

## THE MOST COMMON HEALTH DISORDERS AND WELFARE OF DAIRY COWS AND CALVES

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**Abstract:** Three farms of dairy cows (A, B and C) were observed for health disorders of dairy cows and suckling calves. Farm A is farm with tied system of rearing, with 1100 cows, while farms B and C have 400 and 600 cows kept loose with outdoor pens, respectively. Data regarding welfare criteria of dairy cows (health, feeding, housing and behaviour) were collected and analysed through Protocol of Welfare Quality (2009). Health disorders of dairy cows and suckling calves were collected and statistically analysed by chi-square test ( $\chi^2$  test). Welfare of all of three dairy farms were assessed as acceptable, meaning that provided welfare conditions meet the minimum requirements of animals. Principle of provision of good health was rated as acceptable ( $\geq 20$  points) on farm A, while on farms with loose system (B and C) overall health rated as excellent ( $\geq 80$  points). Occurrence rate of reproductive, locomotor, skin and claws disorders and digestive and systemic disorders of dairy cows and calves up to 4 months old were very different between three farms (A, B, C) with  $\chi^2$ -values of 2901.71, 252.02, 204.08, 1152.31 and 184.23 respectively;  $\alpha < 0.01$ ). According presented data, it is obvious that the majority health problems were observed in tied system of rearing, on farm A, such as reproductive disorders and mastitis, as well as injuries and bad body score and lame cows. The most serious health problems of the calves were diarrhea and bronchopneumonia of different etiology.

**Key words:** calves, dairy cows, health disorders, welfare

## Introduction

Among the different components of dairy cow welfare (health, feeding, housing and behaviour), the European Food Safety Authority (EFSA) reported that dairy cows are especially affected by poor health (EFSA, 2012). Welfare indicator includes many injuries that disturb health status of cattle causing pain through estimation of injuries like lameness and skin alterations; diseases through scrutinizing occurrence of coughing, nasal, ocular and vulvar discharge, hampered respiration, milk somatic cell count, diarrhoea, dystocia, downer cows and mortality, as well as pain induced by management procedures, such as dehorning and tail docking. In addition, many more diseases and disorders occur in farm conditions, reducing production and reproductive results and compromising welfare of different categories of cattle (Broom and Fraser, 2007; Hristov et al., 2012; Stanković et al., 2012). Health problems in dairy cows cause production losses (Rajala-Schultz et al., 1999), lead to treatment costs (Kossaiati and Esslemont, 1997), and are detrimental to animal welfare (FAWC, 1997). According to Fleischer et al. (2001) the incidence of health disorders has increased, possibly because they are associated with increased milk yield and production stress, as well as mortality rates (from 2 to 3.5% in 10 years), with locomotor disorders as one of the main causes (Thomsen et al., 2004).

Having in mind that many diseases often occur in dairy farms in Serbia, the objective of this paper was set to analyse welfare on three farms of different capacity with tied and loose system of rearing, particularly the principle of the good health in respect of the health disorders of these dairy cattle categories.

## Material and Method

Three farms of dairy cows (A, B and C) were observed for welfare and health disorders of dairy cows and suckling calves.

Farm A is farm with tied system of rearing, with 1100 cows, while farms B and C have 400 and 600 cows kept loose with outdoor pens, respectively. Calves are kept individually during the first 15 days and then moved to groups on farms B and C, while on farm A they are being kept tied in stalls on the other side of the feeding corridor opposite to their mothers during the first 5-7 days of life and being transferred to group pens with 5-10 calves each.

Data regarding welfare criteria and principles of dairy cows (health, feeding, housing and behaviour) were collected and analysed through Protocol of Welfare Quality (Anon., 2009). Health disorders of dairy cows and suckling calves were collected and statistically analysed by chi-square test ( $\chi^2$  test). Data collected on these farms was processed by Welfare Quality® scoring system, using specific mathematical operation - Choquet integral, enabling adequate assessment/scoring

of each measure, criterion and principle adequately, according to its relevance and relative contribution to overall assessment of welfare on the farm. According to scores, criteria and principles, overall assessment classifies the welfare on farms into four qualitative categories: not classified, acceptable, enhanced and excellent.

## Results and Discussion

Results of overall welfare assessment on dairy farms through criteria and principles are presented in table 1.

**Table 1. Welfare criteria assessment on three observed farms**

<i>Welfare criterion</i>	<i>Farm A</i>	<i>Farm B</i>	<i>Farm C</i>
<i>System of rearing</i>	<i>Tied</i>	<i>Loose</i>	<i>Loose</i>
Absence of prolonged hunger	100,00	100.0	100.0
Absence of prolonged thirst	100,00	3.0	3.0
Comfort around resting	8,60	45.1	45.1
Ease of movement	15,00	100.0	100.0
Absence of injuries	16,40	99.3	98.7
Absence of diseases	36,70	74.3	86.0
Absence of pain induced by management procedures	28,00	100.0	100.0
Expression of social behaviours	100,00	100.0	100.0
Expression of other behaviours	0,00	0.0	0.0
Good human-animal relationship	70,50	40.7	76.1
Positive emotional state	16,90	58.4	42.0
Welfare principle			
<i>Good feeding</i>	100,00	14,60	14,60
<i>Good housing</i>	11,00	65,40	65,40
<i>Good health</i>	21,30	80,40	89,20
<i>Appropriate behaviour</i>	18,20	28,50	28,30
<i>Overall welfare</i>	<i>Acceptable</i>	<i>Acceptable</i>	<i>Acceptable</i>

Using welfare quality protocol (Anon, 2009), welfare of dairy cattle on three farms were assessed as acceptable, meaning that provided welfare meet the minimum requirements of animals.

Principle of good feeding was assessed as excellent on farm A, while on farms B and C it was unsatisfying ( $\leq 20$  points) for inadequate number of water bowls. Proportion of cows in poor condition on the farms studied corresponds to the interval (0 - 6%), which Webster (2005) found on farms of the highest level of welfare.

The principle of good housing conditions was rated as unacceptable ( $\leq 20$  points) on farm A, while on the farms B and C as enhanced ( $\geq 55$  points), where cows had freedom of movement and better comfort, which is in accordance with results of Ostojić-Andrić et al. (2011) and Forkman and Keeling (2009).

Principle of provision of good health was rated as acceptable ( $\geq 20$  points) on farm A and farms B and C as excellent ( $\geq 80$  points). It should be have in mind that skin alterations are consequence of various causes, housing conditions, spacing and calving parity (Kielland et al., 2009) and unbalanced diet, creating predisposition (Schulze et al., 2009). The presence of injuries in dairy cows on farms B and C does not represent a significant risk factor for their welfare, while on the farm A were determined a significant proportion of cows with skin lesions. Results within the principles of good health show that the average incidence of diseases such as nasal or vaginal discharge, cough, difficult respiration, tachypnoea, mastitis, diarrhoea and lying cow syndrome are not a risk to the welfare on farms B and C (2.25 - 5.00%), according Forkman and Keeling (2009). On farms B and C the absence of disease criterion was enhanced, and on the farm A acceptable. Established poor hygiene of cows might not increase the incidence of mastitis corresponding to the results of Ellis et al. (2007).

Criterion appropriate behaviour on farms B and C was acceptable, while on farm A unsatisfactory. The expression of social behaviour was assessed on all farms as excellent. The relationships of animals to humans and cows co-specific interactions have a major impact on the health, productivity and welfare, being important indicators of welfare (Hemsworth and Coleman, 2011). Good man - animal relationship was rated as enhanced ( $\geq 55$  points) on farms A and C, while on farm B acceptable ( $\leq 55$  points). According to the results of positive emotional state criterion of cows, farms B and C had enhanced quality of welfare, opposite to non-classified of the farm A. Welfare quality on observed farms could be described as acceptable to enhanced, but there are welfare problems as consequences of inadequate rearing conditions, compromising animals comfort, hygiene and freedom to move. Reproductive disorders, such as dystocia, and mortality rate menace dairy cattle welfare.

Generally, welfare level of dairy cattle is influenced by system of rearing and farm capacity, being better on smaller farms regarding lameness and skin lesions. Loose system of rearing has positive influence on cows' welfare, their health and emotional status, possibility of movement and higher comfort (Ostojić-Andrić, 2013).

Observed health problems were related to reproduction, udder health, locomotion, and respiratory, metabolic, and digestive disorders. The data regarding reproductive disorders rate of dairy cows on three dairy farms were presented in table 2.

**Table 2. Reproductive disorders rate of dairy cows on three observed farms**

Farm	A	B	C
size	1100	400	600
System of rearing	tied	loose, with outdoor pens	loose, with outdoor pens
<i>Abortus</i>	4.723	0	0
<i>Ovarian cyst</i>	8.45	17.5	7.5
<i>Corpus luteum persistent</i>	136.27	0	0.83
<i>Endometritis</i>	60.27	65.25	5.00
<i>Pyometra</i>	9.00	0	0
<i>Febris puerperalis</i>	24.09	0	0
<i>Puerperal paresis</i>	9.45	5.5	1.67
<i>Mastitis</i>	85.36	8.75	3.33
<i>Partus gravis</i>	8.09	0	1.83
<i>Sectio Caesarea</i>	2.27	0	0
<i>Prolapsus uteri and vaginae</i>	3.00	0	0
<i>Retentio secundina</i>	35.27	25.5	2.50
<i>Rectovaginae</i>	0.9	0	0
<i>Tumor uteri</i>	0.9	0	0
<i>Urovaginae</i>	0.73	0	0
<i>Vaginitis</i>	5.73	0	0
<i>Thelitis</i>	0.9	0	0
<i>Udder quarters defects</i>	2.36	0	0
<i>Oedema uberis</i>	15.36	0	0
<i>Mumificatio and maceratio feti</i>	0.73	4.25	1.00

Differences between occurrence rate of reproductive disorders of dairy cows on three dairy farms were very significant ( $\chi^2=2901.71$ ;  $\alpha<0.01$ ). Not only that listed reproductive disorders cause many problems in reproduction and consequently in dairy production, but they seriously jeopardize welfare of cows as well, causing pain, limited movement possibility and loss appetite.

The data regarding locomotor disorders rate of dairy cows on three farms were presented in table 3.

**Table 3. Locomotor disorders rate of dairy cows on three observed farms**

Farm	A	B	C
System of rearing	tied	loose, with outdoor pens	loose, with outdoor pens
<i>Diagnosis</i>	%	%	%
<i>Arthritis and poliartthritis</i>	13.00	0	0
<i>Deformatio extremitates</i>	5	0	0
<i>Luxatio</i>	0.181	0	0
<i>Fracture</i>	0.9	0	0

Differences between three farms in of respect locomotor disorders occurrence rate of cows were found to be very significant ( $\chi^2=252.02$ ;  $\alpha<0.01$ ), corresponding to the principle of provision of good health, as well as differences between three farms in respect of skin and claws disorders occurrence rate of cows were found to be very significant ( $\chi^2=204.08$ ;  $\alpha<0.01$ ), presented in table 4.

**Table 4. Skin and claws disorders rate of dairy cows on three observed farms**

Farm	A	B	C
System of rearing	tied	loose, with outdoor pens	loose, with outdoor pens
<i>Diagnosis</i>	%	%	%
<i>Abcesus</i>	0.36		
<i>Phlegmona</i>	3.55	0	0
<i>Contusio</i>	0.73	0	0
<i>Vulnus</i>	3.82	0	0
<i>Panaritium</i>	6.45	0	0

The data regarding digestive and systemic disorders rate of dairy cows on three dairy farms were presented in table 5.

**Table 5. Digestive and systemic disorders rate of dairy cows on three observed farms**

Farm	A	B	C
System of rearing	tied	loose, with outdoor pens	loose, with outdoor pens
<i>Diagnosis</i>	%	%	%
<i>Cahexio</i>	50.91	0	0
<i>Diarrhea</i>	2.45	0	0
<i>Dislocatio abomasi</i>	8.64	0	0
<i>Indigestio</i>	5.73	0	2.50
<i>Intoxicatio</i>	5.73	0	0
<i>Enteritis</i>	1.45	0	0
<i>Hepatopatie</i>	3.64	0	0
<i>Ketosis</i>	29.91	0	0
<i>Meteorismus</i>	1.81	0	0
<i>Mors per apoplexio</i>	0.9	0	0
<i>Sepsis</i>	1.09	0	0
<i>Conjunctivitis</i>	0.181	0	0
<i>Bronchopneumonia</i>	5.27	0	0
<i>Scabies</i>	0.73	0	0

Differences between three farms in respect of digestive and systemic disorders occurrence rate of cows were found to be very significant ( $\chi^2=1152.31$ ;  $\alpha<0.01$ ). These disorders directly influence welfare of cows, due to the impact on principles of good health and good feeding.

The transition period is critically important to health and production of dairy cows. Milk fever, ketosis, retained foetal membranes, metritis, and displaced abomasum primarily impact cows during this period. Immunosuppression (*Mallard et al., 1998*) leads to increased susceptibility to environmental mastitis, with the greatest incidence around parturition (*Smith et al., 1985*).

According presented data, the majority health problems were observed in tied system of rearing, on farm A, such as reproductive disorders and mastitis, as well as injuries, poor body condition score and lame cows, which is in accordance with obtained welfare criterion good health. All of these findings are supported by previous investigations by *Stanković et al. (2014)*.

Mastitis and lameness are the most important diseases of dairy cows (*Bareille et al., 2003*), which was confirmed through this study. The main locomotion disorders included laminitis, under-run heel or sole, sole ulcer, wall abscess, digital dermatitis, white line disease, interdigital granuloma, etc. (*Shearer et al., 2002*).

The occurrence of health disorders during the transition period, such as ketosis, retained foetal membranes and subsequent metritis, or displaced abomasum and secondary ketosis result in lost milk production (*Wallace et al., 1996; Bareille et al., 2003*).

The most important problems of the welfare of cows in Serbia are related to housing with no outdoor outlets or pasture, occurrence of lameness, dystocia, downer cow syndrome and mortality, the manifestation of aggression between animals and bad stockmen attitude (*Ostojić-Andrić, 2013*). Early identification of injuries or disease is becoming difficult because surveillance is expected to decrease, due to use of automatic milking units and feeders that limits personnel requirements (*Frost et al., 1997*).

Significantly lower incidence of joint and udder injuries and less veterinary interventions were recorded if tied cows had possibility to move occasionally vs. cows constantly tied (*Ostojić-Andrić et al., 2011*), as well as clinical and subclinical mastitis rate (*Hristov et al., 2005*).

The data regarding health disorders rate of calves on three dairy farms were presented in table 6. Differences between three farms in respect of digestive and systemic disorders occurrence rate of health disorders of calves were very significant ( $\chi^2=184.23$ ;  $\alpha<0.01$ ). The most serious health problems of the calves were diarrhea and bronchopneumonia.

**Table 6. Health disorders rate of calves (up to 4 months old) on three observed farms**

Farm	A	B	C
Number	476	182	124
<i>Diagnosis</i>	%	%	%
<i>Omphalophlebitis</i>	1.05	0	0
<i>Indigestion</i>	0.84	0	0
<i>Diarrhoea</i>	30.25	54.95	16.13
<i>Bronchopneumonia</i>	98.74	28.57	9.68
<i>Arthritis and poliartthritis</i>	0.84	1.65	0
<i>Sepsis</i>	1.05	0	0

Calving can be a traumatic and risky event in the life of a calf. The most common cause of dystocia is excessively large calf birth weight and a resulting incompatibility of fetal-maternal size, especially at first calving (*Leslie, 2012*). The stress effects of a difficult calving greatly increase the risks of illness and death in young dairy calves. Difficult calving contributes almost 50% of all calf deaths (*Lombard et al., 2007*).

Calves, as all newborns are the most receptive category to pathogens, especially before colostrum intake. On farm A calves are kept tied in stalls on the other side of the feeding corridor opposite to their mothers during the first 5-7 days of life, even before they were offered colostrum, making them easy target for all pathogens in stalls environment through employees, birds, vehicles and open doors, which is common practice on many farms in Serbia.

Keeping good health is the most important condition of dairy cattle welfare. Health control measures include good hygienic, spatial and microclimate conditions of rearing, biosecurity on farms and during transport, programs for the control of major diseases, occurrence of lameness, claws care, control of mastitis and use of anaesthetics and analgesics as standard in operative procedure (SOP) of dehorning of the calves (*Hristov and Stanković, 2009; Anon., 2010; Ostojić-Andrić, 2013*).

## Conclusions

According obtained data, dairy cattle welfare of all of three dairy farms were assessed as acceptable, meaning that provided welfare conditions meet the minimum requirements of animals. Principle of provision of good health was rated as acceptable ( $\geq 20$  points) on farm A, while farms with loose system (B and C) overall health rated as excellent ( $\geq 80$  points).

On the farm A was determined a significant proportion of cows with skin lesions, while presence of injuries on farms B and C does not represent a significant risk factor for their welfare. Results within the principles of good health show that the average incidence of diseases such as nasal or vaginal discharge, cough, difficult respiration, tachypnoea, mastitis, diarrhoea and down cow syndrome



are not a risk to the welfare on farms B and C (2.25 - 5.00%). On farms B and C the absence of disease criterion was enhanced, and on the farm A acceptable.

Occurrence rate of reproductive, locomotor and skin disorders and digestive and systemic disorders of dairy cows and calves up to 4 months old were very different between three farms of different size and system of rearing, with  $\chi^2$ -values of 2901.71, 252.02, 204.08, 1152.31 and 184.23 respectively;  $\alpha < 0.01$ ). The most serious health problems of the calves were diarrhea and bronchopneumonia. According presented data, it is obvious that the majority health problems were observed in tied system of rearing, on farm A, such as reproductive disorders and mastitis, as well as injuries, poor body condition score and lame cows.

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## Najčešći zdravstveni poremećaji i dobrobit muznih krava i teladi

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## Rezime

Tri farme muznih krava (A, B i C) su analizirane u pogledu zdravstvenih poremećaja i dobrobiti krava i teladi. Na farmi A je zastupljen vezani sistem držanja sa 1100 krava, dok se na farmama B i C sa 400 odnosno 600 grla, krave drže slobodno.

Podaci o dobrobiti mlečnih krava (zdravlje, ishrana, smeštaj i ponašanje) su prikupljeni i analizirani primenom protokola za ocenu kvaliteta dobrobiti (Anon, 2009). Poremećaji zdravlja krava u laktaciji i teladi su prikupljeni i statistički analizirani hi-kvadrat testom ( $\chi^2$  test).

Dobrobit na sve tri mlečnih farmi je ocenjena kao prihvatljiva jer zadovoljava minimalne zahteve životinja. Princip obezbeđenja dobrog zdravlja je ocenjen kao prihvatljiv ( $\geq 20$  bodova) na farmi A, dok je na farmama sa slobodnim sistemom (B i C) ocenjen kao odlično ( $\geq 80$  poena). Pojava reproduktivnih, lokomotornih, digestivnih i sistemskih poremećaja mlečnih krava i teladi do 4 meseca starosti se veoma razlikovala između tri farme različite veličine i sistema uzgoja, sa  $\chi^2$ -vrednostima 2901,71, 252.02, 204.08, 1152,31 i 184,23, redom ( $\alpha < 0,01$ ). Prema iznetim podacima, češća pojava zdravstvenih problema je uočena u vezanom sistemu uzgoja, na farmi A, u pogledu reproduktivnih poremećaja, mastitisa, povreda, loše telesne kondicije i hromosti krava, kao i proliva i bronhopneumonija teladi različite etiologije.

## References

- ANON. (2003): Code of Recommendations for the Welfare of Livestock: Cattle. Defra publication. London.
- ANON. (2008): Introduction to the recommendations for animal welfare. Article 7.1.1. Pages 235–236 in Terrestrial Animal Health Code 2008. World Organization for Animal Health (OIE), Paris, France.
- ANON. (2009): Welfare Quality Assessment Protocols. Cattle Protocol without Veal Calves. <http://www.welfarequality.net/network/45848/7/0/40>.
- ANON. (2010): Animal Welfare (Dairy cattle) Code of Welfare. MAF Biosecurity New Zealand, Wellington.
- ANDERSON D.E., MUIR W.W. (2005): Pain management in ruminants. *Vet. Clin. Food. Anim.*, 21, p. 19-31.
- BAREILLE N., BEAUDEAU F., BILLON S., ROBERT A., FAVERDIN P. (2003): Effects of health disorders on feed intake and milk production in dairy cows. *Livest. Prod. Sci.* 83:53–62.
- BROOM D.M., FRASER A.F. (2007): Domestic animal behaviour and welfare, 4th Ed. CAB International, Oxfordshire, UK.
- EFSA (2012) Scientific Opinion on the use of animal-based measures to assess welfare of dairy cows. *EFSA Journal* 2012; 10(1):2554, 81 pp.
- ELLIS K.A., INNOCENT G.T., MIHM M., CRIPPS P., GRAHAM L. MC, HOWARD C.V., WHITE D.G. (2007): Dairy cow cleanliness and milk quality on organic and conventional farms in the UK. *Journal of Dairy Research*, 74, p. 302-310.
- FAWC (1997): Report on the Welfare of Dairy Cattle. Farm Animal Welfare Council (FAWC), London, UK.
- FORKMAN B., KEELING L. (2009): Assessment of Animal Welfare Measures for Dairy Cattle, Beef Bulls and Veal Calves. Welfare Quality Reports. Cardiff University. Sweden. p. 1-314.
- FLEISCHER P., METZNER M., BEYERBACH M., HOEDEMAKER M., KLEE W. (2001): The relationship between milk yield and the incidence of some diseases in dairy cows. *J. (Dairy Sci.* 84:2025–2035.
- FRASER D. (2008): Understanding animal welfare. Oral presentation. *Acta Veterinaria Scandinavica*. 2008, 50(Suppl 1):S1 doi:10.1186/1751-0147-50-S1-S1.
- FROST A.R., SCHOFIELD C.P., BEAULAH S.A., MOTTRAM T.T., LINES J.A., WATHES C.M. (1997): A review of livestock monitoring and the need for integrated systems. *Comp. Electr. Agric.* 17:139–159.
- GONZALEZ L.A., TOLKAMP B.J., COFFEY M.P., FERRET A., KYRIAZAKIS I. (2008): Changes in Feeding Behavior as Possible Indicators for the Automatic Monitoring of Health Disorders in Dairy Cows. *J. Dairy Sci.* 91:1017–1028.

- HEMSWORTH P.H., COLEMAN G.J. (2011): Human-Livestock interactions: the stockperson and the productivity and welfare of intensively farmed animals. 2nd edition, CAB International, Wallingford.
- HRISTOV S., STANKOVIĆ B., RELIĆ R. (2005): Klinički i subklinički mastitis u krava. *Biotehnologija u stočarstvu*, 21, 29-39.
- HRISTOV S., STANKOVIĆ B. (2009): Najznačajniji propusti u obezbeđenju dobrobiti životinja na farmama goveda i svinja. *Zbornik naučnih radova*, vol. 15 (3-4) 95-102.
- HRISTOV S., VUČINIĆ M., MAKSIMOVIĆ N., STANKOVIĆ B. (2007): Minimalni standardi o uslovima gajenja i dobrobiti goveda. U monografiji: "Dobrobit životinja i biosigurnost na farmama", Poljoprivredni fakultet, Zemun, 131-139.
- HRISTOV S., STANKOVIĆ B., DOKMANOVIĆ M. (2010): Standardi dobrobiti goveda i svinja. *Zbornik radova: Prvi naučni simpozijum agronoma sa međunarodnim učešćem, Jahorina 9-11. decembar 2010.* 143-150.
- HRISTOV S., ZLATANOVIĆ Z., STANKOVIĆ B., OSTOJIĆ-ANDRIĆ D., DAVIDOVIĆ V., JOKSIMOVIĆ TODOROVIĆ M., PLAVŠIĆ B., DOKMANOVIĆ M. (2011): Procena dobrobiti krava u slobodnom sistemu držanja. *Veterinarski glasnik*, Vol. 65, Broj 5-6. 399-408.
- HRISTOV S., STANKOVIĆ B., ZLATANOVIĆ Z. (2012): The most important indicators of dairy cows welfare evaluation. *Proceedings of the First International Symposium on Animal Science. Book I, 8-10 November 2012, Belgrade, Serbia*, 313-327.
- HRISTOV S., STANKOVIĆ B., OSTOJIĆ-ANDRIĆ D. (2014): Different approaches to assess the welfare of dairy cows with some results in Serbia. *Proceedings of the International Symposium on Animal Science 2014, September 2014, Belgrade – Zemun*, 320-328.
- KIELLAND C., RUUD L.E., ZANELLA A.J., ØSTERÅS O. (2009): Prevalence and risk factors for skin lesions on legs of dairy cattle housed in freestalls in Norway. *J Dairy Sci.*, 92 (11) p. 5487-96.
- KOSSAIBATI M.A., ESSLEMONT R.J. (1997): The costs of production diseases in dairy herds in England. *Vet. J.* 154:41–51.
- LOMBARD J.E., GARRY F.B., TOMLINSON S.M., GARBER L.P. (2007): Impacts of dystocia on health and survival of dairy calves. *J. Dairy Sci.* 90:1751-1760.
- LESLIE K. (2012): Health and Immune Function of Dairy Calves. *WCDS Advances in Dairy Technology (2012) Volume 24*: 177-188.
- MALLARD B.A., DEKKERS J.C., IRELAND M.J., LESLIE K.E., SHARIF S., LACEY VANKAMPEN C., WAGTER L., WILKIE B.N. (1998): Alteration in immune responsiveness during the peripartum period and its ramification on dairy cow and calf health. *J. Dairy Sci.* 81:585–595.
- OSTOJIĆ-ANDRIĆ D., HRISTOV S., NOVAKOVIĆ Ž., PANTELIĆ V., PETROVIĆ M.M., ZLATANOVIĆ Z., NIKŠIĆ D. (2011): Dairy cows welfare

- quality in loose vs. tie housing system. *Biotechnology in Animal Husbandry* 27 (3), 287-296.
- OSTOJIĆ-ANDRIĆ D. (2013): Ocena kvaliteta dobrobiti na farmama mlečnih krava. Doktorska disertacija. Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd.
- OSTOJIĆ-ANDRIĆ D. (2013): Ocena kvaliteta dobrobiti na farmama mlečnih krava. Doktorska disertacija, Univerzitet u Beogradu - Poljoprivredni fakultet, Beograd.
- RAJALA-SCHULTZ P.J., GRÖHN Y.T., MCCULLOCH C.E. (1999): Effects of milk fever, ketosis, and lameness on milk yield in dairy cows. *J. Dairy Sci.* 82:288–294
- REGULA G., DANUSER J., SPYCHER B., WECHSLER B. (2004): Health and welfare of dairy cows in different husbandry systems in Switzerland. *Preventive Veterinary Medicine*, 66, 247-264.
- SHEARER, J., BELKNAP E., BERRY S., GUARD C., HOBLET K., HOVINGH E., KIRKSEY G., LANGILL A., VAN AMSTEL S. (2002): The standardization of input codes for capture of lameness data in dairy records. Pages 346–349 in: Proc. 12th Int. Symp. Lameness in Ruminants, Orlando, FL. Online. <http://www.avis.org/proceedings/RumLameness/2002/toc.asp#state2> Accessed Apr. 20, 2007.
- SCHULZE W.H., WESTERATH K.A., LEACH H.R., KNIERIM U. (2009): Scoring of Cattle: Integument Alterations of Dairy and beef Cattle and Veal Calves. In: Assessment of Animal Welfare measures for dairy cattle, Beef Bulls and Veal Calves. Welfare Quality Reports No.11. Edited by: Forkman B., Keeling L. Cardiff University, Uppsala, Sweden. p.43-50.
- SMITH K.L., TODHUNTER D.A., SCHOENBERGER P.S. (1985): Environmental mastitis: cause, prevalence, prevention. *J. Dairy Sci.* 68:1531–1553.
- STANKOVIĆ B., ZLATANOVIĆ Z., HRISTOV S., MAKSIMOVIĆ N., BOŽIĆ A. (2014): Reproductive and related disorders on dairy farms with different levels of welfare quality. Proceedings of the International Symposium on Animal Science 2014, September 2014, Belgrade – Zemun, 329-337.
- THOMSEN P.T., KJELDSSEN A.M., SØRENSEN J.T., HOUE H. (2004): Mortality (including euthanasia) among Danish dairy cows (1990–2001). *Prev. Vet. Med.* 62:19–33.
- WALLACE R.L., MCCOY G.C., OVERTON T.R., CLARK J.H. (1996): Effect of adverse health events on dry matter consumption, milk production, and body weight loss of dairy cows during early lactation. *J. Dairy Sci.* 79(Suppl. 1): 205. (*Abstr.*).
- WEBSTER J. (2005): *Animal welfare: Limping towards Eden*. Blackwell Publishing.