profile of rumen fermentation of carbohydrates, based on analysis of pH, VFA, and ratios of acetic, propionic and butyric acids in rumen fluid, is important for diagnostics of rumen function in relation to nutrition level of dairy cows. The quantity and ratio of metabolites of rumen fermentation of carbohydrates reflects response of rumen microflora to the diet intake regarding the quantity and ratio of fibrous and non-fibrous carbohydrates and structural effectiveness of the mixed feed ratio (TMR) in the prepartum phase of dairy cow nutrition (Crooker et al., 2007).

The parameters analysed show the degree of adaptation of rumen microflora and rumen walls. Evaluation of mutual relationships and interactions: - nutritional composition of diet, - level of rumen fermentation, - and influence on markers of internal energy metabolism allows one to evaluate the intake and control of metabolism of nutrients in the phase of negative energy balance and to determine nutrition strategy focused on prevention metabolic load and on proper management of productive health in high-yield animals.

Productive health of dairy cows is a functional state of homeostatic and homeoretic mechanisms of control of nutrient metabolism aimed at reaching the genetic productive potential while preserving the cellular and organ compensative mechanisms involved in regulation of metabolic load on animals.

MATERIAL AND METHODS

Under breeding conditions we conducted a 2-years experiment to validate the analytical and software capacity of optimization of carbohydrates composition of rations in relation to biological evaluation of animal response focusing on the following relationships: nutrition › rumen fermentation › blood metabolism › production and health and evaluation of the respective feedback. The results of our investigations obtained from 270 animals from five herds of dairy cows with mean milk yield of 7 – 9 thousand litres, using three sampling times, were evaluated according to: 1) *Biological productive phases*: before parturition, after parturition. - at the peak of lactation; 2) I*nteraction of the investigated parameters*: - diet - rumen - blood. This way of inter-pretation of results allows analysing the influence: - of feed intake, – quantity and ratio of nutrients in rations, – of ration structure on rumen fermentation level and its impact on blood serum metabolism;

Nutrient composition of TMR samples were analyzed for moisture, ash and mineral content were determined by Atomic absorption spectroscopy utilizing a Perkin Elmer. Crude protein and crude fat was analyzed using Tecator system, Values for nonstructural carbohydrates were calculated as follows: NFC %= 100-{NDF %+CP %+ash %+fat %}. VFA in ruminal fluid and β- hydroxybutyric acid (BHM) in plasma were analyzed two coupled capillaries by isotachophoresis using EA 102 (manual capillary electrophoresis system). Plasma metabolites were analyzed by enzymatic colorimetric assay using procedure modified from available kits (glucose - Biolatest Glukoza GOD 1500, AST - Randox AST AS 147, Bilirubin – Biolatest Bil st. methods by Jedrassik-Grof.). Non-esterified fatty acids (NEFA**)** was analyzed by colorimetric methods (Duncomb 1964).

RESULTS AND EVALUATION

Evaluation of energy metabolism in investigated herds using mean values and individual deviations from reference values for markers of rations, rumen fermentation and blood metabolites provided characteristic metabolic relations for individual transient phases at the current system of nutrition and rearing of dairy cows:

- In the phase of preparation for parturition - the relationships obtained are summarised in Table 1.

Table 1. Level of energy metabolism in dairy cows 21 days before parturition
Tablica 1. Razina metabolizma energije u mliječnih krava 21 dan prije teljenja

Parameter - Parametar			Reference values Referentne vrijednosti	Mean ± s Sredina ± s	Individual - Pojedinačno %	
					increased povećana	decreased smanjena
Number of herds - Broj krda				20		
TMR	CP	%	12.0 – 15.0	14.4 ± 2.7	45	20
	NDF	%	32.0 – 38.0	41.1 ± 6.3	60	30
	NFC	%	30.0 – 35.0	35.5 ± 4.1	45	15
	NEL	MJ/kg	6.2 – 6.5	6.23 ± 0.3	22	45
Number of animals - Broj životinja				121		
Rumen Burag	pH		6.4 – 6.6	6.58 ± 0.33	41	22
	VFA	mmol/l	80 – 130	102.8 ± 22.4	15	10
	Acetic acid	C2 %	60.0 – 65.0	66.7 ± 3.6	57	2
	Propionic acid	C_3%	20.0 – 25.0	20.8 ± 3.0	2	38
	$C_2 : C_3$		2.5 – 3.0 : 1	3.3 ± 0.7	53	4
Blood Serum	Glucose	mmol/l	2.0 – 4.1	3.24 ± 0.6	7	3
	NEFA	mmol/l	< 0.35	0.34 ± 0.1	30	-
	BHM	mmol/l	0.2 – 1.24	0.89 ± 0.34	12	-
	AST	ukat	0.22 – 0.5	0.47 ± 0.2	40	-
	Bilirubin	umol/l	0.17 – 5.13	3.49 ± 2.0	13	-

Feed rations – analysis of nutrient composition according to both mean values and individual deviations showed a bulk character of TMR with increased values of neutral-detergent fibres (NDF) in 60 % of herds regarding both the means 41.1 ± 6.3% and individual values. Compensation of decreased quality of bulk feed by addition of concentrates with marginal values of non-fibrous carbohydrates (NFC) 35.5 ± 4.1% with individual increase in 45% of herds cannot ensure sufficient supply of energy in the prepartum phase. The calculated mean energy NEL 6.23 ± 0.3 MJ/kg dry mater was close to the lower reference limit with decreased values in 45% of herds. Such character of feed rations, supplied to dairy cows in the phase of preparation for parturition, restricts significantly the adaptation of rumen metabolism to the concentrate-type of TMR fed after parturition and also dry mater and energy intake, particularly in the last decade before parturition.

Rumen fermentation with the following mean values: - pH 6.58±0.33 was at marginal level with 41% of animals showing increased values exceeding pH 6.8. – the sum of volatile fatty acids (VFA) reached on average the medium level of 102.8±22.4 mmol/l.

- Increased relative proportion of acetic acid (C_2) with mean value of 66.7±3.6% and individually increased level in 57% of examined animals, mean level of propionic acid (C_3) close to the lower limit (20.8±3.0%) and decreased levels observed in 38% of animals, mean ratio of $C_2 : C_3$ equal to 3.3±0.7:1, with excessive increase in the ratio observed in 53% of animals confirmed that the character of fermentation corresponded to the bulk-type rations with low degree of adaptation of rumen fermentation in the phase of preparation for parturition.

- Decreased total level of propionic acid (below 20 mmol/l) was detected individually in 38 % of

animals. Such prepartum level in dairy cows restricts the supply of glucogenic sources for saturation of foetus needs and evokes the state of lipomobilization in prepartum metabolism of dairy cows. When dividing animals according to the level of propionic acid (Fig. 1) in rumen content, the degree of lipomobilization with mean value of NEFA equal to 0.38 ± 0.16 corresponded to the group with level below 20 mmol/l, while at reference values of propionic acid above 20 mmol/l the values of NEFA reached the level of 0.31± 0.1 mmol/l.

Fig 1. **Values of NEFA in relation to rumen propionic acid level.**

Slika 1. **Vrijednosti NEFA u vezi s razinom propionske kiseline u buragu**

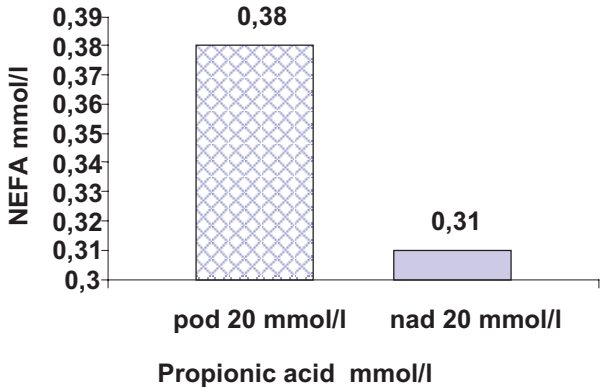
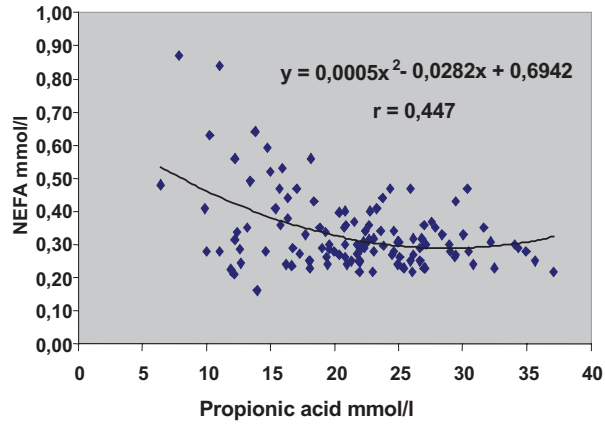


Fig. 2. **Regression relationship of rumen propionic acid level and serum NEFA**

Slika 2. **Odnos regresije razine propionske kiseline u buragu i seruma NRFA**



In the animals with decreased levels of propionic acid in the rumen, manifestation of lipomobilization with values of NEFA > 0.35 mmol/l was detected in 42% of dairy cows while in animals with propionic acid exceeding 20 mmol/l, manifestation of lipomobilization was observed in 18.3% dairy cows prepartum. The influence on lipomobilization of propionic acid as the most important precursor of glucogenesis in relation to serum level of NEFA (Fig. 2) was also confirmed by direct regression relationship (r = 0.447).

Energy metabolism – internal environment with mean values of blood glucose reaching 3.24±0.6 mmol/l at medium level. The mean level of non-esterified fatty acids (NEFA) was 0.34±0.1 mmol/l and individual levels were increased in 30% of animals, as a manifestation of lipomobilization due to negative energy balance in dairy cow in the stage of preparation for parturition.

State of metabolic load on the liver – was observed by means of AST the mean value of which was at the upper limit and reached 0.47±0.2 ukat/l with individually increased values in 40% of examined animals. – The mean level of bilirubin was 3.49±2.0umol/l with individually increased values in 13% of cows postpartum.

The postpartum phase – the relationships are summarised in Table 2. The sudden change to the concentrate type of TMR with increased mean level of NFC reaching 38.2 ± 3.7% and also individually in 50% of herds and low level of adaptation of rumen fermentation before calving resulted in a decrease in mean rumen pH to 6.22±0.41, close to the lower limit, with occurrence of individual acidification of the rumen in 50% of animals. The system of feeding after calving was accompanied with increased mean level of VFA equal to 117.6±18.8 mmol/l and individually increased levels in 23% of animals due to reduced absorption of VFA, caused by insufficient proliferation of rumen mucosa. The relative proportion of acetic acid (C_2) reached mean value of 63.0±4.5% and individual varying values were increased in 30% and decreased in 20% of examined animals.

Table 2. Level of energy metabolism in dairy cows up to 21 days after calving
Tablica 2. Razina metabolizma energije u mliječnih krava do 21. dana poslije teljenja

Parameter - Parametar			Reference values Referentne vrijednosti	Mean ± s Sredina ± s	Individual - Pojedinačno %	
					increased povećana	decreased smanjena
Number of herds - Broj krda				20		
TMR	CP	%	17.0 – 18.0	16.1 ± 1.7	20	30
	NDF	%	30.0 – 35.0	36.1 ± 3.6	60	5
	NFC	%	32.0 – 38.0	38.2 ± 3.7	50	25
	NEL	MJ/kg	6.6 – 6.8	6.5 ± 0.3	-	50
Number of animals - Broj životinja				121		
Rumen Burag	pH		6.3 – 6.5	6.22 ± 0.41	41	50
	VFA	mmol/l	80 – 130	117.6 ± 18.8	23	10
	Acetic acid	C2 %	60.0 – 65.0	63.0 ± 4.5	30	20
	Propionic acid	C_3%	20.0 – 25.0	24.4 ± 3.9	31	12
	$C_2 : C_3$		2.5 – 3.0 : 1	2.68 ± 0.6	37	22
Blood Serum	Glucose	mmol/l	2.0 – 4.1	2.81 ± 0.6	-	10
	NEFA	mmol/l	<0.8	0.42 ± 0.2	3	-
	BHM	mmol/l	0.2 – 1.24	1.15 ± 0.64	34	-
	AST	ukat	0.22 – 0.5	0.59 ± 0.2	64	-
	Bilirubin	umol/l	0.17 – 5.13	4.55 ± 1.8	33	-

The mean proportion of propionic acid (C_3) was close to the upper limit (24.4±3.9%) and individually increased values were detected in 31% of animals. The mean C2:C3 ratio of 2.68±0.6:1, which corresponded to the optimum level, and individual deviations – lower ratio in 37% and higher in 22% of animals - indicated different adaptation of rumen fermentation in dairy cows to the concentrate-type of diet after calving.

Energy metabolism – with mean values of blood glucose reaching 2.81±0.6 mmol/l which corresponded to the lower third of reference values. The mean level of non-esterified fatty acids (NEFA) was 0.42±0.2 mmol/l which corresponded to the reference level as a manifestation of controlled lipomobilization due to negative energy balance in dairy cows in the postpartum phase and manifestation of ketogenesis with mean value of beta hydroxybutyric acid close to the upper limit of BHM 1.15 ± 0.64 and individual occurrence of increased values in 34% of cows.

State of metabolic load on the liver – observed through analysis of the activity of AST with increased mean value reaching 0.59 ± 0.2 μkat/l and also individually increased levels in 64% of examined animals and mean bilirubin concentration of 3.49±2.0μmol/l corresponding to medium level with individual increase in 13% of dairy cows postpartum, pointed to the functional load on the liver related to negative energy balance, lipomobilization, and liver lipid infiltration in the prepartum phase.

The peak of lactation – The analysis provides relationships which are summarised in Tab. 3. Persistence at marginal levels of NDF, 33.6 ± 5.1% on average with individually increased values of 40% TMR, are considered a manifestation of harvesting the bulk feed in late vegetative phase. Variations in dosage of concentrate feed affect the level of non-fibrous carbohydrates which reached on average the medium level of recommended values. Individually increased levels were confirmed in 30% and decreased in 35% TMR with decreased energy level in 44 examined herds.

Table 3. Level of energy metabolism in dairy cows at the peak of lactation
Tablica 3. Razina metabolizma energije u mliječnih krava na vrhuncu laktacije

Parameter - Parametar			Reference values Referentne vrijednosti	Mean ± s Sredina ± s	Individual - Pojedinačno %	
					increased povećana	decreased smanjena
Number of herds - Broj krda				20		
TMR	CP	%	16.0 – 18.0	16.8 ± 2.0	25	40
	NDF	%	28.0 – 33.0	33.6 ± 5.1	40	10
	NFC	%	36.0 – 42.0	39.8 ± 3.6	30	35
	NEL	MJ/kg	6.9 – 7.1	6.76 ± 0.3	6	44
Number of animals - Broj životinja				121		
Rumen Burag	pH		6.0 – 6.4	6.26 ± 0.4	41	29
	VFA	mmol/l	80 – 130	116.6 ± 22.6	23	10
	Acetic acid	C2 %	60.0 – 65.0	63.5 ± 3.9	31	17
	Propionic acid	C_3%	20.0 – 25.0	23.6 ± 3.1	23	9
	$C_2 : C_3$		2.5 – 3.0 : 1	2.75 ± 0.5	28	24
Blood Serum	Glucose	mmol/l	2.0 – 4.1	3.1 ± 0.5	2,5	3,3
	NEFA	mmol/l	< 0.5	0.31 ± 0.1	3,0	-
	BHM	mmol/l	0.2 – 1.24	0.96 ± 0.6	25	-
	AST	ukat	0.22 – 0.5	0.54 ± 0.2	52	-
	Bilirubin	umol/l	0.17 – 5.13	3.5 ± 1.4	17	-

Rumen fermentation – in the productive phase shows marked stabilization of the mean values of rumen pH (6.26 ± 0.4), sum of VFA (116.6 ± 22.6 mmol/l), concentration of acetic acid (63.5 ± 3.9 mmol/l) and propionic acid (23.6 ± 3.1), all at the medium level of reference range. When analysing the individual values, we should say attention to the parallel decrease in pH in 29%, and relative decrease in acetic acid in 17% and increase in propionic acid in 23%, which occurred predominantly in herds with increased proportion of NFC (30%), in herds with unsuitable structure of TMR and at selective feeding on rations.

Energy metabolism and metabolic load on the liver in the highest yield group confirmed the marked trend of stabilisation of all investigated parameters in animals and also of the biological dependence as it is not the high production but the unsuitable nutrition in the transitional phases which results in disorders of productivity, health and subsequently of reproduction of dairy cows.

DISCUSSION

An increase in milk yield is conditional on improved level of nutrition, technological procedures of animal feeding and production of conserved feed. With regard to the influence of feed important is the significant variability of nutritional composition of bulk feed according to the type, quality, level of nutrients and energy value but also its usability by animals.

From the nutritional point of view, the fibre content in bulk feed, according to its quantity, character and structure, affects the level of nutrition and usability of rations in the following ways: - it limits the digestibility of feed, - due to its bulk character and filling effect regulates the uptake if feed, - according to the structure affects the motoric function and rumination and thus also secretion of saliva and rate of passage of feed through the rumen environment.

Proportion of fibres in bulk feed, which represents the form of structural – rumen effective

fibres, is responsible for stabilisation of rumen environment in three principal directions: • production of saliva and buffering capacity stabilises the rumen pH level, • forms an intricate layer of fibrous fraction of bulk feed which captures particles of concentrate and bulk feed and thus increases their rumen digestibility, • acts as a permanent source of energy for development of rumen microflora which, by decomposition of fibres ensures continuous supply of energy nutrients to liver and mammary gland (Allen M., 2001). Optimally balanced rations allow rumen fermentation to ensure transformation of nutrients and produce 60 – 70 % of cow energy needs. Changes in the rumen environment in relation to feed type affect directly its microbial population, rumen fermentation profile and utilisation of nutrients by animals and rumen microflora (Van Kessel and Russell 1996).

When increasing the milk yield, covering of energy needs of high-yield dairy cows is limited by their physical bulk feed intake capacity. The fibre content in feed is evaluated chemically by the neutral detergent fibres (NDF) and acid detergent fibres (ADF) content in feed and mixed feed rations (TMR). The concentration and physical structure of neutral detergent fibres is related to the activity of rumination and maintenance of rumen pH (Allen M.,1997). Intake of feed or dry matter depends on energy requirements of dairy cows for milk production. The limiting factor for intake of feed and energy is the quantity and mutual ratio of diet carbohydrates and frequency in which the character of NDF in rations acts by means of two regulation mechanisms:

• *the filling effect of rations* is derived from the quantity, quality, structure and digestibility of fibres (NDF) in the rations – at high productivity the daily intake is limited by the level of 1.2% NDF of animal body weight.

• *rumen fermentability of feed* – affects the intake of ration dry matter. With rapidly fermentable feed the produced and absorbed VFA may result in reduction of feed intake through decrease in rumen pH but also through neuro-humoral control of satiation. The extent and rate of rumen degradation of carbohydrates depend on composition of feed and nutrients in TMR and directly affect the quantity and ratio of VFA in the rumen fluid (Sutton, et. al., 2003).

Energy intake with regard to quantity and ratio of carbohydrates in TMR is particularly important in the transient phase of dairy cow nutrition with impact on rumen metabolism, milk yield and animal health parameters (Rabello et al., 2003). Both sources of energy for dairy cows in the phase of negative energy balance and imbalanced ratio of supply of C_2 : C_3, and deficient supply of glucogenic nutrients stimulate lipomobilization (van Knegsel et al., 2007), which is confirmed diagnostically by increase in values of NEFA and their incomplete oxidation in liver, manifested by increased levels of beta hydroxybutyric acid, or results in manifestation of ketosis and lipid infiltration of liver (Duffield 2000). The present system of evaluation of the level of dairy cow nutrition in the most critical prepartum phases and at the peak of lactation analysed the relevant nutritional level and the causes of different results of milk production, milk components and reproductive and health parameters.

CONCLUSION

The obtained results indicated decreased quality and nutritional value of produced bulky feed harvested in late vegetation phase. Increased proportion of concentrate feed, as a principle of increasing concentration of nutrients in TMR, was manifested by acidification of the rumen and tendency to decreased fat content in milk and increased manifestation of hoof disorders. Further increase in the level of productivity, effectiveness of production and milk components requires the following: - improvement in quality, nutritional value and digestibility of bulk feed, - nutritional prevention and management of productive health in herds should be achieved through increase in dry matter intake in bulk feed and phase nutrition that should stabilise the rumen and intermediary metabolism of high-yield dairy cows.

REFERENCES

1. Allen, M. S. (1997): Relationship between fermentation acid production in the rumen and requirement for physically effective fiber. J. Dairy Sci. 80, 1447-1462.
2. Allen, M. (2001): Formulating lactating cow diets for carbohydrates. Proc. 5th. Western dairy management conference. April 4-6, Las Vegas, Nevada.

3. Crooker, B. A., Carriquiry, M., Weber, W. J. (2007): Energy balance of the periparturient dairy cows. Four State Dairy Nutrition and Management Conference,13-14 june, Dubuuque, Iowa, 1-6.
4. Duffield, T. (2000): Subclinical ketosis in lactating dairy cattle. Vet. Clin. North Am. Food Anim. Pract. 16, 231–253.
5. Duncomb, W. G. (1964): Clinic. Acta, 9,122-125
6. Rabelo, E., Rezende, R. L., Bertics, S. J., Grummer, R. R. (2003): Effects of transition diets varying in dietary energy density on lactation performance and ruminal parameters of dairy cows. J.Dairy Sci. 86:916–925
7. Sutton, J. D., Dhanoa, M. S., Morant, S. V., France, J., Napper, D. J., Schuller, E. (2003): Rates of production of acetate, propionate, and butyrate in the rumen of lactating dairy cows given normal and low-roughage diets. J. Dairy Sci. 86: 3620–3633.
8. Van Knegsel, A. T. M., Van den Brand, H., Graat E. A. M., Dijkstra, J., Jorritsma, R., Decuypere, E., Tamminga, S., Kemp, B. (2007): Dietary energy source in dairy cows in early lactation: Metabolites and metabolic hormones. J. Dairy Sci. 90, 1477-1485
9. Van Kessel, J. S., Russell, J. B. (1996): The effect of amino nitrogen on the energetic of ruminal bacteria and its impact on energy spilling. J. Dairy Sci. 79, 1237-1243

SAŽETAK

Vrednovanje metabolizma energije analiziranjem obroka, fermentacije buraga i krvnih markera provedeno je na osnovi 20 uzoraka 363 mliječne krave, te traženja međusobnih odnosa u prelaznim razdobljima i na vrhuncu laktacije. Istraživanje je potvrđeno sljedećim rezultatima:

U razdoblju priprema za teljenje - glavnina obroka sadržavala je povećane vrijednosti neutralnih deterdžentnih vlakana (NDF u 60% stada) i kiselih deterdžentnih vlakana (ADF u 50% stada) s graničnim vrijednostima nevlaknastih ugljikohidrata (NFC). Povećane razine octene kiseline (u 57% životinja) te smanjene razine propionske kiseline (u 38% životinja), s većim omjerom C2:C3=3.3:1 u 53% životinja, značajno ograničavaju prilagodbu metabolizma buraga na vrstu koncentrata u obroku nakon poroda. Navedeni tip fermentacije rezultira negativnom energetskom ravnotežom sa sklonošću lipomobilizaciji (30% životinja) i manifestacijom opterećenja jetre (40% životinja).

U razdoblju poslije teljenja - promjena obroka na koncentrat tipa TMR s povećanim razinama NFC u 50% stada i niskim stupnjem prilagodbe fermentacije buraga rezultirala je acidifikacijom buraga (50% životinja), popratnom ketogenezom (34% životinja), povećanim jetrenim opterećenjem (64% životinja) i pojavom ketoze (12-34% životinja).

U razdoblju vrhunca laktacije - primijećena je postupna stabilizacija buraga kao i intermedijarnog metabolizma uz ispoljavanje ketogeneze u 25% ispitanih životinja, s hranidbenim i metaboličkim poremećajima jetre u 52% životinja. Daljnje povećanje razine proizvodnje mlijeka i sastojaka mlijeka zahtijeva poboljšanje kakvoće, hranidbene vrijednosti i probavljivosti krmiva. Povećanje udjela koncentrata kako bi se povećala koncentracija hranjivih tvari u TMR očituje se acidifikacijom buraga s tendencijom smanjenja mliječne masti u mlijeku i povećanom pojavom oštećenja papaka.

Ključne riječi: kakvoća krmiva, NDF,NFC, fermentacija buraga